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THE SUBSTITUTE AND THE EXCUSE: Growing Sustainability, Growing Sugarcane in São Paulo, Brazil

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On the PowerPoint slide, a graph showed deforestation rates in the Brazilian Amazon over the past century. Because of the charismatic role of Amazonian deforestation in climate change discourses, no one in the audience had to actually look to know that significant deforestation had occurred. This was especially the case because the audience mostly consisted of Brazilian scientists working on climate change mitigation. I was at this conference in São Paulo as an anthropologist from the United States studying such scientific work.

But then the presenter challenged this common deforestation narrative. He provincialized it, a move also familiar to this audience. He argued that few talk about the massive deforestation of Europe only a couple hundred years earlier, or the widespread environmental destruction in the Americas during European colonization before that. His point was that Brazil is used as a posterchild for deforestation, yet it was merely doing what other countries had done earlier for their own development.

The speaker then recounted the 1972 international climate meeting in Stockholm where "developing" countries like Brazil resisted the positioning of environmentalism as incompatible with national development (Hochstetler and Keck 2007). Environmentalism, development, and growth could, and needed to,

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go together. As the speaker continued, describing how Brazil's environmental policies have evolved since then (seeing stronger regulations that reduced deforestation rates significantly until recent right-wing administrations rolled this back), a version of his point still hovered over the talk and infused the entire conference. "Developed" countries could not define one-size-fits-all environmental policies. Sustainability was coupled with growth and development for these scientists who were also "concerned citizens" (Monteiro and Rajão 2017).

This article explores how the research practices of environmentally minded scientists in Brazil align with conceptualizations of growth and development. How do these practices configure new sociotechnical assemblages of sustainability and growth, including how sustainability and growth go together (Ong and Collier 2008)? Such assemblages include the concept of *sustainable growth*, but other permutations of sustainability/growth as well. And how do we assess whether or not these scientific agendas and sociotechnical assemblages reinforce growth-centric petro-extractivism? Scholars have critiqued notions of sustainable growth for reinforcing existing racialized and geopolitical asymmetries as well as extractive growth ideologies (Checker 2020; Howe and Boyer 2019), a critique I will continue to develop here. Other scholars have meanwhile studied ways of doing science that directly challenge environmentally and socially destructive industrial production processes. This has included work on agroecology (Rojas, de Azevedo Olival, and Spexoto Olival 2019; Oliver 2016), "selva" farming (Lyons 2020), anticolonial environmental science (Liboiron 2021; Murphy 2017a; TallBear 2014; Green 2020), environmental civic science (Wylie 2018), alter-engineering of hydrocarbon infrastructures (Shapiro 2021), degrowth (Escobar 2018), and "extraction without extractivism" (Ureta and Flores 2022). Yet this article instead stays in the thick of notions like sustainable growth, asking what we learn from scientists who do not work on alternative scientific frameworks directly. Like Andrea Ballestero (2019, 23), I find that for my interlocutors, "making a difference requires getting closer to, not distancing oneself from, what is already in place." I argue that while their science sometimes reproduces the hegemonic contexts within which it takes place, it can also nurture the possibility for otherwise. In other words, this article most broadly concerns actors within peripheralized Western imperial science (Vessuri 1988; Cesarino 2015) who potentially press on the grooves of the status quo while working in the thick of it.

To do so, this article reflects on encounters with São Paulo biologists leading research on renewable biofuels and materials, like bioplastic, made from sugarcane. Renewables using sugarcane, the infamous founding colonial plantation crop, illuminate the complexities and paradoxes of coupling sustainability and growth. Sugarcane-based biofuels have been produced at large scale in Brazil since the 1970s, but new scientific advancements could expand their scope and volume. Environmentalists, though, are concerned about the land-use and social impacts of sugarcane cultivation. Sugarcane was brought to the country in the 1500s, spurring slavery-based colonial industry, and over the past five centuries the crop has seen widespread dispossession of land, environmental destruction, and notoriously difficult, even deadly, labor conditions. Brazil still grows more sugarcane than any other country today. Would renewables promote further land use and exacerbate enduring social issues? Proponents of sugarcane renewables nonetheless maintain that especially with new scientific developments, these concerns are unwarranted and renewables would truly prove sustainable—as well as promote bioeconomic growth. A key variable in this logic is that these new scientific developments include making more sugar extractable from sugarcane, so that more sugar is produced per same area of land. This increases efficiency and, the thinking goes, sustainability. One form of growth, economic, is decoupled from another, land expansion.

Regardless of the actual feasibility of this decoupling (Parrique 2019), during my work with these scientists I was struck by such differentiations in kinds of growth: not only the vegetative/biological growth of the crop but also growth in land and resource use, industry growth, economic growth, national development, and, finally, sustainable growth. While it is not unexpected that a term like *growth* be so polysemous, I felt curious about how these meanings of growth often contradicted each other. This prompted me to look more closely at growth in scientists' practices around sugarcane, especially given that the very etymology of *growth* relates to plants and agriculture.

Take, for instance, the case of sugarcane maturation, which challenges expectations of a linear, proportional relationship between crop growth and productivity (i.e., more crop growth means more product). Maturation, or ripening, consists of the conversion of carbohydrates in the leaves into simple sugars in the stalk. Those simple stalk sugars are harvested to make refined sugar and biofuels, so maturation increases sugar/biofuels yield. Chemicals called maturants applied to fields near harvest promote maturation. Curiously, maturants work by impeding growth, as maturation is actually oppositional to growth. Maturants divert the plant's energy away from growth and toward maturation. Once, while explaining this to an anthropology audience in Brazil, I misspoke that chemical "killers" are applied to fields, as the Portuguese word for "killer" is similar to that for maturant. But as we laughed, I realized and exclaimed that it still made sense. These maturants *are* growth-inhibiting plant killers. Maturation begins to unpack the complexities of *sugarcane* growth as something distinct from *sugarcane industry* growth.

So sugarcane biological growth, curiously, differs from sugarcane industry growth. Is this simply due to *growth*'s polysemy, such that it isn't fair to assume biological and economic growth should be aligned in the first place? Why is it important to put these different growths on the same plane of analysis? I maintain it is not merely an academic leap to connect the biological mechanics of sugarcane growth to social configurations of capitalist growth (Roy 2018; Hartigan 2017). Sugarcane productivity and growth were closely linked to early capitalist productivity and growth. Sugarcane plantations proved central to the emergence of racializing extractive capitalism, and the biological specificities of cane and other crops continue to be more than incidental to formations of labor and production (Mintz 1985; Besky 2013). Similarly, crop health and cultivation have directly shaped conceptions of population health and governance (Hetherington 2020). As these scholars show, growth at molecular scales is worth analyzing alongside/as growth in broader conceptual domains.

Tracing this traffic between different domains and scales of growth within scientists' research practices sheds light on how these scientists enact various sociotechnical arrangements of sustainability and growth. Here, this tracing work constitutes following what I'm calling the "material of growth." The material of growth names the objects, substances, or ideas doing the growing itself, distinct from the mechanism of growth (e.g., *primitive accumulation*, or Anna Tsing's [2012] *scalability*, the key example indeed being sugarcane plantations in Brazil) though these are always related. The material of growth might be anything: a market or economy, but also a plant or molecule. Paying attention to materials of growth allows me to trace their contradictions, blurrings into, and divergences with each other. This in turn illuminates how they traffic with broader imaginaries around growth that blur and diverge too, even when the mechanism of growth does not appear to change. Analyzing materials of growth opens up new dimensions of growth's social lives that may otherwise prove too subtle to notice. In other words, tracing the materials of growth in sugarcane research makes for a method of understanding how visions of renewables are constituted by the traffic between biological, industrial, and economic growth. *I ultimately show that scientists' work on different materials of sugarcane growth enables different permutations of sustainability/growth, despite the similarity of their research practices at first glance.*

Below I will briefly situate this attention to materials of growth within current literatures. Then I will detail how my interlocutors' molecular biology research explicitly intervenes into sugarcane growth, in ways distinct from traditional breeding or genetically modified (GM) crops. My analysis consists not of descriptions of complex encounters but subtle shifts in understanding seemingly straightforward moments. These include mundane lab practices and times when scientists narrated their work to me or others (which were rarely just transfers of knowledge, but important performances of the science itself [Myers 2015]). This material is drawn from ethnographic fieldwork carried out between 2013 and 2022 in the state of São Paulo. I highlight two cases, showing how despite similar technical practices, scientists enact distinct materials of growth that seed various permutations of how sustainability and growth might come together. Specifically, the first case involves "sustainable growth," which, despite ideals of renewability, lays the molecular foundations for reproducing petro-extractivist growth. This happens through *substitution*, replacing oil with cane. The second case, with no explicit substitution, creates the conditions for other potential arrangements of sustainability/growth. This happens when scientists use sugarcane renewables as an *excuse* to develop other research outcomes. With this excuse, scientists work on sugarcane renewables and at the same time do not work on renewables. This working-but-not-working marks a way of staying in the thick of sugarcane renewables while also not committing to sugarcane fully. Working-but-not-working keeps people tethered to their existing conditions, but creates space for potentially doing something different in the future. This carries no guarantees for disrupting petro-growth, but it opens possibilities for otherwise while/through continuing work in the meantime.

In all, this article asks how specific materials of growth make sugarcane into a "capitalist species" today (Blanchette 2020). Staying with the trouble (Haraway 2016) of plant science, it asks what can be learned from sugarcane's molecules (Murphy 2017a; Myers 2015; Sanabria 2016; Agard-Jones 2014; Choy 2011) via scientists' attunements to them (Hartigan 2017; Reis-Castro 2021; Wanderer 2018; Helmreich 2009). By analyzing how Brazilian scientists' research aligns with (sustainable) growth, this article shows how minute technical practices establish the conditions for reinforcing the petro status quo and/or opening more pluripotent possibilities.

GROWTH AND ITS MATERIALS, IN BRAZILIAN SUGARCANE AND BEYOND

How do we understand growth in terms of sugarcane renewables when sugarcane biological growth and sugarcane industry growth are not only distinct phenomena but sometimes even at odds? Particularly when, in the meantime, growth is defined with concepts like development that often cut across and collapse biological and economic realms? In other words, growth is curious in being clearly polysemous at the same time that its many meanings are frequently transposed onto each other. As Tsing (2012, 506) asks, “Why have people called [capitalist] expansion ‘growth’ as if it were a biological process?” Biological growth is laminated onto social processes, following Carbon Imaginary biontologies (Povinelli 2016). Because it seems commonsense to overlay individual biological growth, population growth, and national economic growth, Murphy (2017b) requires a denaturalizing analysis to demonstrate how GDP is actually inversely related to increased birthrates (and thus why governments selectively discourage the growth of racialized populations). Julie Livingston (2019) similarly recognizes the seemingly paradoxical “self-devouring growth.” In this complicated traffic between biological and economic growth (Cooper 2008), at stake is how one understands the ramifications of scientists’ work on sugarcane growth for broader ideas of industrial growth and/as sustainability.

To empirically trace this traffic between domains and scales of growth, I follow how scientists variously intervene on and craft sugarcane’s material of growth. This attention to the material of growth builds on the scholars cited in the previous paragraph, who implicitly recognize various materials of growth, as well as scholars who analyze this more explicitly. For one, Hannah Landecker (2023) examines growth as not only an aim but an object in twentieth-century industrialized animal husbandry in the United States. This engendered a biochemical modernity “in which matter moves differently” (Landecker 2023, 79). Sandra Calkins (2019) shows how bananas in Uganda offer a distinct conceptualization of growth’s relationship with health. Timothy Mitchell’s (2011) analysis of carbon democracy illuminates oil as a material of growth engendering specific governance and epistemology. By focusing on the material of sugarcane growth in Brazilian labs, I show how scientific manipulations of molecular possibilities enable different permutations of sustainability/growth—the next potential stage in sugarcane’s centuries-long history of shaping economic futures.

Refined sugar is made by boiling down and purifying sugary sugarcane juice from pressed stalks. It was the original commodity that motivated sugarcane plantation/industry growth and continues to be important today. Sugarcane cultivation in Brazil started in the early 1500s as the foundation of a colonial economic system that utilized Indigenous and later African slave labor. Over the next several centuries the industry grew through land expansion enabled by deforestation in the northeast of the country, and through the laboring bodies, regularly driven to death, of millions of enslaved people (Eisenberg 1974). Increases in sugar production during this time came almost exclusively from increased land use and slave labor, rather than technological changes (Schwartz 1985). In the terms of this article, the material of growth was land and racialized laboring bodies.

Then in the late-nineteenth century, production rates increased as mills were industrialized, for example with steam-powered equipment (Eisenberg 1974). This introduced exponential changes in productivity, compared to the linear changes from increasing land and labor. I argue that sugar-processing productivity became a new material of growth at this time via industrial technology. More sugar could now be produced on the same amount of land with the same amount of labor, though land and racialized laboring bodies continued as growth materials as well. In 1888, slavery was abolished, replaced by, effectively, indentured servitude (Scheper-Hughes 1992). Around this time and into the twentieth century, sugarcane expanded into the whiter and richer southeast region, especially the state of São Paulo. Producers there utilized European immigrant labor to turn exhausted coffee plantations into sugarcane fields (Dean 1969), forming part of state whitening projects (Campos 2019). Sugarcane production in this region continued expanding into and devastating the Mata Atlântica rainforest. Production in São Paulo grew throughout the twentieth century, exceeding the Northeast in the 1950s. Many laborers from the Northeast started traveling south for the harvesting season in precarious labor patterns (Elias 2003).

In the 1970s, the industry expanded again when the military regime implemented a national sugarcane biofuels program (Nunberg 1986). Sugarcane production quadrupled within a decade through additional labor expansion, environmental destruction, and increases in productivity from breeding research (Eaglin 2022).[1] Biofuel consumption burgeoned, aided by the development of flex-fuel vehicles that can take either gas or biofuels and that today comprise almost all cars on the road in Brazil (Bennertz 2014). In all, land (i.e., devastated environments) and racialized laboring bodies as materials of growth continued throughout the twentieth century, alongside increases in sugar productivity (through industrialization and breeding) as an additional material of growth.

Biofuels (ethanol) are made by not refining but fermenting sugarcane juice, a relatively simple process akin to making beer or wine. Thus, sugary sugarcane juice is the key starting point in sugarcane commodity production, and this continues to inform how the material of sugarcane industry growth shifts and evolves. Research on renewables today newly targets biochemical features of sugarcane, constituting the extension of the "plantation network" into molecular biology labs (Labruto 2018). And yet, while scientists inherit this history, it is not always explicit in their understandings of how their work on sugarcane matters today, nor their ideas about the traffic between biological, economic, and other growth taking shape in and via the plant. This article takes up this work. Part of this includes critiquing notions of sustainable growth stemming from sugarcane work. Still, I also suggest that—without romanticizing sugarcane's materiality as some antidote to its history (Bond 2022), nor taking scientists' visions of sustainability/growth at face value—staying in the material and industrial thickness of sugarcane renewables reveals how and whether molecules matter for the complex empirical practices of seeding future possibilities. This constitutes the focus of the following ethnographic sections.

SUBSTITUTION (OR, THE RENEWAL OF PETRO-EXTRACTIVIST GROWTH)

Today, almost all cane in and around São Paulo is harvested and processed with machines, so labor productivity is managed increasingly through equipment maintenance and operator training. Land expansion has slowed with environmental regulations. The pace at which new sugarcane varieties increase yield has also slowed; breeding offers smaller and smaller yield gains, and genetically modified or transgenic cane remain uncommon due to technical difficulties. After a surge around the turn of the twenty-first century, sugarcane productivity has stagnated, as producers discuss with concern at every industry event.

As a result, academic scientists have promoted new kinds of solutions focusing on the plant's biochemistry and metabolism (Labruto 2018), even if the industry has been hesitant in taking up these still relatively experimental approaches. In this section I recount one such research agenda, developing "energy cane," exemplified by a scientist I call João.[2] Through attunement to the material of growth, I trace how energy cane distills sugar's value (energy) to the extent that the sugar in sugarcane is no longer even necessary. This forms part of João's vision of substituting oil with cane, advancing sustainable energy-driven growth. I argue critically that this nonetheless creates the conditions for reproducing the structural aspects of petro-extractivist growth, merely swapping in a different source material (cane in place of oil) rather than changing manufacturing or extraction arrangements. I call this sustainability via substitution.

By the time I spoke with João in 2017 I had already heard him present at several major events. The new director of a national biomass research center and still an active professor, he was quite busy but gracious with his time. As I sat down in his university office, he launched into an animated overview of the current state of biofuels and sugarcane in Brazil. His dedication to growing Brazil's bioeconomy made him an insightful interlocutor. He deftly traversed the granular details of his lab's research and broader visions of sugarcane's potential. This was less usual, though not totally exceptional, among the scientists I interviewed, who more often stayed within the technical realm. For João, the technical details of sugarcane's biochemistry were crucial to its potential for eco-friendly renewables, potential not just related to but one and the same as Brazil's bioeconomy potential.

Speaking quickly, João sketched diagrams of cane and chemical reactions on large pieces of blank paper in front of me. He pulled a fresh page every few minutes from a nearby stack. He was especially enthusiastic about a variety called energy cane, drawings of which now covered the paper in front of me (Figure 1). Energy cane, João declared, was the future of sugarcane in Brazil. It grows massively, up to three times taller than typical varieties, sometimes towering almost two stories tall. By expanding skyward, it allows for the production of much more biomass in the same area of land, making energy cane, in theory, more sustainable.

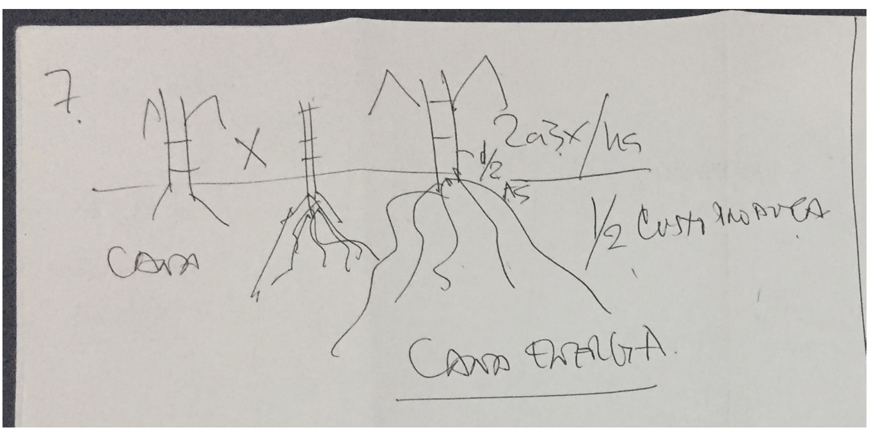

Figure 1. João's sketch of energy cane, which can grow "two to three times more per hectare" than standard cane. Photo by Katie Ulrich.

Before returning to my conversation with João, I'll note that one might think it odd, then, that few actually grow this spectacular energy cane right now. This is because per conventional processing methods, energy cane is not advantageous to the sugarcane industry. As another scientist playfully put it, energy cane is not an engineering marvel, but, in fact, a "crappier" version of cane. While sugarcane breeding historically has worked to maximize sugar production, energy cane is made to have *less* sugar. Less sugar means more biomass (leaves, stems, and other fibrous components), as less of the plant's energy is diverted to sugar synthesis, allowing the plant to grow and grow. So, energy cane has less sugar and more biomass, enacting a tradeoff between sugar and growth. Sugar and biomass/growth are not just not equivalent, but compete with each other. Yet the industry is built around sugar extraction. What happens now that energy cane literally decreases sugar content?

People like João nevertheless remain optimistic about energy cane because of new biochemical tools that allow the fermentation of biomass into bioproducts. These biochemical tools are the focus of João's research. He does not breed energy cane, which has been around for decades, but examines how to make it utilizable. After all, biomass does not equal utilizable biomass. Unlike manually pressing stalks to extract sugary juice, the process to make biomass fermentable is technoscientifically complex. João develops biochemical tools that make biomass extractable and utilizable, allowing energy cane's prolific biomass to be extracted and fermented into bioproducts. Energy cane's sugar-growth tradeoff becomes moot. Rather than making cane produce more sugar, along the lines of many GM/breeding efforts to increase yields in other agricultural crops, energy cane represents a different approach. This constitutes a subtle but important shift.

The desirability of energy cane works through taking what was ultimately valuable about sugarcane—being a source of energy, for both consumers of refined sugar and the yeast fermenting sugarcane juice to produce bioproducts—and making this no longer dependent on the stalk sugar. Cane being a source of energy no longer depends on *stalk sugar*, because João's biochemical tools make *biomass* into utilizable energy for fermentation. As a result, cane no longer needs sugar for the fermentation of bioproducts. Instead of *sugar*cane, we have *energy* cane. The shift in material of industry growth, then, is from sugar to energy, or from sugar to biomass-as-energy.

Biomass has been used for thousands of years as an energy source, with people burning wood for cooking and heat. Yet, once more, I argue that energy cane does something subtly different. While in Brazil sugarcane leaves and stems are indeed burned to make bioelectricity, energy cane enacts (Mol 2002) the biomass of leaves and stems as sources of a different kind of energy: a fermentation energy to make bioproducts. With energy cane, biomass becomes meaningful through a lens of a particular type of energy, energy to feed fermentation. Combustion shifts to fermentation. Fermentation enrolls new relationships between energy, matter (biomass), microorganisms (fermenting yeast), plants (cane), and humans (Landecker 2023).[3] This only becomes possible with biochemical tools like the ones João develops, which make biomass fermentable. Put differently, the value of the biomass is its ability to stand in for stalk sugar. This is quite peculiar because, again, biomass (the plant's growth) biologically and historically competes with sugar accumulation. "Crappy" energy cane turns this antagonism on its head, allowing biomass to take the form of energy for fermentation. Energy cane enacts a shift from biomass-as-growth to biomass-as-stand-in-for-sugar, because biomass becomes energy for fermentation. As a result, after 500 years cane no longer even needs stalk sugar, and promises 500 more years of capitalist commodity exchange.

The paradox of "crappy" energy cane thus reflects the new way biomass is enacted as a particular kind of energy, that for fermentation, thanks to emerging biochemical tools. Biomass could not always stand in for stalk sugar/energy in this way. This is helpfully captured in the unusual work it took to make the energy cane varietal cross. This did not form part of João's research, but I describe it because the energy cane cross reflects shifting materials of growth (sugar to energy) on the industrial level. In other words, it illuminates the traffic between molecular and industrial materials of growth. Tracing the history of the energy cane cross takes us to a museum, the Varietal Garden of a government-funded sugarcane research center in the state of São Paulo. The Varietal Garden is a large, fenced outdoor field that I visited one sunny fall day. As I walked through the gates of the Varietal Garden with Carla, the researcher showing me around, she described it as a "living museum" because it preserves hundreds of different varieties of sugarcane. These include historical varieties five hundred years old, from Brazilian sugarcane's infancy. Throughout the garden the varieties grow in neat rows, each labeled with their cross information, varietal traits, and historical notes. As we walked around, Carla motioned for me to compare the historical varieties with the modern ones, noting their height, stalk thickness, and coloring. You could visually appreciate the impact of breeding over the past several hundred years, she reflected.

The garden, as a living museum, mostly serves educational purposes for local high schoolers and international researchers. But the garden also served an important role in producing crosses of energy cane a few decades ago. Energy cane consists of a standard modern sugarcane variety (with high sugar content plus pest and disease resistance) crossed with one of the oldest varieties, *S. spontaneum*, which has high fiber (biomass) and low sugar content. This is the tradeoff between sugar and biomass that defines energy cane. Yet to create such crosses, this historical variety, *S. spontaneum*, was not simply growing in fields, available for breeding. Being high-fiber and low-sugar, the historical *S. spontaneum* variety essentially stands as the antithesis of what the industry has desired for hundreds of years, high sugar production. As we walked around the Varietal Garden more, Carla pointed out the thickness of stalks, thicker ones corresponding to higher sugar content. Since early on, she explained, breeders have always selected for the sweetest, thickest varieties. Thin, higher-fiber varieties were simply bred out of existence. To make the energy cane cross, they needed to use the historical, thin *S. spontaneum* variety preserved in the Varietal Garden museum. The researchers had to effectively go back in time to before modern industry had conditioned the genetics of cane to suit sugar productivity as the industry's preferred material of growth, that is, to before this material of growth was physically inscribed into the plant's genome and morphology. Indeed, at an industry conference a couple of years earlier, I had seen a slide depicting the energy cane cross. A large red X in the middle represented the crossing (through breeding), and to either side of the X stood the "parent" varieties. One side was an image of a contemporary variety, labeled "Year 2020," while the other side was the historical variety ("recovered" a hundred years ago), labeled "Year 1920." The present was literally crossed with history. The resulting energy cane was exceedingly tall, with strikingly thin stalks.

Thus, energy cane's very genetics and morphology are an inscription (Latour and Woolgar 1986) of this shift in the material of industry growth (Hartigan 2017). The energy cane of the future is a cross between the industry's conventional growth material, sugar productivity, and a growth material that the industry had devalued for centuries but that is now gaining new value through biochemical tools: fiber/biomass, made utilizable as energy for fermentation. This cross was only possible because of a museum that had motivations other than sugarcane industry growth and the national economic growth long tied to it. These other motivations, like education, led the museum to keep propagating this other yet-to-be material of growth in the form of the historical sugarcane variety.

Overall, this shift in material of growth—from sugar to energy, and therefore from sugarcane to energy cane—is related to a broader energopolitical shift (Boyer 2014) called second-generation biofuels, which utilize the leaves and stems of conventional cane in addition to the stalks to make fuel. This approach intends to make biofuels more sustainable, as more fuel results from the same amount of crop. Yet energy cane takes this second-generation shift in material of growth far beyond typical second-generation fuels. With energy cane, biomass actually supplants, not just supplements, stalk sugar.

What's at stake with biomass-as-energy supplanting sugar as the material of growth? What does it mean to João to promote energy cane rather than other varieties or biotechnologies? I will argue that energy cane creates the molecular conditions of possibility for a substitutive approach to sustainable growth: growing Brazil's sustainable bioeconomy by substituting oil with cane. This substitutive approach, though, potentially reproduces petro-extractivist growth.

Namely, for João, as he told me, "You have an energy cane that is a new petroleum." Energy cane could replace petroleum as a feedstock for fuels, plastics, and all other chemicals currently petro-based. Instead of refining these materials from oil, one can ferment them from energy cane using biotechnologies. João follows energy cane's new material of industry growth, energy that supplants sugar, to its ultimate conclusion. Sugar is supplanted by energy to the extent that now cane can even become oil, an energy feedstock. Energy cane's prolific biomass becomes the material of post-petroleum growth. Yet this post-petroleum growth has a *substitutive* nature (Badami 2021; Rudge and Ehrenstein, forthcoming). Substitution articulates similarity and difference (Hayden 2023). A substitute has to be similar enough to what it's replacing, yet some axis of difference also needs to be in place. I use *substitution* here to flag problematic practices within environmental efforts that keep petro-extractivist structures, such as endless production and growth, the same while displacing difference onto other sites, such as the chemical form of the feedstock (oil versus cane). In many instances of post-petroleum sustainability, the ghost of petroleum (Adams and Fortun 2021) remains in this "post-" formulation, as replacements seek to replicate what petroleum has provided. This is sustainability also known as the drop-in. Drop-in fuels or materials, constituting most renewables today, are those that can be smoothly dropped into existing infrastructures without much alteration otherwise.[4] Indeed, the actors spending the most money researching renewables globally are large oil and gas companies. This is precisely because drop-ins, in theory, don't require as great a change in production processes, extraction practices, and consumer-end behaviors, including overall growth in energy use. With substitutive drop-in sustainability, energy companies and their primary consumers, industrial manufacturers, can still follow resource- and waste-intensifying production/consumption routines that exploit environmental and human health. Different carbon sources (plants versus oil), similar practices and structures. This facilitates the continuity of petro-extractivism—which, after all, extends far beyond the technical extraction of oil to social systems and cultures (LeMenager 2014; Gómez-Barris 2017)—including its mandate for (bio)economic growth. Substitution, at once molecular and conceptual, masquerades similarity and continuity of problematic status quos behind the idea of desirable difference.

Energy cane's material of growth, biomass-as-fermentation-energy, thus constitutes a new instance of the convergence of the biological and economic that goes back to capitalism's sugarcane origins. It is a contemporary negotiation of the relationship between cane's biological growth and the material of industry growth. Cane's biological growth no longer has to be traded off with the accumulation of sugar, as these are collapsed in energy cane. Biomass can now take the energetic form of stalk sugar through biochemical technologies like those João researches, merging these materials of biological and industry growth. João's research shows how this happens at simultaneously molecular and conceptual levels. His are the technical practices through which sugarcane today can be made into oil. This becomes the basis of sustainable growth. However, it also creates the conditions for the renewal of petro-extractivist-growth via renewables. João still deeply cares about Brazil's environmental and bioeconomic futures, but this is the form his care takes (Hartigan 2017).

Many have similarly identified how renewable energy efforts, perhaps surprisingly, tend to maintain petro-extractivist systems (Caporusso 2019; Howe and Boyer 2019; Ahmann 2019; Shapiro 2021). The fossil fuel industry and government development apparatuses alike have adopted the phrase *sustainable growth*, often reproducing petro-extractivism's geopolitical asymmetries as well (Günel 2019; Cross 2019; Folch 2019; Jobson 2019). But, staying in the thick of Brazilian sugarcane research reveals further empirical complexities and possibilities. I take a cue from Duygu Kaşdoğan's (2020) analysis of algae waste-to-biofuels systems, which also shows that sustainability is often premised on extractivist growth imaginaries. However, Kaşdoğan argues that "blue degrowth," or the actual material of algae growth in my terms, can challenge this. In a similar way, the next section asks how paying attention to the material of growth in a second case of sugarcane renewables can expand understandings of sustainability/growth efforts. This second case centers around the research agenda of a different scientist, Gustavo, to "redesign growth" in sugarcane. Gustavo redesigns growth as he works to expand what counts as sugar in sugarcane. Expanding what counts as sugar is accompanied by a sensibility that renewables offer a "good excuse" for developing other research outcomes. Gustavo's work is thus not a direct alternative to petro-extractivism like agroecology or similar efforts. Instead, the political ramifications of Gustavo's work lie in its inherent tension: between being about something but also not being about that thing. This about-sugarcane-but-not-about-sugarcane sensibility means that Gustavo works within existing conditions in the meantime, but without a full commitment to the substitutive futures therein.

THE EXCUSE (FOR OTHER FUTURES)

Gustavo runs a lab at a university in the state of São Paulo, researching sugarcane and other biomass to the end of making renewables. Gustavo is well known in the field and has been integral to developing Brazil's contemporary sugarcane-molecular-biology network, which includes dozens of labs and several new research centers. He was an early director of the same national biomass and renewables research center that João now leads. Gustavo first welcomed me into his lab in 2013, saying that the social impacts of sugarcane biofuels were crucial to understand. He was enthusiastic about my work and always happy to sit down with a fresh pot of coffee and speak at length about sugarcane's history, economics, and politics in Brazil. When I returned over the next several years to catch up and interview him further, the experience of talking with him was always quite similar, though with an increasing heaviness as the mid-2000s-to-early-2010s surge in sugarcane funding ebbed and right-wing administrations enacted increasingly restrictive science funding policy as well as detrimental environmental policy.

After all, even though the previous section demonstrated how sugarcane biofuels can be enrolled to maintain petro-extractivist systems, Gustavo's deep concern for the environment was a main motivation for his current work. One of his projects throughout the years has focused on making renewables by utilizing not only the sugary juice from the stalk but also the leaves and stems (the second-generation approach). This approach, again, increases biofuel production without increasing land use, so Gustavo hopes to elevate sugarcane's sustainability. Thus, through technical practices similar to João's, he works to make biomass (leaves and stems) utilizable for sugar-based bioproducts. Yet key material-conceptual differences obtain in their approaches, as I will now examine.

The first thing I noticed while working in Gustavo's lab was the difference between his lab's two physical spaces. The first is accessed from the hallway of the main building. It's a biochemistry lab, with neatly organized benches and hoods, centrifuges gently whirring, and a little loft housing bulky analytical equipment. This lab smells sterile and chemical. The second space is another lab accessed from outdoors behind the main building. It's attached to a small greenhouse with rows of uniform plants in labeled tubs, so sunlight and the smell of dirt seep into this lab. I enjoyed spending my mornings writing notes in the greenhouse lab's loft, looking through window blinds down onto the plants.

Despite sugarcane and other crops actively growing in the greenhouse, their vegetative growth was not quite the object of the lab's investigation. Instead, Gustavo investigates what he calls "redesigning growth," which started after the plants were harvested. It was an ordeal of a morning post-harvest, with all lab members called on to stop their research and help. The benches of the sterile indoor lab became cluttered with buckets of dry ice and Dewars of liquid nitrogen, as researchers noisily ground leaves and stems in frozen mortars with frozen pestles, chatting while they did so. Hands were cold despite layers of gloves, but at least it was only a few hours until all the biomass had been turned into frozen powder and stored in plastic test tubes, awaiting biochemical processing and analysis. The samples were kept frozen during the entire process to prevent changes to the biomass's molecular structure.

The lab cared about preserving this molecular structure of biomass so that they could elucidate its precise contents and architecture. The test tubes of frozen, ground-up biomass were eventually biochemically processed for the analysis of this molecular structure. Processing involves days to weeks of adding various solvents to strip molecular layers off one by one to get to the base structure. Samples are washed with water after each step. I spent hours in the lab moving tubes back and forth between centrifuge, bench, and sink. But the final outcome proved suspenseful and exciting. After all the processing work, the samples were sent through a high-performance liquid chromatography machine, which spat out a graph of various peaks representing the molecular structure. Green and growing sugarcane leaves were transformed into frozen samples, then into small volumes of clear liquid, and finally into a digital line on a graph. Whereas sugarcane producers in the fields take pictures of each other holding an upright cane stalk to demonstrate its impressive size, in this lab, the delicate graph peaks provided a different way of visualizing growth—reflecting a different material of growth.

Understanding biomass's molecular structure allows Gustavo to develop biochemical tools, or even modify sugarcane, to make biomass easier to ferment into bioproducts. This often requires compromising the plant's structural integrity because, again, biomass is the basis of growth. For this reason Gustavo describes his efforts as "redesigning growth." In other words, Gustavo seeks to redesign growth, so that growth's molecular material (biomass) is amenable to not growth but different aims, i.e., being fermented into bioproducts.

This resembles energy cane's sugar-growth tradeoff, and Gustavo's techniques are indeed similar to and sometimes the same as João's biochemical tools. But, I suggest there is a subtle but important difference between Gustavo's and João's research, made clear by an analytical attunement to the material of growth. Whereas João's energy cane enacts biomass as fermentation energy to *supplant* stalk sugar, Gustavo's redesign of sugarcane growth *supplements* the stalk's sugar. He doesn't seek to replace it altogether. Gustavo *expands* what counts as sugar within the plant, rather than distilling sugar's value (energy). Energy cane enacts biomass-as-energy as a new material of industry growth, whereas Gustavo's redesigned sugarcane enacts "newly found sugars" as a new material of industry growth. These differing materials of growth enable various permutations of how these scientists conceptualize sustainability/growth. Even though João's and Gustavo's technical work is similar—they are both researching biochemical tools to utilize the leaves and stems (biomass) to make bioproducts more efficiently and sustainably—energy cane constitutes the molecular conditions of a "new petroleum" crop that seeds substitutive sustainable growth, while Gustavo's redesign of sugarcane growth has the potential to do something different. I will elaborate on this difference next.

The first hint about a difference between João's and Gustavo's research came in the form of Gustavo's nonchalance about energy cane. The several times I asked him about it, he would nod and affirm it is another variety, but he did not find it very interesting. One time, he went further by actually bringing up João, his friend and colleague. João is very excited about energy cane, Gustavo explained, but it is an example of the disconnect between different research goals. Much of the research on advanced renewables that Gustavo helped coordinate in the 2000s and early 2010s focused on sugarcane, but now there is this "different plant," energy cane. He implied that energy cane research differed enough to not be compatible with his research. Gustavo summed it up: "This [energy cane] is one path. The other is improving the productivity of sugarcane." For him, these constituted separate routes in fashioning cane's sustainable future.

How can we understand Gustavo's clear distinction in the context of very similar technical practices? There are many ways, as other scientists and even Gustavo himself later described, that research on energy cane and research like Gustavo's are in fact translatable to each other. Paying attention to the material of growth helps us see these shared technical practices in such a way that what seemed similar can now also be analyzed along an axis of difference. I suggest Gustavo's notion of separate paths speaks to the different materials of growth these research projects entail (biomass-as-energy with João's energy cane, and new sugar for Gustavo), and the different sensibilities around sustainability/growth that accompany such materials of growth. Specifically, in contrast to a cane that constitutes a "new petroleum" for ad infinitum extraction, Gustavo maintains that sugarcane biofuels are likely only a transitional technology. In fact, in his words, his research will be more useful for broader applications, like improving the productivity of food crops. His research on finding new sugar within the plant may prove most important for helping find new starch in corn, new sweet in sweet potato, or some other application altogether. This view is captured in his explanation to me, in one of our first conversations, that biofuels are a "good excuse" (in English) to make other biotechnologies. In expanding what counts as sugar, Gustavo expands how sugar may count in future outcomes, even if this entails going beyond sugar(cane) altogether. This notion of the "excuse" is key for Gustavo, and it came up repeatedly in our conversations over the years. I also identified it in the practices and imaginaries of other scientist interlocutors.

Finding new sweet in sweet potato and the like could be seen as the continuation of industrial agriculture's long history of extracting more and more value from crops and animals, central to capitalist expansion and growth. I do not argue that Gustavo's research repudiates this, but that the excuse creates the conditions for other possibilities *as well*. The excuse is defined by a productive tension of working on sugarcane renewables but also not working on sugarcane renewables. "Biofuels are just an excuse." In this working-but-not-working, one finds the chance to contest existing conditions, relations, and practices without floating away from their grounding. In this yes-and-no space, there is the possibility, though no promise, of laying the foundations for imagining sustainability and growth otherwise, without the pretense of being able to abandon sugarcane and start from *terra nullius* (Liboiron 2021; Ballestero 2019).

In this way, the excuse (sugarcane renewables) is not fully an empty signifier. J. L. Austin (1957, 10) devoted a lecture to the performative properties of excuses, explaining, "surely, it just the sort of situation where people will say 'almost anything.'" An excuse's content and truthfulness become less important than its form (Herzfeld 1982). For Gustavo, in contrast, the excuse of sugarcane renewables is not merely incidental or meaningless. Yet his work is simultaneously not exhausted within existing value regimes around cane. The excuse is not empty, but nor is its contents settled. This suggests an understanding of the excuse more in line with STS theorizations of the material-semiotic (Barad 2007). It is the contradictory fact of the excuse's content mattering and not mattering that creates interesting political possibilities here.

This contradictory mattering imbues Gustavo's excuse with a speculative temporal element. The excuse functions as a placeholder, a temporal hinge (Riles 2011); it allows one to wait for something else (not quite knowable) while still doing work in the meantime that is necessary to bring about that something else (McKay 2018). Within the waiting-but-working of the excuse, one might find time to negotiate new horizons (Petryna 2022). For this reason the excuse is related to other ideas about potentiality within science, such as the distinction between basic and applied research. Basic science is commonly understood as foundational, academic research that generates the potential for many as-yet-unknown, even surprising, insights and technological applications (Rheinberger 1997). *Basic science* is a term researchers like Gustavo, and João, use to describe their work. (Both rely on government-sourced, academic research grants.) Basic scientists may capitalize on hype, invoking fashionable or highly valued scientific topics to secure funding in an excuse-like modality (e.g., Lomnitz and Chazaro 1999). Temporalities of potential within science are also central to venture capital in biotech, where speculation itself makes for a significant if not primary commodity (Rajan 2006; Pollock 2019; Peterson 2014; Hayden 2003; Günel 2019). While basic science, hype, and even capitalist speculation can provide conditions for the excuse, I argue that the excuse is not reducible to these and widens how anthropologists and STS scholars can understand potential in a scientific context. The excuse is not only a temporality but also a tension that resists the future as a general form, unknowable or not, from totally inhabiting the present (Adams, Murphy, and Clarke 2009). In this tension, the future is both meaningful and not meaningful, just as the past and present are both meaningful and not meaningful. One can stay within the thick of complex sugarcane relations and *from within*, not from without, create the conditions for possibly imagining a future without sugarcane (as we know it, or at all). Gustavo works on sugarcane renewables, but he also doesn't.

Like how queer petro toxicity helps us imagine "a future that extends from but arrives at a place radically different from the present" (Davis 2022, 100), the excuse demonstrates how possibility can stem from unexpected places. This is similar to Ballestero's (2019) interlocutors' production of "future histories of water." These bureaucrats see their practices around water access as something that will become meaningfully legible, as historically important, from a not-quite-known position in the future. Theirs is a different kind of critique of current systems, a practice of "creating a difference without resorting to radical difference or the Otherwise," which entails "committing to the world as it is, but differently" (Ballestero 2019, 24). After all, Gustavo's research does not directly challenge petro-extractivist growth, like other efforts of agroecology or degrowth (Kallis 2018; Parrique 2019). The knowledge his research generates might (and probably will) be used within current production systems. He still finds Brazil's bioeconomic growth, or something like it, important. But I argue that this excusive modality of doing research creates space for other possibilities, such as, perhaps, excusive sustainable growth. As Isabelle Stengers (2010, 10) puts it, speaking of a scientist subjectivity I see as related to the excuse, "To resist a likely future in the present is to gamble that the present still provides substance for resistance." Sugarcane might become something else rather than oil, and Gustavo is not only open to this but oriented by it.

CONCLUSION

This article has considered similar sugarcane research agendas and argued that the ways different scientists have carried out and conceptualized their research practices have enabled different permutations of sustainability and growth. This insight becomes possible with attention to the materials of sugarcane growth that scientists work with. The first research agenda, exemplified by João, centers around energy cane. Energy cane draws out sugar's value as energy, configuring biomass to stand in for that energy, to the extent that stalk sugar is supplanted and energy cane becomes a "new petroleum." This creates the molecular conditions of possibility for a substitutive form of sustainability. The second research agenda, exemplified by Gustavo and named by him "redesigning growth," is characterized by working to find new sugar in sugarcane by expanding what counts as sugar. Expanding what counts as sugar might even take him beyond sugarcane renewables. Gustavo sees his research on sugarcane renewables as an excuse for other potential as-yet-unknown applications.

Energy cane and its substitutive sustainability can prove problematic because merely the carbon source is changed, not the petro-extractivist-growth system. *How might a scientist working on sugarcane biofuels, the carbon source, also/instead work toward changing the system?* The excuse is not a direct way of working on the system, but a way to work on sugarcane biofuels and also not work on sugarcane biofuels. The excuse forms a way of working on the carbon source but also not working on it. There might be other possibilities in that "not working." Gustavo's constitutes a different way of "doing" sustainable growth, using it to think about something else.

Looking out from the middle of the "seas of cane" covering the interior of São Paulo and the greater region—reflecting the crop's long but also recent history of ecological destruction and racialized labor violence, all propped up by an imperial science developed out of spaces like sugarcane plantations in the first place (McKittrick 2021)—it seems clear that techno-fixes and sustainable development are not the simple solution. Yet it also does not seem enough to say that scientists are merely cogs in the machine, or that they merely capitalize on eco-hype to get funding. Many care deeply about climate change and its uneven effects in the world, as well as the unevenness of the world and its effect on climate change. We need better analytical tools to understand the role of these scientists in society today. This article has aimed to do this, by analyzing "the ethical possibilities for the future that [scientists] inscribed in their technical craft" (Ballestero 2019, x). This article has attuned to the "material of growth" to empirically trace such possibilities, building a conceptual and ethnographic bridge between sociotechnical assemblages of sustainability/growth and anthropological work on materiality.

Ultimately, similar scientific practices and materials can make nonetheless different futures possible. Even then, the line between similarity and difference remains fine. Like João's and Gustavo's similar technical practices, the substitute and the excuse feel like two sides of the same coin. In one moment, they appear the same. Both reflect sugarcane's multiplicities, its becoming many other things than just refined sugar. Both concern change amid the status quo, energetic or scientific. Yet in another moment, the substitute and the excuse appear different again, laying the molecular foundations for distinct material-social arrangements. Their multiplicities take on distinct natures. As I hope to have shown in this article, the relationship between the substitute and the excuse is not a strict dualism. The very tension between them *is* their forms. Substitution is not oil but still oily. The excuse is sustainable growth but not sustainable growth. In scientists' everyday practices, the conditions are created for new sociotechnical permutations. In the end, the work toward an otherwise might be found even right in the middle of technocratic petro-extractivism, in addition to the vital sites of non-normativity (anti–white supremacy, anticolonialism, anticapitalism, antiheteronormativity) that have long challenged status quos.

ABSTRACT

Amid climate change and produced unevenness in geopolitical development, the question of how sustainability and growth might be brought together is a concern for many scientists of renewable energy in the Global South. This article explores answers *offered by scientists in São Paulo, Brazil, who make renewable fuels and materials from sugarcane. Drawing on ethnographic fieldwork and tracing the "material of growth," the article analyzes the traffic between sugarcane biological growth, industry growth, and economic growth in the context of the crop's history of colonial expansion and environmental destruction. It argues that some scientific practices lay the molecular foundations for a* substitutive *"sustainable growth" that replicates petro-extractivist growth. Others allow for further permutations of how sustainability and growth might go together, particularly when scientists use sugarcane renewables as an* excuse *to develop other research aims. The article contributes to anthropological understandings of science, energy cultures, technical practices, and transition.* [biofuels; sugarcane; energy transition; sustainability; substitution; excuse; growth; Brazil]

RESUMO

Em meio a um contexto de aquecimento global e de desigualdades produzidas no desenvolvimento geopolítico, a questão de como sustentabilidade e crescimento podem andar juntos é uma preocupação para muitos cientistas de energia renovável no Sul Global. Este artigo explora respostas concedidas por cientistas de São Paulo, Brasil, que produzem biocombustíveis e materiais renováveis a partir da cana-de-açúcar. Com base em trabalho de campo etnográfico e no rastreamento do "material do crescimento," o artigo analisa a circulação entre o crescimento biológico da cana-de-açúcar, o crescimento da indústria, e o crescimento econômico no contexto da história canavial de expansão colonial e destruição ambiental. Argumento que algumas práticas científicas lançam as bases moleculares para um "crescimento sustentável" substitutivo *que replica o crescimento petroextrativista. Já outras possibilitam novas configurações conjuntas de sustentabilidade e crescimento, particularmente quando cientistas usam produtos renováveis feitos a partir da cana-de-açúcar como* desculpa *para desenvolver outros objetivos de pesquisa. O artigo contribui para a compreensão antropológica da ciência, culturas energéticas, práticas técnicas, e transição.* [biocombustíveis; cana-de-açúcar; transição energética; sustentabilidade; substituição; desculpa; crescimento; Brasil]

NOTES

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1. Green Revolution interventions were typically less prominent than the country's robust domestic cane-breeding research (Eaglin 2022).
2. All interlocutor names in this article are pseudonyms. Conversations and interviews were conducted in Portuguese and translated by the author unless otherwise noted.
3. This shift is similar in form to what Hannah Landecker (2023) identifies as a shift in twentieth-century U.S. animal feeding from a focus on nutritional deficiencies to the industrialization of metabolism (fermentation is a type of metabolism). As she describes, this shift comprised "the wholesale remaking of streams of matter and energy among microorganisms, plants, animals, and humans" (Landecker 2023, 57).
4. Lab researchers like João mainly encounter this smooth *imaginary* of the drop-in. For an analysis of how drop-in biofuels are in fact not so smooth in reality, see Kean Birch and Kirby Calvert (2015).

REFERENCES

Adams, James, and Kim Fortun
2021 "Petro-ghosts and Just Transitions." *Public Books*, June 8.
Adams, Vincanne, M. Murphy, and Adele E. Clarke
2009 "Anticipation: Technoscience, Life, Affect, Temporality." *Subjectivity* 28: 246–65. https://doi.org/10.1057/sub.2009.18
Agard-Jones, Vanessa
2014 "Spray." *Somatosphere,* May 27.
Ahmann, Chloe
2019 "Waste to Energy: Garbage Prospects and Subjunctive Politics in Late-Industrial Baltimore." *American Ethnologist* 46, no. 3: 328–42. https://doi.org/10.1111/amet.12792
Austin, J. L.
1957 "A Plea for Excuses: The Presidential Address." *Proceedings of the Aristotelian Society* 57, no. 1: 1–30. https://doi.org/10.1093/aristotelian/57.1.1
Badami, Nandita
2021 "Shadows for Sunlight: Epistemic Experiments with Solar Energy in India." PhD dissertation, University of California, Irvine.
Ballestero, Andrea
2019 *A Future History of Water*. Durham, N.C.: Duke University Press.
Barad, Karen
2007 *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning*. Durham, N.C.: Duke University Press.
Bennertz, Rafael
2014 "The Brazilian Ethanol Car: A Sociotechnical Analysis." PhD dissertation, Universidade Estadual de Campinas.
Besky, Sarah
2013 *The Darjeeling Distinction: Labor and Justice on Fair-Trade Tea Plantations in India*. Berkeley: University of California Press.
Birch, Kean, and Kirby Calvert
2015 "Rethinking 'Drop-In' Biofuels: On the Political Materialities of Bioenergy." *Science and Technology Studies* 28, no. 1: 52–72. https://doi.org/10.23987/sts.55357
Blanchette, Alex
2020 *Porkopolis: American Animality, Standardized Life, and the Factory Farm*. Durham, N.C.: Duke University Press.

Bond, David
2022 *Negative Ecologies: Fossil Fuels and the Discovery of the Environment*. Berkeley: University of California Press.
Boyer, Dominic
2014 "Energopower: An Introduction." *Anthropological Quarterly* 87, no. 2: 309–33. https://doi.org/10.1353/anq.2014.0020
Calkins, Sandra
2019 "Health as Growth: Bananas, Humanitarian Biotech, and Human-Plant Histories in Uganda." *Medicine Anthropology Theory* 6, no. 3: 29–53. https://doi.org/10.17157/mat.6.3.658
Campos, Marcelo Roberto
2019 "Formas contemporâneas de trabalho escravo no cultivo da cana-de-açúcar no Brasil" [Contemporary Forms of Slave Labor in the Cultivation of Sugarcane in Brazil], master's thesis, Universidade Estadual Paulista.
Caporusso, Jessica
2019 "The State of Energy: Material Dimensions of 'Dirty' Renewables in Mauritius." *Shoring: The Society for the Diffusion of Useful Knowledge*, no. 4: 18–19.
Cesarino, Letícia
2015 "Estudos pós-coloniais da ciência e tecnologia: Desafios e possibilidades" [Postcolonial Studies of Science and Technology: Challenges and Possibilities]. *Reunião de Antropologia da Ciência e da Tecnologia* 2, no. 2: 1–15.
Checker, Melissa
2020 *The Sustainability Myth: Environmental Gentrification and the Politics of Justice*. New York: New York University Press.
Choy, Tim
2011 *Ecologies of Comparison: An Ethnography of Endangerment in Hong Kong*. Durham, N.C.: Duke University Press.
Cooper, Melinda
2008 *Life as Surplus: Biotechnology and Capitalism in the Neoliberal Era*. Seattle: University of Washington Press.
Cross, Jamie
2019 "The Solar Good: Energy Ethics in Poor Markets." *Journal of the Royal Anthropological Institute* 25, no. S1: 47–66. https://doi.org/10.1111/1467-9655.13014
Davis, Heather
2022 *Plastic Matter*. Durham, N.C.: Duke University Press.
Dean, Warren
1969 *The Industrialization of São Paulo, 1880-1945*. Austin: University of Texas Press.
Eaglin, Jennifer
2022 *Sweet Fuel: A Political and Environmental History of Brazilian Ethanol*. Oxford: Oxford University Press.
Eisenberg, Peter
1974 *The Sugar Industry in Pernambuco: Modernization without Change, 1840–1910*. Berkeley: University of California Press.
Elias, Denise
2003 *Globalização e Agricultura: A Região de Ribeirão Preto – SP* [Globalization and Agriculture: The Region of Ribeirão Preto – SP]. Editora da Universidade de São Paulo.
Escobar, Arturo
2018 *Designs for the Pluriverse: Radical Interdependence, Autonomy, and the Making of Worlds*. Durham, N.C.: Duke University Press.
Folch, Christine
2019 *Hydropolitics: The Itaipu Dam, Sovereignty, and the Engineering of Modern South America*. Princeton, N.J.: Princeton University Press.

Gómez-Barris, Macarena
2017 *The Extractive Zone: Social Ecologies and Decolonial Perspectives*. Durham, N.C.: Duke University Press.
Green, Lesley
2020 *Rock | Water | Life: Ecology and Humanities for a Decolonial South Africa*. Durham, N.C.: Duke University Press.
Günel, Gökçe
2019 *Spaceship in the Desert: Energy, Climate Change, and Urban Design in Abu Dhabi*. Durham, N.C.: Duke University Press.
Haraway, Donna
2016 *Staying with the Trouble: Making Kin in the Chthulucene*. Durham, N.C.: Duke University Press.
Hartigan, John
2017 *Care of the Species: Races of Corn and the Science of Plant Biodiversity*. Minneapolis: University of Minnesota Press.
Hayden, Cori
2003 *When Nature Goes Public: The Making and Unmaking of Bioprospecting in Mexico*. Princeton, N.J.: Princeton University Press.
2023 *The Spectacular Generic: Pharmaceuticals and the Simipolitical in Mexico*. Durham, N.C.: Duke University Press.
Helmreich, Stefan
2009 *Alien Ocean: Anthropological Voyages in Microbial Seas*. Berkeley: University of California Press.
Herzfeld, Michael
1982 "The Etymology of Excuses: Aspects of Rhetorical Performance in Greece." *American Ethnologist* 9, no. 4: 644–63. https://doi.org/10.1525/ae.1982.9.4.02a00020
Hetherington, Kregg
2020 *The Government of Beans: Regulating Life in the Age of Monocrops*. Durham, N.C.: Duke University Press.
Hochstetler, Kathryn, and Margaret Keck
2007 *Greening Brazil: Environmental Activism in State and Society*. Durham, N.C.: Duke University Press.
Howe, Cymene, and Dominic Boyer
2019 "Joint Conclusion to *Wind and Power in the Anthropocene*." In *Energopolitics: Wind and Power in the Anthropocene*, by Dominic Boyer, 194–198. Durham, N.C.: Duke University Press.
Jobson, Ryan Cecil
2019 "The Case for Letting Anthropology Burn: Sociocultural Anthropology in 2019." *American Anthropologist* 122, no. 2: 259–271. https://doi-org /10.1111/aman.13398
Kallis, Giorgos
2018 *Degrowth*. New York: Columbia University Press.
Kaşdoğan, Duygu
2020 "Designing Sustainability in Blues: The Limits of Technospatial Growth Imaginaries." *Sustainability Science* 15, no. 1: 145–160. https://doi.org/10.1007/s11625-019-00766-w
Labruto, Nicole
2018 "The Plantation Network: Brazilian Bioenergy Science and Sustainability in the Global South." PhD dissertation, Massachusetts Institute of Tehnology.
Landecker, Hannah
2023 "The Food of Our Food: Medicated Feed and the Industrialization of Metabolism." In *Eating beside Ourselves: Thresholds of Foods and Bodies*, edited by Heather Paxson, 56–85. Durham, N.C.: Duke University Press.
Latour, Bruno, and Steve Woolgar
1986 *Laboratory Life: The Construction of Scientific Facts*. Princeton, N.J.: Princeton University Press.

LeMenager, Stephanie
2014 *Living Oil: Petroleum Culture in the American Century*. Oxford: Oxford University Press.
Liboiron, Max
2021 *Pollution Is Colonialism*. Durham, N.C.: Duke University Press.
Livingston, Julie
2019 *Self-Devouring Growth: A Planetary Parable as Told from Southern Africa*. Durham, N.C.: Duke University Press.
Lomnitz, Larissa Adler, and Laura Chazaro
1999 "Basic, Applied, and Technological Research: Computer Science and Applied Mathematics at the National Autonomous University of Mexico." *Social Studies of Science* 29, no. 1: 113–34. https://doi.org/10.1177/030631299029001005
Lyons, Kristina
2020 *Vital Decomposition: Soil Practitioners and Life Politics*. Durham, N.C.: Duke University Press.
McKay, Ramah
2018 *Medicine in the Meantime: The Work of Care in Mozambique*. Durham, N.C.: Duke University Press.
McKittrick, Katherine
2021 *Dear Science and Other Stories*. Durham, N.C.: Duke University Press.
Mintz, Sidney
1985 *Sweetness and Power: The Place of Sugar in Modern History*. New York: Penguin.
Mitchell, Timothy
2011 *Carbon Democracy: Political Power in the Age of Oil*. London: Verso.
Mol, Annemarie
2002 *The Body Multiple: Ontology in Medical Practice*. Durham, N.C.: Duke University Press.
Monteiro, Marko, and Raoni Rajão
2017 "Scientists as Citizens and Knowers in the Detection of Deforestation in the Amazon." *Social Studies of Science* 47, no. 4: 1–19. https://doi.org/10.1177/0306312716679746
Murphy, M.
2017a "Alterlife and Decolonial Chemical Relations." *Cultural Anthropology* 32, no. 4: 494–503. https://doi.org/10.14506/ca32.4.02
2017b *The Economization of Life*. Durham, N.C.: Duke University Press.
Myers, Natasha
2015 *Rendering Life Molecular: Models, Modelers, and Excitable Matter*. Durham, N.C.: Duke University Press.
Nunberg, Barbara
1986 "Structural Change and State Policy: The Politics of Sugar in Brazil since 1964." *Latin American Research Review* 21, no. 2: 53–92. https://doi.org/10.1017/S0023879100015971
Oliver, Beatriz
2016 "'The Earth Gives Us So Much': Agroecology and Rural Women's Leadership in Uruguay." *Culture, Agriculture, Food, and Environment* 38, no. 1: 38–47. https://doi.org/10.1111/cuag.12064
Ong, Aihwa, and Stephen J. Collier, eds.
2008 *Global Assemblages: Technology, Politics, and Ethics as Anthropological Problems*. New York: John Wiley.
Parrique, Timothée
2019 "The Political Economy of Degrowth." PhD dissertation, Université Clermont Auvergne, Stockholms Universitet.
Peterson, Kristin
2014 *Speculative Markets: Drug Circuits and Derivative Life in Nigeria*. Durham, N.C.: Duke University Press.

Petryna, Adriana
2022 *Horizon Work: At the Edges of Knowledge in an Age of Runaway Climate Change*. Princeton, N.J.: Princeton University Press.
Pollock, Anne
2019 *Synthesizing Hope: Matter, Knowledge, and Place in South African Drug Discovery*. Chicago: University of Chicago Press.
Povinelli, Elizabeth
2016 *Geontologies: A Requiem to Late Liberalism*. Durham, N.C.: Duke University Press.
Rajan, Kaushik Sunder
2006 *Biocapital: The Constitution of Postgenomic Life*. Durham, N.C.: Duke University Press.
Reis-Castro, Luísa
2021 "Becoming Without: Making Transgenic Mosquitoes and Disease Control in Brazil." *Environmental Humanities* 13, no. 2: 323–47. https://doi.org/10.1215/22011919-9320178
Rheinberger, Hans-Jörg
1997 *Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube*. Stanford, Calif.: Stanford University Press.
Riles, Annelise
2011 *Collateral Knowledge: Legal Reasoning in the Global Financial Markets*. Chicago: University of Chicago Press.
Rojas, David, Alexandre de Azevedo Olival, and Andrezza Alves Spexoto Olival
2019 "Cultivating Alternatives to Authoritarian Populism in Amazonia." *Journal of Latin American and Caribbean Anthropology* 24, no. 4: 958–81. https://doi.org/10.1111/jlca.12454
Roy, Deboleena
2018 *Molecular Feminisms: Biology, Becomings, and Life in the Lab*. Seattle: University of Washington Press.
Rudge, Alice, and Véra Ehrenstein
Forthcoming "The Logic of Carbon Substitution: From Fossilized Life to 'Cell Factories.'" *Review of Agricultural, Food, and Environmental Studies*.
Sanabria, Emilia
2016 *Plastic Bodies: Sex Hormones and Menstrual Suppression in Brazil*. Durham, N.C.: Duke University Press.
Scheper-Hughes, Nancy
1992 *Death without Weeping: The Violence of Everyday Life in Brazil*. Berkeley: University of California Press.
Schwartz, Stuart
1985 *Sugar Plantations in the Formation of Brazilian Society: Bahia, 1550-1835*. Cambridge: Cambridge University Press.
Shapiro, Nicholas
2021 "Alter-Engineered Worlds." In *Making and Doing: Activating STS through Knowledge Expression and Travel*, edited by Gary Lee Downey and Teun Zuiderent-Jerak, 179–95. Cambridge, Mass: MIT Press.
Stengers, Isabelle
2010 *Cosmopolitics I*. Translated by Robert Bononno. Minneapolis: University of Minnesota Press.
TallBear, Kim
2014 "Standing With and Speaking as Faith: A Feminist-Indigenous Approach to Inquiry." *Journal of Research Practice* 10, no. 2: N17.
Tsing, Anna Lowenhaupt
2012 "On Nonscalability: The Living World Is Not Amenable to Precision-Nested Scales." *Common Knowledge* 18, no. 3: 505–24. https://doi.org/10.1215/0961754X-1630424

Ureta, Sebastián, and Patricio Flores
2022 *Worlds of Gray and Green: Mineral Extraction as Ecological Practice*. Berkeley: University of California Press.
Vessuri, Hebe M. C.
1988 "The Universities, Scientific Research, and the National Interest in Latin America." *Minerva* 24: 1–38. https://doi.org/10.1007/BF01102552
Wanderer, Emily
2018 "The Axolotl in Global Circuits of Knowledge Production: Producing Multispecies Potentiality." *Cultural Anthropology* 33, no. 4: 650–79. https://doi.org/10.14506/ca33.4.09
Wylie, Sara Ann
2018 *Fractivism: Corporate Bodies and Chemical Bonds*. Durham, N.C.: Duke University Press.