THE WENNER-GREN SYMPOSIUM SERIES

PATCHY ANTHROPOCENE: FRENZIES AND AFTERLIVES OF VIOLENT SIMPLIFICATIONS

GUEST EDITORS: NILS DURANDT, ANDREW S. MATHEWS, AND ANNA LOWENHAUPT TSING

Patchy Anthropocene: Landscape Structure, Multispecies History, and the Retooling of Anthropology
Learning to Read the Great Chernobyl Acceleration: Literacy in the More-than-Human Landscapes
The Tree Snail Manifesto
Coffee Landscapes Shaping the Anthropocene: Forced Simplification on a Complex Agroecological Landscape
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Wenner-Gren Symposium Supplement 20

Danilyn Rutherford

In June 1955, in Princeton, New Jersey, the Wenner-Gren Foundation hosted the International Symposium “Man’s Role in Changing the Face of the Earth.” There were only four anthropologists in attendance, two of whom, Sol Tax and Pierre Teilhard de Chardin, were trusted advisors of the Foundation. The rest of the seventy participants came in all flavors: there were mining executives, philanthropists, museum directors, botanists, geologists, historians, philosophers, physicists, government officials, the Director of Planning for the Housing Division of the Israeli Ministry of Labor, Darwin’s grandson, a scientist at the American University in Cairo, two social scientists from the University of Lucknow, a dean of the humanities, and a sanitation engineer. The organizers were the famous geologist Carl Sauer, the famous zoologist Marston Bates, and the even more famous city and regional planner and man of letters Lewis Mumford. The number of participants from outside of Europe and North America could be counted on one hand. There were no women other than some secretaries and a few of the participants’ wives.

As is still the tradition, the symposium participants distributed their papers ahead of time. Instead of presenting them, they talked freely around a set of shared themes. Discussionists summed up each day’s session, and the organizers provided a summary at the end. Along with fifty-three of the papers, the discussions are documented in the 1,236 page volume that came out of the event (see Thomas 1956). At the time of the symposium, there was anxiety in the air: about totalitarianism and the effects of industrial society on the human soul, and about the possibility of nuclear war. But what shaped the conversation in Princeton was a telling of history in which human mastery took center stage. William L. Thomas, the book’s editor, dedicated the volume to “George P. Marsh [the nineteenth-century diplomat and philologist whom many view as the United States’ first environmentalist] and to the earliest men who first used tools and fire, and to the countless generations between whose skillful hands and contriving brains have made a whole planet their home and provided our subject for study” (Thomas 1956:v). Even though they documented the costs of what they quaintly called “civilization,” those who met in Princeton assumed a vision of Earth as the house that man built.

As Anna Tsing, Andrew Mathews, and Nils Bubandt explain in the introduction to this special issue, other assumptions guided the fifteen anthropologists, three biologists, and two historians who gathered in Sintra, Portugal, on September 8–14, 2017 (fig. 1). So different, the picture painted by this symposium, in which cattle act as agents of colonial expansion and anticolonial resistance (see Ficek 2019); in which snails seduce scientists, spur activism, and launch the careers of indigenous scholars (see Hadfield and Haraway 2019); in which underground giants sculpt the earth and shape the imaginations of romantic geologists and Bangladeshi farmers alike (see Khan 2019). So different, the vision of the modular simplifications that gave rise to our modern, industrialized world, and the feral proliferations they spawned, born of the violence that created these landscapes, yet evading the order it imposed. Anthropology did more than host a party of disciplinary strangers and nonacademic movers and shakers in this symposium. In calling for a retooling of the discipline, the organizers invited their colleagues to lead the way in pioneering a new way of noticing the social relations, cutting across species, that structure more-than-human worlds. They called for observations that were specific, but not parochial, that documented both damage and hope. A patch, the organizers explained, is a structured element of a broader surround, like a stand of trees growing in a prairie or a breach opened in a forest by an animal trail or a road. They called for an approach to the Anthropocene that attends to its patches: “the uneven conditions of more-than-human livability in landscapes increasingly dominated by industrial forms” (Tsing, Mathews, and Bubandt 2019).

The discussions in Sintra unfolded in six sessions. Naveeda Khan and Atsuro Morita kicked off the proceedings with a journey into the deep past and contingent future of two major deltas. Khan drew on her research among char dwellers in Bangladesh to explore what it means to place a human present in the context of geological time, drawing together the writings of the Romantic poet Novalis and the insights of scientists and villagers on the role of earthquakes in creating their riverine worlds (see Khan 2019). Morita played with the tension between the stripped-down models embraced by hydrologists and their everyday life in places where urban development is
just as consequential as the dynamics they were trained to ob-
serve in causing floods (Morita and Suzuki 2019). If the first
rubric was eventful landscapes, the second was industrial con-
centrations, explored through a pair of papers focused on the
unexpected effects of the industrial production of three domes-
ticated species: salmon (Heather Swanson), chickens (Frédéric
Keck), and coffee (Ivette Perfecto). In each case a violently sim-
plified landscape unleashed boundary-breaching forces: farmed
salmon, outcompeting wild salmon in the industrialized wa-
ters of the Columbia River (see Swanson 2019); the SARS virus
and spirits in and around the industrial chicken farms of Hong
Kong (see Keck 2019); leaf rust on plantations and smallholder
coffee holdings in Central America (see Perfecto, Jiménez-Soto,
and Vandermeer 2019).

A further exploration of these feral effects followed indus-
trial concentrations, with three papers focused on creatures of
empire that both threaten and sustain local worlds. Rosa Ficek
brought us cattle, agents of capital and colonialism in the New
World but also unexpected allies of their opponents, from es-
caped slaves, who sold the hides of errant cattle in what is now
Puerto Rico, to Panamanian environmentalists, who managed
to halt road building in a protected forest by pointing to the
diseases the free passage of cattle could bring (see Ficek 2019).
Jacob Doherty brought us storks, which serve as the avian in-
frastructure of Kampala’s waste system, despised, yet essential
to the functioning of this metropolis, like the human waste
pickers who join the birds in processing the filth (see Doherty
2019). Michael Dove gave us three snapshots from the Indo-
Malay region, where species and farming systems targeted by
colonial managers have survived in the face of plantation agri-
culture, with early colonial kings, late colonial rubber producers,
and contemporary smallholders conjuring alternative visions of
a cultivated world (see Dove 2019).

Less fortunate have been many species of Pacific tree snail,
studied by the biologist Michael Hadfield, who relates a life-
time spent exploring and defending these creatures and their
delicate island homes. Donna Haraway’s companion piece riffs
on the themes raised by Hadfield’s extraordinary life among
snails and their comrades, pointing to the co-emergence of a
politicized scientist and a threatened species, struggling to build
a livable future against all odds (see Hadfield and Haraway 2019). Vanessa Agard-Jones broke important ground in her exploration of chemical kinship in Martinique, where pesticides seep into human bodies and set new terms for more-than-human politics and social bonds. Historian Kate Brown complicated our picture of a crisis we thought we knew well, showing how the nuclear disaster at Chernobyl was merely a punctuation mark in a long history of damage—to trees, to communities, to ways of life (see Brown 2019).

Eduardo Viveiros de Castro and Natasha Myers brought the conversation to a close, not with optimism but with a tempering of the vision of global apocalypse inspired by some discussions of planetary crisis. Viveiros de Castro spoke of ontological anarchy and the potential of indigenous world-making to disrupt dominant models (see Viveiros de Castro 2019). Myers documented the deep histories oak trees and their First Nations companions are bringing into play to shape the future of a Toronto park. Yen-Ling Tsai, who could not be present, sent along a brochure introducing her project in queer farming in the rural outskirts of Taipei, where she is involved in a collective creating new forms of kinship among humans, rice plants, and snails (see Tsai 2019). More than just a set of case studies, the essays that resulted from this provocation add up to a shared conclusion. The house that man built is not just his home, nor is man the only builder. Anthropology is in a perfect position to document the Anthropocene’s entanglements, injuries, and lines of flight.

At Wenner-Gren, we are always on the lookout for good topics for symposia. We are committed to an inclusive vision of anthropology. We are also committed to the proposition that anthropology has something important to say about the range of problems currently facing our world. In the next few years, we plan to host symposia focusing on one or the other aspect of our mission. Some will create new, field-spanning conversations that expand our understanding of what anthropology is or could be. Others will provide a setting for bold and substantive collaborations between anthropologists and scholars in other disciplines. If you have questions or suggestions, we would love to hear from you. For information on the Wenner-Gren Foundation, the symposium program, and what makes for a good symposium topic, see our website at http://www.wennergren.org/programs/international-symposia.

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Patchy Anthropocene: Landscape Structure, Multispecies History, and the Retooling of Anthropology

An Introduction to Supplement 20

by Anna Lowenhaupt Tsing, Andrew S. Mathews, and Nils Bubandt

The Anthropocene deserves spatial as well as temporal analysis. “Patchy Anthropocene” is a conceptual tool for noticing landscape structure, with special attention to what we call “modular simplifications” and “feral proliferations.” This introduction suggests guidelines for thinking structurally about more-than-human social relations; “structure” here emerges from phenomenological attunements to specific multispecies histories, rather than being system characteristics. Indeed, we discuss “systems” as thought experiments, that is, imagined holisms that help make sense of structure. Ecological modeling, political economy, and alternative cosmologies are systems experiments that should rub up against each other in learning about the Anthropocene. We address the misleading claim that studies of nonhumans ignore social justice concerns as well as suggesting ways that ethnographers might address “hope” without rose-colored glasses. This introduction offers frames for appreciating the distinguished contributions to this supplement, and it traces key changes in anthropological thinking from the time of this supplement’s predecessor, the Wenner-Gren Foundation–sponsored 1956 volume, Man’s Role in Changing the Face of the Earth. Rather than interrogating philosophies of the Anthropocene, the supplement shows how anthropologists and allies, including historians, ecologists, and biologists, might best offer a critical description.

Coffee rust (Hemileia vastatrix) is a fungus that grows on coffee leaves, weakening and sometimes killing the bushes and reducing coffee production. The rust evolved in East Africa along with coffee. But research suggests that the global spread of coffee rust as a pest is marked by its special affinity for plants grown in unshaded monocrop production—that is, industrial plantations. Rust spores probably crossed the Atlantic Ocean from Africa to Central America in high stratospheric winds, and by the mid-1980s rust was reported sporadically from most of the coffee-growing Americas. However, it did not cause an epidemic until 2012. From trees in industrial plantations, it spread to smallholder farms, where coffee is grown with other plants and under shade. Although shady polyculture reduces wind and therefore slows the spread of the fungus, once coffee rust began its mighty spread, that was not enough. Rust proliferated across the landscape (see the paper in this issue by Ivette Perfecto, M. Estelí Jiménez-Soto, and John Vandermeer [2019]).

The story of how coffee rust spread globally is a story of “patchy Anthropocene,” that is, the uneven conditions of more-than-human livability in landscapes increasingly dominated by industrial forms. The contributions to this special issue seek to recalibrate the tools of anthropology to equip ourselves to study these uneven landscapes. We suggest that by broadening our notions of social relations into more-than-human space and time, anthropology may recapture what it does best: attending to specificity without being parochial. The multidimensional crises of our times call for an anthropology, we propose, that takes landscapes as its starting point and that attunes itself to the structural synchronicities between ecology, capital, and the human and more-than-human histories through which uneven landscapes are made and remade. Coffee rust offers an example of what we mean here, for coffee rust only became a serious pest—like so many of the plagues and predicaments of our time—in the affordances of specific landscape forms. The coffee rust fungus has been around for a long time. It took the plantation form, with its perilous ecological simplifications, to allow the fungus to become an epidemic and to proliferate outside the plantation. The rust spread across coffee-growing land-

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scapes around the world, finding traction wherever there are unshaded monoculture plantations. This specification marks the unevenness to which patchiness alerts us. Plantations are elements of a topography of difference: inside are scenes of modular discipline; outside life—human and nonhuman—continues in its unruly riot, but now swept by plantation-encouraged plagues. Tracing the multispecies socialities and histories that both shape and become shaped by such landscape differences, we argue, is the best starting point for an anthropology of the frenzied, accelerated conditions of anthropogenic life sometimes called the Anthropocene.

Despite criticisms of the term “Anthropocene,” it seems likely that the concept—in all its unruly polysemy—will continue to inspire interdisciplinary conversation for some time (Swanson, Tsing, and Bubandt 2015). Celebratory, homogenizing and essentializing portrayals of the Anthropocene (and of the anthropos that is imagined as its sole agent) have caused many critics within the human sciences to argue against the concept (Demos 2017; Malm and Hornborg 2014; Moore 2015). Our approach is different. It is one of critical and curious engagement rather than either celebration or rejection. It is one of attention to specific landscape histories and structures rather than a study that begins and ends with the planet as its unit of analysis. We believe that anthropology has much to offer to the study of phenomena glossed under the term “Anthropocene.” The Anthropocene debate, in turn, pushes anthropology in new directions, challenging us to look at our object of study and at the lives of those with whom we study anew. We humans are suspended in many webs that go far beyond those of signification, in webs that human animals are far from alone in weaving (pace Geertz 1977:5). Studying the structures and histories of such multispecies webs in a time of global environmental frenzy means thinking about the suspension of human life in more-than-human landscape histories in new methodological and transdisciplinary ways. It means learning to think structures and systems differently, and it means being willing to reconsider whether anthropology is and should only be a “minor science” (Marcus and Pisarro 2008), a science content to deconstruct hegemonic forms of knowledge and study the world “otherwise.” Such deconstructions of hegemonic universal claims about the world are a critical and crucial dimension of anthropology. But we claim that dispatches from specific sites, which conclude that “just-here-where-I-did-my-fieldwork,” everything is different, are no longer enough. Everything is arguably different in every place now. How are we to understand this radical difference when it happens both site specifically and on a planetary scale? When radical difference is simultaneously a matter of human ontology and multispecies survival? In the face of the challenges of the Anthropocene, anthropology must dare to be more than the voice of parochial alterity; dare to allow anthropological stories of the “otherwise” into concrete transdisciplinary conversations about planetary structures that “change everything” (Klein 2015). We need to reclaim, in a new register, anthropology’s heritage of daring to make big claims about humans and about the worlds that humans coinhabit with others instead of being content to deconstruct such claims. But we have to make such claims with all the circumspection that also is the trademark of anthropology. The Anthropocene is a gift to anthropology, but without careful anthropological reflexivity, it is, as Bruno Latour (2014) suggests, a poisoned gift. How, then, to go about it? If this is the question that lies at the heart of the current conjuncture between anthropology and Anthropocene, “patchy Anthropocene” is the beginning of our answer.

This special issue is a collection of stories from a patchy Anthropocene, ethnographies of contemporary forms of simplification and proliferation that are reshaping human and nonhuman life in radically new ways. It assembles a selection of anthropologists, historians, biologists, and ecologists who bring both critical distance and empirical curiosity to their study of the state of the world, in its uneven patches and its dynamics of more-than-human livability.

In this introduction, we outline five ways to make “patchy Anthropocene” come to life as an analytic tool:

1. **Noticing landscapes shows us Anthropocene patches.** We introduce the term “landscape structure” for observations of the patterns of human and nonhuman assemblages as these emerge historically. While the history of anthropological theory has taught anthropologists to think of structures as components of systems (and in recent decades to be suspicious of both as a result), we separate them analytically. While we are cautious about systems-thinking (see below), structures are for us phenomenological markers of heightened field sensibility. Landscape structures catch our attention as form coming into being. A phenomenological attunement to landscape forms as well as to beings-in-landscapes allows multispecies histories to come into view.

2. **Two kinds of landscape structures are key to the anthropogenic disturbances we call Anthropocene: “modular simplifications” and “feral proliferations.”** Plantations are an example of modular simplifications; plantation-encouraged diseases are an example of feral proliferations. Anthropocene patches emerge in the relationship between simplifications and proliferations. Tracing these relations can show us just how and why Anthropocene landscapes are so proliferous and so treacherous.

3. **Systems are thought experiments with which to make sense of structures.** Patchy Anthropocene juggles multiple kinds of systems-making as well as multiple kinds of landscapes. Earth systems scientists gave us the concept of the Anthropocene as a system (Rockström et al. 2009). The social sciences have responded with alternative kinds of systems-thinking, such as political economy (Moore 2015). In either case, analysts tend to pick one kind of systems-thinking and argue that it is fully adequate to know the world. In contrast, we approach systems through what Eduardo Viveiros de Castro (2019) calls “ontological anarchy.” Many kinds of systems deserve to rub up against each other in understanding the patchy Anthropocene—not only ecological models and theories of political economy but also what we might call, for want of a better word, nonsecular cosmologies.
4. Can we acknowledge catastrophe while also imagining possibility? Jonathan Lear (2006) calls such imagining “radical hope.” Thought work of this kind gains traction through the specificity of cosmology and circumstance. The Anthropocene may be planetary, but our grip on collaborative survival is always situated—and thus patchy.

5. “Patches” are sites for knowing intersectional inequalities among humans. An anthropology of a patchy Anthropocene needs to be “people-focused” and, at the same time, engaged with multispecies relations. Throughout history, humanitarian calamities and global inequalities have been enacted through nonhuman agency that reacts to human design. Consider, for instance, the environmental justice crisis from radioactivity to toxic wastes (Bullard and Wright 2012; Johnston and Barker 2008). Patchy Anthropocene brings the legacies and tools of social justice–based analysis into Anthropocene studies. Yet this double focus requires a broadening of what “politics” and “critique” is in anthropology. It requires rethinking anthropology’s anthropocentrism while insisting that people matter, still.

The rest of our introduction explains these points. The papers in the special issue are organized to speak to these issues; however, in recognition that each paper addresses many issues, the discussion that follows draws from papers outside their table-of-contents organization.

Noticing Landscapes Shows Us Anthropocene Patches

“Patch” is a term we borrow, and modify, from landscape ecology; there, “landscapes” are units of heterogeneity whose components—at any scale—are patches (White and Pickett 1985; Wu and Loucks 1995). Patches show us landscape structure, that is, morphological patterns in which humans and nonhumans are arranged. A forest, a city, or a plantation: each of these is a landscape structure. We recognize these landscape structures through observations, comparisons, and attunements; landscape structures may be analyzed as part of systems, whether cosmologies, ecological models, or political economies, but they need not be.

Humans have shaped landscape structure since the origin of our species (e.g., Redman et al. 2004); however, the great ecological shifts of the Anthropocene require special attention to the landscape disturbances of imperialism and industry. European colonialism depended on landscape structures such as deepwater harbors and resource plantations. Global capitalism spreads fossil fuel–burning factories and container shipping. The post–World War II Great Acceleration has intensified the making of imperial and industrial landscape projects, which brings on the Anthropocene.

Noticing landscape structure is not new to anthropology. Think, for instance, of E. E. Evans-Pritchard’s (1940) classical study of the way ecological difference shaped the Nuer cow complex or of Clifford Geertz’s (1963) study of colonial history and “patchy” agricultural intensification in Indonesia. Yet in recent years, however, many anthropologists have become so wrapped up in our interlocutors’ cosmologies and concepts that we have stopped looking at the landscape for ourselves. We have lost the habit of noticing through our own observations of the world in addition to conversations with human interlocutors (Mathews 2018). The Anthropocene is a wake-up call urging us to reinvent observational, analytical attention to intertwined human-and-nonhuman histories.

Several papers in this special issue show us how to better “read” the landscape. Kate Brown (2019) takes us to the Chernobyl exclusion zone. How shall we assess the effects of radioactivity? Brown proceeds not only through conversations with residents but also by teaching herself “landscape literacy.” She leads us not only to hear human stories but also to see the sickly curved needles of a pine growing out of a bomb crater. The morphologies of plants and the toxic burdens of diseased bodies are amenable to our senses, propelling our capacity to imagine landscape structures, histories, and large-scale transformations (Mathews 2018).

Such literacy involves conversations with other committed observers, including natural scientists. This direction is pursued in the extraordinary dialogue between biologist Michael Hadfield and science studies theorist Donna Haraway (2019). Hadfield explains how his attention was drawn to the disappearing Achatinella tree snails of Hawaii and what he did over the next 40 years to learn about them and to train a new generation of Pacific scholars to that noticing. Haraway weaves an analysis of the importance of this kind of work for the ways humanists and social scientists know the world. In these accounts, one mirrored in the other, the scholarship of documenting and understanding the ecology of Achatinella is inseparable from political protest, interwoven with the teaching of biology to indigenous youths across Polynesia, and developed from a symbiogenetic relationship with feminist science studies. Noticing matters in all these ways.

Our use of the term “structure” can perhaps be clarified in cautious dialogue with an anthropological pioneer of the study of social structure, A. R. Radcliffe-Brown. Radcliffe-Brown’s use of “structure” is both an inspiration and a caution to us. Like Radcliffe-Brown, but in contrast to the use of structures in the French tradition, we are interested in structures as accessible to the senses. But structures are, for us, forms in which histories of social relation reveal themselves. In this sense, our use of “structure” works against one of the analytical postulates for which Radcliffe-Brown is most famous: the distinction between structure and change. Radcliffe-Brown introduced structure as a tool for building transhistorical natural law. In contrast, the landscape structures we urge anthropologists to notice are always coming into being. “Structures” is our analytical word for the form in the world that catches the eye, begs for attention in a phenomenological sense, but also points to longer trajectories. Like the morphologies of trees, which show us historical growth patterns (Mathews 2017a), the structures we identify are signs of landscape-making, a historical process. Landscape structure shows history rather than opposing it.
This foreshadows our second gripe with the “structures” of structural-functionalism: we are strongly opposed to the anthropocentrism of Radcliffe-Brown’s social structures. Ironically, Radcliffe-Brown uses examples from the nonhuman world to define “social structure”—only then to quickly dismiss these examples as irrelevant to anthropological inquiry:

In a hive of bees there are the relations of association of the queen, the workers and the drones. There is the association of animals in a herd, of a mother-cat and her kittens. These are social phenomena; I do not suppose that any one will call them cultural phenomena. In anthropology, of course, we are only concerned with human beings, and in social anthropology, as I define it, what we have to investigate are the forms of association to be found amongst humans. (Radcliffe-Brown 1940:2)

In our use of the term “landscape structure,” we bring back what Radcliffe-Brown tossed away, namely, the notion of more-than-human social structure.

“Modular Simplifications” and “Feral Proliferations” Make Anthropocene Landscapes

More-than-human social structures reveal themselves, so we argue, in at least two dominant landscape forms in the contemporary world: in modular simplified forms and in feral proliferations. Each of these is entangled in the history of the other, histories that are at once human and more-than-human.

The term “modular” in “modular simplifications” is borrowed from Hannah Appel’s work on oil company enclaves in Equatorial Guinea (2012), which in turn draws from James Ferguson’s (2006) analysis of the uneven landscape of private security and mineral extraction in Africa. Appel uses the term “modularity” to discuss the social discipline of oil company enclaves, produced by imaginaries of industry and investor “risk.” In this kind of leaping globalization, uneven topographies are key to understanding both connections and disconnects. Appel’s concept can be useful to understand nonhuman as well as human landscapes in their mutual historical formation. To think about ecological simplifications, beginning with the modularity of the plantation is helpful. However, at least in landscapes, modular simplifications never fully wall themselves off; feral proliferations mix insides and outsides.

Plantations create monocrops to make it possible for coerced and alienated labor—and more recently, machines—to tend crops without the care that farming otherwise requires. Contemporary plantations thus continue to carry histories of slavery and the displacement of indigenous communities. This “modular” simplification has spread around the world together with human coercion as plantation labor; this regimentation of human and nonhuman life must be thought together. Plantations attempt to reduce the number of living things in an area to just one kind; everything but that which is required for the reproduction of the economic product should be eliminated. This is not just an issue for plants; feedlots are essentially animal plantations. Such simplifications have social and ecological effects beyond alienation: diseases are nurtured and spread around the world. These latter are our “feral proliferations.”

We have already introduced coffee plantations as a modular simplification with feral effects—the coffee rust fungus (Perfecto, Jiménez-Soto, and Vandermeer 2019). Coffee plantations are not so different from industrial chickens, as introduced in this issue by Frédéric Keck (2019). In Hong Kong and southern China, chickens are raised in uniform lots whose massive size defies the imagination. Such ecological simplifications, as with coffee plantations, have consequences, including the emergence of avian viruses capable of infecting humans as well as birds. The uniformity and crowding of the chickens in effect constitutes a natural laboratory for viruses that produce new and virulent forms. The viruses bred under such conditions spread far beyond the chicken farms, potentially infecting humans around the world. Large-scale ecological simplifications, then, invite “feral proliferations” that end up rippling through the entire landscape mosaic.

Consider, too, the spread of toxins, another form of “feral proliferation.” Brown’s (2019) exploration of the radioactive landscapes of the Ukraine and Belarus, mentioned above, offers an important reminder that industrial infrastructures have effects far beyond their designs. Radioactivity mutates the metabolisms of living things, which spread not only through wind and water but also through food chains. Or consider the hormone-disrupting pesticides used in Martinique to kill borer beetles in the island’s banana plantations, as described by Vessa Agard-Jones in her contribution to the symposium that gave rise to this special issue (see also Agard-Jones 2013). Seeping across boundaries of land, water, and skin, toxins permeate living things, human and not human.

Ecological simplifications clear out species diversity to create increased densities of some kinds of individuals. Such increased densities may stimulate feral effects, of nuclear, toxic, viral, bacterial, fungal, or animal kinds. High populations of hatchery-produced salmon in the US Pacific Northwest, for example, outcompete wild salmon, reducing wild salmon populations (Swanson 2018, 2019). The hatchery salmon themselves become a feral proliferation and dangerous competitors for wild salmon. Heather Anne Swanson’s study (2019) shows how attempts to increase food for humans can have wide-reaching feral effects for the ecological health of surrounding organisms.

Ecological simplifications have been historically tied to colonial conquest, as Rosa Ficek (2019) argues in her consideration of the cattle complex in Latin America. Making the landscape safe for cattle went hand in hand with the destruction of indigenous communities and native ecologies. Yet just because the colonizers emptied landscapes for cattle does not mean they were in control. As Ficek shows, sometimes cattle destroyed the ecological relations that were meant to nurture them. Sometimes feral cattle supported rebellious human subjects as they spread beyond and before advancing empires.
And sometimes they gave rise to far-reaching developments in governance and political economy that no colonizer could have predicted. Cattle in the Americas offer a model of this: Anthropocene landscapes emerge in the relation of ecological simplification and feral proliferation. Colonial and capitalist planning take part in this emergence but do not fully determine the results.

Cattle, like coffee rust, show us that feral effects are not exterior to the modular landscape patches that afford their proliferation. The modular and the feral are messily entangled in landscape structures.

Systems Are Thought Experiments with Which to Make Sense of Structures

In embracing an analysis of landscape structure as a way to understand patch dynamics, this special issue offers a more awkward, nuanced story about systems, the most common way in which ecologists and planetary scientists discuss the Anthropocene. Systems, of course, have also been a common theoretical concept through which anthropologists have sought to understand cultures and societies. Systems are imagined holisms through which structures fit together (Otto and Bubandt 2010). Perhaps that is why contemporary anthropologists are so suspicious of systems. Systems, we realize, offer a snapshot of history, not an account of unpredictable change. They reify categories for the sake of the analysis. And yet they do important and necessary work for us.

In this special issue, we argue that three kinds of systems-thinking come into play for their importance to understanding “patchy Anthropocene”: ecological models, nonsecular cosmologies, and political economies. We argue that these three kinds of system building have things in common, and that there are important things to be gained from each. Each offers interpretive frameworks for moving from observations of landscape structures to ways of understanding the Anthropocene. Papers in this special issue show the importance of each: Heather Swanson (2019) defends “carrying capacity” models as a component in struggles for more-than-human livability; Frédéric Keck (2019) discusses Buddhist versus scientific cosmologies for working with birds and their illnesses; Yen-Ling Tsai (2019) shows intersections of kinship and capitalism in transforming landscapes. We argue that a key contribution that anthropologists can make to Anthropocene studies is to juxtapose these alternative kinds of systems-thinking—thus opening attention to multiple ways of gaining traction on observations of landscape structure. In addressing the spatial and historical unevenness that hides in plain sight in the Anthropocene, we need to find a way of addressing empirically the planetary scale of the Anthropocene without remaining naively beholden to its unitary pretensions. Holding in critical tension the diverse kinds of systems-thinking in ecological models, nonsecular cosmologies, and political economies offers such a way.

First, ecological models: Earth systems and climate models have been the gateway to the Anthropocene (e.g., Steffen et al. 2015). In most such discussions, the Anthropocene is a condition known through modeling of mass aggregated data. This is what Timothy Morton calls a hyperobject (Morton 2013). And it is as a hyperobject, a phenomenon that can be computed and thought (as a future event) but not directly experienced (in the present), that the Anthropocene, like global warming, is making a difference in politics, media, and public perception. But a hyperobject is also made. In the Earth systems approach to the Anthropocene, the heterogeneity of landscape structure is erased in this making because global data collection is imagined as necessary to build a planetary totality. We respect this project, and we support important uses of it—including recognition of the phenomenon of global climate change. In the process of building systems models supported by data infrastructures, however, researchers necessarily simplify and provisionally freeze what entities they will notice and count, the “state variables” such as sea level, carbon dioxide concentration, or population. Systems models create a world by projecting and extrapolating from such provisionally frozen entities, both illuminating what is in that world and excluding other ways of seeing (Mathews 2017b). Once we are committed to a model, it is very hard to change the way we identify data. How might anthropologists both use models and yet refuse to conflate them with the fullness of the world (Edwards 2010)?

In their account, Atsuro Morita and Wakana Suzuki (2019) describe efforts to model river deltas, but also how transformations within patches have potential landscape-transforming effects whose possibilities are silenced by systems models. Hydrologists who have studied the Chao Phraya delta of Bangkok in Thailand are taken aback by a flood produced by a relatively modest rain event. Local people (and perhaps anthropologists) are much less surprised, because they recount histories of infrastructures, however, researchers necessarily simple and, as a component in struggles for more-than-human livability; Yen-Ling Tsai (2019) shows intersections of kinship and capitalism in transforming landscapes. We argue that a key contribution that anthropologists can make to Anthropocene studies is to juxtapose these alternative kinds of systems-thinking—thus opening attention to multiple ways of gaining traction on observations of landscape structure. In addressing the spatial and historical unevenness that hides in plain sight in the Anthropocene, we need to find a way of addressing empirically the planetary scale of the Anthropocene without remaining naively beholden to its unitary pretensions. Holding in critical tension the diverse kinds of systems-thinking in ecological models, nonsecular cosmologies, and political economies offers such a way.

First, ecological models: Earth systems and climate models have been the gateway to the Anthropocene (e.g., Steffen et al.
alone would not be enough to restore salmon-rich watersheds. Salmon were being defeated by a multitude of destructive forces, from toxin-filled agricultural irrigation to sediment-releasing logging. Because political battles over dams and fishing had produced baseline numbers for salmon, modeling these numbers as “carrying capacity” could play a crucial role in arguing for salmon-healthy rivers. Anthropologists who are prejudiced against quantitative analysis, Swanson argues, fail to note the importance of ecological models in more-than-human politics. When we have the numbers, she suggests, we should use them.

Model thinking introduces necessary simplifications. As Viveiros de Castro (2019) points out in his discussion of thinking with models and examples, simplifications have both pleasures and dangers. We need such simplifications, he argues, to make sense of the world of “critters and processes, qualities and quantities.” This is what he calls, following Geertz (1977), “models of” (Viveiros de Castro 2019). Both model thinking through simplification and thinking by example have their place. But Viveiros de Castro reminds us of the dangers when “models of” become normative “models for” that inspire authoritative simplifications—sponsored by states and corporations—that destroy landscapes and silence other visions of the world (Law 2015). Model thinking is genealogically linked to the modular landscapes we discussed above. If modular landscapes work by banishing unruly forms of more-than-human sociality, model thinking works by banishing the power of the example, the exception, and the otherwise. The routines of data gathering and model building undermine modelers’ capacities to notice change, transformation, and historical specificity in the world. Models are data infrastructures (Edwards 2010) that both enable and deaden observation. As anthropologists come into conversation with Earth systems modelers, then, it seems important to hang on to our capacity to remember what Viveiros de Castro calls “ontological anarchy.” Models can coexist with other modes of systems-thinking, including cosmological alternatives.

Second, then, nonsecular cosmologies: If cosmologies are a form of systems-thinking, spirits are a kind of model, too. Like models, spirits anticipate results and modify “the state of the world according to a certain intention” (Viveiros de Castro 2019). In his paper on chickens, mentioned above, Keck (2019) shows us spirits as well as viruses emerging from the industrial chicken farms of Hong Kong. Hong Kong’s bird-watchers know spirits as well as birds, and they show us the intertwined histories of secular and nonsecular understandings of risk, care, and death in the midst of industrial simplifications. “Risk,” as understood by chicken farmers, emerges in new light: a firmly secular category takes on nonsecular overtones when cooked up in the fevered mix of spirits and viruses (see Szerszynski 2017). In the uncanny valleys of the Anthropocene, spirits, ghosts, and monsters of many kinds proliferate (Bubandt 2018). What unites these spirits, ghosts, and monsters—regardless of whether they emerge in villages, media, chicken farms, or scientific laboratories—is their disregard for boundaries, whether these boundaries are spatial, conceptual, or corporeal.

Thinking of geological science as a cosmology, for instance, alerts us to the role of imaginative extrapolation in linking landscape observations with deep time. This alternative is explored in Naveeda Khan’s contribution to this issue (2019), in which she explores the romantic roots of geology. This genealogy matters, because it was, after all, primarily the science of geology that gave us the Anthropocene, a term that may or may not yet still become a formal geological unit of time (Zalasiewicz et al. 2017). Khan argues that the nonsecularity of the unruly world of more-than-human agency in the Anthropocene is revealed to us in the romantic roots of the science of geology itself. Khan’s article follows the processes that make both humans and deltas vulnerable to the eventfulness of the earth’s mantle. In the delta of the Brahmaputra/Jamuna River, char inhabitants and hydrologists alike come to sense that delta islands and river morphologies are the outcome of earthquakes. Shifting tectonic plates, irrigation infrastructures, and dams can shift rivers or starve deltas of sediments. Khan uses the concept of discardance to draw attention to the ways that people come to be “tormented” by this subterranean deep time of rocks and tectonic plates.

 Spirits might be models that have a habit of escaping the systems out of which they emerge. They invite us to unpredict these systems in surprising ways. Spirits may close high-tech airports, affect democratic elections, or aid scientific discovery (Bubandt 2006, 2019; Bubandt and van Beek 2011). But spirits are not the only models that do this work of unprediction (see Viveiros de Castro 2019). Indeed, is it not central to the contested appeal of the scientific models of the Anthropocene that they allow us to “unpredict the world” in new ways? A key part of the interest of many anthropologists in the natural science models of the Anthropocene is, arguably, that the “unpredic-tion” of the Anthropocene feels—in both promising and uncanny ways—like a homecoming of sorts, namely, a return to a world of unseen forces that might just possibly also include spirits: a return to the doubt that lingers in witchcraft as much as in climate science (Bubandt 2014; Oreskes and Conway 2010), and a return to the unpredictability of a world that was not modern after all (Latour 1993). The uncanniness of the Anthropocene grows from the way this model-made reality has added new verisimilitude, new truth-likeness, to spirits, monsters, and ghosts (Bubandt 2017, 2019; Tsing et al. 2017). At the very historical juncture where modern reason declared spirits and monsters to be dead, the graphs of the Great Acceleration (Steffen et al. 2015) have helped draw the contours of the uncanny valleys of the Anthropocene in which the spirits and monster dwell . . . after all (Bubandt 2018).

Ontological anarchy is therefore not exterior to systems-thinking. It is the ghost that stirs within and between systems. In this sense, anthropologists need to take natural science models as seriously as spirits. Doing so means neither taking them naively for granted nor dismissing them out of hand as cultural constructions. At the right epistemological and ontological distance, working with the simplifications of systems can clarify our understanding of the modular simplification of the world.
We even might propose alternative and more productive simplifications that bring life, in all its historical patchiness, into model-thinking, as in Latour’s recent collaboration with critical zone scientists (Arènes, Latour, and Gaillardet 2018). Engaging anthropologically with systems is not by necessity to enslave our analyses to the rational and reductive reasoning of the imagined world of “models-for.” On the contrary, it may well help open the door to a more unruly, nonsecular Anthropocene.

Third, political economies: Consider the Green Revolution, a recent historical event of social and ecological simplification with massive consequences for both Earth systems and landscape structures across Asia. What allowed the event to sponsor such systemic and structural changes? In at least some places, including Taiwan, Green Revolution advocacy for a particular family form cemented a package in which chemicals, machines, and international markets could come together in what appeared to be a project for everyone’s wellbeing. “Families” as a unit of farming erased the implications of toxins, debt, and plantation-bred pathogens. A charismatic package was created in which modularity appeared glamorous and forward looking. Such modular simplifications, however, left out the nets of kinship, both human and not human, that had allowed farming to thrive over the longue durée (Tsai 2019). In Taiwan, some of these “odd kin” are plants and animals; others are spirits and ghosts. Together they create a queer more-than-human kinship that challenges agricultural simplifications, offering alternatives.

In contrast to Tsai’s analysis, Michael Dove (2019) argues for the generativity of family farming and its longue durée legacies. Smallholders, Dove argues, create ecologically diverse landscape patches; plantation agriculture has always been parasitic upon this smallholder creativity. Dove links plantation landscape structure with events and systems in Southeast Asia across five centuries. Colonial and postcolonial rulers have defined commodity crops as having fixed properties that are amenable to control and simplification, as they seek to produce simplified commodity-producing landscapes. In contrast, smallholders and natives cultivate rubber, pepper, and Imperata grass in a variety of ways. They note the political histories that brought these crops into their landscapes, and they are wary of the dangers of over-reliance on one crop. Through their attention to economic crises and the alternative morphologies that emerge from human-plant-landscape relations, smallholders imagine critiques of dominant political economies. It is precisely this possibility of alternative ontological relations and plant morphologies that plantation simplifications seek to deny. This is “epistemicide,” the insistence on one form of knowledge and on a one-world world ontology (Law 2015). Epistemicide flattens human worlds, identifying particular arrangements as functionally necessary rather than historically contingent. An anthropology of a patchy Anthropocene requires attention to a diversity of modes of knowing as well as modes of living.

Here we suggest that varied modes of systems-thinking, from ecological modeling to nonsecular cosmologies to political economies, might sit side by side in building our knowledge of patchy Anthropocene. Our willingness to rub these kinds of systems together contrasts with most Anthropocene theorists who pick one of these and dismiss the others. Our position here resonates with Donna Haraway’s claim that the Anthropocene needs many names (Haraway 2015). To “Anthropocene,” with its global Earth systems models, Haraway adds not just Capitalocene (Moore 2015) to point to the power of capital but also Chthulucene, in which animal and spirit beings cavort together. By allowing all three purchase, we too show how planetary and patchy work together.

Can We Acknowledge Catastrophe While Also Imagining Possibility?

What is the place of hope in the Anthropocene? Is it possible to hope, when it was the millenarian hope of modernity that got us into the mess of the Anthropocene in the first place (Buck-Morss 2002)? Michael Hadfield’s essay on his research on tree snails in Hawaii (Hadfield and Haraway 2019) offers a place to begin to address this question. Hawaii is one of the premier extinction capitals of the world. In the last thousand years, two-thirds of Hawaii’s more than 100 endemic bird species and more than 700 species of snails have gone extinct (van Dooren 2017). Hadfield’s study of Achatinella tree snails takes place in the midst of their own extinction crisis. Thirty-two out of Hawaii’s 42 endemic species of tree snails have been pushed into extinction by a combination of habitat loss, shell collection, and the introduction of rats and other predators. All 10 surviving species of Hawaiian tree snails are now critically endangered. Amid this unfolding catastrophe—the end of the world for tree snails, as it were—Hadfield’s contribution to this issue, a tree snail manifesto cowritten with life-long friend and collaborator Haraway, is testimony to the impossibility of doing nothing. “The Tree Snail Manifesto” is a love story tied by the biological poetics and devastating politics of the holobiont snail (Hadfield and Haraway 2019); it is also an intimate account of the pleasures and difficulties of collaboration across the human-natural science divide.

Too often the Anthropocene forces upon us an imagination of the future that, as Haraway has put it elsewhere, is infected by an impossible choice between “technotheocratic geoenigneering fixes and wallowing in despair” (Haraway 2016:56).

Hope in the Anthropocene, if it is not the desperate hope of isolating oneself behind trade barriers, border walls, and immigration laws, tends to take the shape of a hopeful politics of technological transcendence, the zombie version of modernist hope. Transhumanism, “green capitalism,” the Singularity University in Silicon Valley, and the ecomodernist movement are all versions of this revived modernist hope for capitalism and humanity to reinvent itself in a “greener” and “better” form in the face of crisis and disruption. The Anthropocene, the ecomodernists suggest, for instance, can be “good, even great” if we put “humankind’s extraordinary powers” in its service (Breakthrough Institute 2015). The “good Anthropocene” of ecomodernism is a big, universal, and scalable dream world...
disciplinary learning. As Had (Hamilton 2015) observes, those tied by the history of the tree snail, hope is necessarily (Tsing, Mathews, and Bubandt 2019) demonstrates, there is nothing simple or straightforward about aligning natural science, activism, feminism, and indigenous politics. Nothing is given, except the impossibility of doing nothing. This is a more humble and troubled hope, a hope “by example” (to speak in the terms offered by Viveiros de Castro [2019]). In learning to hope against hope in the Anthropocene, anthropologists have much to offer by way of those with whom we study.

After all, as Déborah Danowski and Eduardo Viveiros de Castro (2016) point out, denizens of the Anthropocene are not the first humans who have been forced to contemplate the end of their world. Indigenous people across the globe have experienced the end of the world multiple times over in colonial history. In his study of indigenous memories of the devastation visited upon the Crow Nation by North American settler colonialism, Jonathan Lear identifies in the prophetic dreams of Chief Plenty Coup what he calls “radical hope” (Lear 2006). As opposed to the ontological certainty of the scalable hope of modernist or monotheistic optimism, “radical hope” is deeply pragmatic, epistemologically ambivalent, and under-articulated, because it is “directed towards a future goodness that transcends the current ability to understand what it is” (Lear 2006:103). Radical hope, Lear continues, “anticipates a good for which those who have the hope as yet lack the appropriate concepts with which to understand it.” Collaboration—open and curious—across multiple registers of knowledge and being are needed for anticipatory action in the face of this Real Unknown. Radical hope, one might say, is what is required in a tree snail world.

Take the marabou storks that in recent years have begun to multiply in Kampala, the sprawling capital of Uganda (Doherty 2019). The storks have given up their seasonal migration routes and have instead begun to permanently occupy trees across the city. From their treetop perches, the storks make daily trips to the municipal landfill, where they pick through organic waste side by side with the human salvage workers who make a living collecting metal and plastic from the site for sale as recycling material. Marabou storks and destitute salvagers do not figure in official plans for waste management in Kampala, and yet they are critical to the city’s infrastructural ability to handle its escalating garbage crisis. Ungainly and associated with dark rumors of rotting corpses during the days of Idi Amin, the marabou storks are disliked by most in the Ugandan capital except by the salvage workers who know them most intimately. On a patch of wasteland in an East African mosaic of the Anthropocene, co-species toleration exists precariously and for the time being between marabou storks and salvage workers: beings that most in Kampala choose to ignore or despise. Doherty offers a patchy, exemplary hope that is neither scalable nor unequivocal. The marabou storks accumulate in their bodies the mercury, chemicals, and pathogens of the waste they consume—as do the salvage workers. Both are para-sites: bodies that exceed the state simplifications that also shape them, bodies that do critical but criminalized work, bodies that are linked in their shared exposure to the poisonous hazards of the Anthropocene. This is not much by way of hope. But it is not nothing either.

Like Jacob Doherty, Vanessa Agard-Jones’s contribution to our symposium invited us to see the kinds of contagious politics that may grow from common exposure. Plantation workers exposed to toxic chlordecone developed a “kin/esthesia,” a political aesthetics of movement and connection, and a form of queer kinship that begins at the molecular level but—in all its contradictions—seeps into both activism and everyday life. Chemical contamination, like marabou storks, reminds us that a politics of exposure in the ruined landscapes of the Anthropocene is a more-than-human politics.

Dove’s (2019) attention to “epistemicide” is also, ironically, a form of radical hope. It is obvious from Dove’s treatment that alternative modes of knowledge continue a lively existence, even as they are flattened by hegemonic projects of colonial governance. No single standard of knowledge has been able to exist alone over the 500 years of his account. Every plant carries with it multiple modes of human knowledge and practice. Despite the power of plantation science, smallholder alternatives continue to make their way in the world.

In unexpected ways, Ficek’s (2019) cattle also point us to the patchiness of multispecies politics. “Unexpected” because cattle, after all, are quintessential creatures of the Anthropocene: central contributors to global warming, water shortage, deforestation, and territorial dispossession and land grabbing. Yet, in twentieth-century eastern Panama, the risk of foot-and-mouth disease allowed environmental NGOs to lobby against the construction of a highway into vulnerable forest land, and national parks have been created along the border to Colombia as a buffer zone against the disease. Ficek argues that such unexpected effects of cattle complicate conventional accounts of cattle as creatures who by their nature are always complicit in colonization and dispossession. Like Dove’s (2019) warning against a facile demonization of oil palm trees (Elaeis guineensis) or Imperata grass, Ficek’s account shows that bovines are more than methane-belching colonial creatures and that livestock proliferation works to produce patchy landscapes of riotous ferality as well as simplification. From the feral and unexpected encounters between bovines and humans in Panama, as from those between marabou storks and salvagers in Uganda, the illegitimate hope of a kind of co-species collaboration in ruins emerges for which we do not have a language.

Unlike modernist utopias or mere optimism, the patchy hope that emerges from these stories is not scalable; it exists in specific patches of the Anthropocene that resist easy globalization. Hope is patchy because capitalist and ecological structures themselves are patchy (Bear et al. 2015; Tsing 2015) and because the Anthropocene itself is ontologically patchy (Vi-
veiros de Castro 2019). Scalable dreams ignore this at their own peril. Patchiness is hope’s condition of possibility and its limit at the same time. Patchy hope operates on the acute awareness of its own limitation. Indeed, it operates on the acute likelihood of its own failure: tree snail love amid extinction; marabou proliferation amid the internalization of pollution. Patchy hope works with the dilemma of staying with the trouble (Haraway 2016): the impossibility of doing nothing compounded by the acute awareness of the politically fraught nature of collaboration across multispecies, disciplinary, and multiperspective difference. Patchy hope works within a register of internal failure rather than heroic action.

Patchy landscapes reverberate with the patchy hope of multiple histories (Mathews 2018). Natasha Myers, who was present at this symposium, reminded us of the kind of patchy hope that can be cultivated in the oak savannas of Ontario. Oak savannas are the result of thousands of years of hunting practices by the Haudenosaunee, the Anishinaabe, and other First Nations who lived in the Ontario region until the lands were sold to the British Crown in the late eighteenth century. The First Nations dispossessed from their lands, oak savannas were increasingly turned into farmland and parks. Only in the last 2 decades have restoration efforts sought to bring back fires that could maintain an oak savannah that would otherwise disappear. Following these restoration efforts in Toronto’s High Park, Myers (2017) reminds us of the limitations of ecological science and asks whether one might do “ecology otherwise” by becoming attuned to plant sensing. Demonstrating how middle-class urban recreational areas may hide colonial histories as effectively as plantations (see Dove 2019), Myers highlights the need for an affective ecology that recovers the now erased landscape ties to the dispossessed First Nation peoples of the Toronto oak savannas.

“Patches” Are Sites for Knowing Intersectional Inequalities among Humans

The concept of a unified and homogeneous Anthropocene makes it difficult to incorporate anthropological insights about differences and inequalities among humans. In contrast, such insights are key to the conceptualization of “patchy Anthropocene.” Patches show us histories of genocide, displacement, exploitation, and oppression—together with the ecological consequences of these programs. All the papers in this special issue address human inequalities: cattle push forward Anthropocene colonization, with its genocidal practices (Ficek 2019); smallholders’ perspectives on plant life are systematically erased in Southeast Asia (Dove 2019); Ugandan garbage pickers work alongside birds to find their livelihoods in the ruins (Doherty 2019). Several papers address how scholars might get enough distance from still-hegemonic frameworks of progress, modernization, and growth to avoid their unjust exclusions. Khan (2019) argues that the Romantic tradition for knowing nature offers promises for drawing us into the hugeness of a geological scale without the alienated simplifications of big-data models.

Tsai (2019) shows how Green Revolution ecological simplifications are also kinship and gender simplifications that matter. By excluding “odd kin” in favor of idealized nuclear families, the Green Revolution ensured its own nonsustainability—both in controlling landscapes and in controlling human social arrangements. The “good Anthropocene” of design, she shows, is always coming undone.

Patchy Anthropocene is an analytical program for including social inequalities in attention to environmental degradation, but this is not a simple matter of “add and stir.” Indeed, we argue, “attention to social inequalities” and “Anthropocene” have an awkward relationship in the Strathernian sense of the term (Strathern 1987), that is, as oppositions without synthesis. Anthropocene works through an appeal to Enlightenment universals; attention to social inequalities requires an acknowledgment of the “much more” out there. Enlightenment categories authorize our search for knowledge. But they also betray and exclude us over and over. Patchy Anthropocene takes hold of this contradiction to grapple within it, rather than to imagine it away. One way to illustrate this, and to move toward a conclusion, is to acknowledge and examine the relationship between this special issue and the 1955 conference that inspired the Wenner-Gren Foundation to sponsor it.

This special issue grew from an invitation by the Wenner-Gren Foundation to commemorate the sixtieth anniversary of the 1955 conference and the subsequent publication Man’s Role in Changing the Face of the Earth (Thomas 1956). The magisterial 1956 volume conjured up an image of a planet reshaped by human industry, but it was an image that is a very different one from the patchy Anthropocene that the contributions to this special issue outline. The categories “Man,” “Change,” and “Earth” are unsatisfactory for our work, even as they make it possible. Indeed, the changing shape of more-than-American anthropology since the 1950s provides a guided tour through continuing struggles with these stubborn categories.

Earth

Man’s Role in Changing the Face of the Earth (Thomas 1956) is a sprawling compendium that stretches across space, time, and disciplinary knowledge. Such ambitions formed within the post–World War II burst of big, synthetic science that emerged from US confidence in its world leadership. One place to begin in thinking about the world that gave rise to the 1956 volume is the Great Acceleration, that candidate for Anthropocene status that begins with the radioactive signature of the first atomic bombs at the end of World War II (McNeill and Engelke 2016). As Steffen et al. (2015) argue, this period can be characterized by the rapid uptick of anthropogenic changes to both human and nonhuman Earth systems. This was also the period shaped by the rise of American hegemony. The global leadership of the United States and the Great Acceleration developed together through the US export of Anthropocene-stimulating Earth-modification technologies (Ehbron and Tsing 2017; Tsing 2019). Race, gender, and class inequalities peculiar
to the United States at that period were built into Great Acceleration aspirations (Brown 2013). Patchy Anthropocene landscapes are also landscapes of American hegemony—such as those made by the Green Revolution in Taiwan as described in this issue by Tsai (2019). US hegemony shaped the anthropology of the 1950s. American anthropologists imagined themselves at the helm of a global ship of knowledge, taken over from European empires. Enlightenment universals were important for claiming that mantle. But the American innovation was Big Science. American anthropology tried out group research—think Puerto Rico (Julian Steward; see Silverman 2011), Zinacantan (Evon Vogt; see Vogt 2004), or Modjokuto (Douglas Oliver; see Geertz 2000)—as well as outsized ambitions to manage modernization. The grand epic of Man’s Role in Changing the Face of the Earth was possible only in that context. Only a decade later, “big anthropology” collapsed. Amid popular protest against US aggression in Indochina, American anthropologists began reading social theory with a vengeance, making up for lost time. European theorists reassumed importance in guiding the discipline (e.g., Bourdieu 2013 [1977]; Foucault 1977). Americans scaled back, transforming the discipline within critical discussion of difference and alternatives to hegemonic common sense. Anthropological holism was no longer what it used to be (Otto and Bubandt 2010).

Man

This process of self-conscious scaling back lasted through the end of the twentieth century and into the twenty-first. Michelle Rosaldo’s contribution to feminist anthropology offers an exemplary case. In their pioneering contribution, Woman, Culture, and Society, Rosaldo and Lamphere (1974) asked what they imagined as universal questions about women’s subordination to men. By 1980, however, Rosaldo was ready to scale back, using critical social theory: She argued that anthropologists needed to begin, instead, with questions of what counts as male and female in a given cultural setting (Rosaldo 1980). Feminist anthropology moved into the ethnographic study of gender in places and, then, further specified, in situations (Butler 1990). Intersectionality brought race and other social inequalities into the heart of feminist studies (Crenshaw 1989). This kind of move characterized most of American anthropology, which became known by the 1980s for its exemplary ethnographies rather than its ambitions to manage the world. Indeed, it was this strategic retreat that allowed important critical work in anthropology on Enlightenment concepts of Man—and its corollaries freedom (e.g., Mahmood 2004), political agency (e.g., Abu-Lughod 1990), personhood (e.g., Strathern 1988), and nature (e.g., Haraway 1990).

Change

The 1990s and the first decade of the twenty-first century offered a new challenge for anthropologists: the rising tide of capital expansion and labor mobility that went under the name “globalization.” European and American social theorists jumped at the chance to describe and analyze these new developments (e.g., Hardt and Negri 2001). At the same time, these developments toppled the leadership of northern scholars, who now were reduced to one of many global players—even as theorists (Ribeiro and Escobar 2006). As anthropology gained diversity, so too did attention to alternative temporalities, epistemologies, and ontologies. New scholarly developments challenged the importance of those Enlightenment categories that supported colonial rule (e.g., Chakrabarty 2000), on the one hand, and indigenous murder and displacement (e.g., Mignolo 2018), on the other. An emerging cosmopolitan anthropology quickly found a foothold in globalization studies: anthropologists showed that travel and traction were interdependent in the making of both widely spreading and parochial social forms (Inda and Rosaldo 2008). The concept of “change” itself was thus transformed from a uniform Enlightenment progress to an appreciation of historical trajectories that shifted through articulation (Tsing 2005). But these shifts also led anthropologists back to big claims. Informed by the particularistic knowledge and knowledge-making perspectives the discipline had spent the last 20 years acquiring, description of big social processes was back. In contrast to the world-engulfing “big anthropology” of the 1950s, however, this time description aimed to incorporate radical difference within understandings of worlds-in-the-making.

Political ecology—an interdisciplinary mix of political economy and environmental studies—took root in anthropology as a part of this turn, revitalizing environmental anthropology with thinking about spatial scales and social difference in the 1990s (Blakie 1985; Bryant 1992). A decade into the 2000s, political ecology was joined by multispecies ethnography (Kirksey and Helmreich 2010), which added cross-species relations to discussions of radical difference. Anthropological studies of globalization are one source of inspiration for new work on the Anthropocene. So, too, is the “ontological turn,” which rejects cosmopolitanism to point out that not everyone is connected by colonial hybridities. Some kinds of differences are sustained—and despite centuries of colonial occupation (de la Cadena 2015; Escobar 2018). This observation only raises the stakes to bring tools for understanding radical difference inside world description. Meanwhile, US hegemony declines and other forms of geopolitical organization emerge. It is within this set of legacies and critical frameworks that anthropologists in this special issue approach the challenges of the Anthropocene.

The contributions of our special issue revitalize discussions of landscape structure and system to draw this legacy into interdisciplinary conversation about the Anthropocene. Holding on to insights that have brought us into productive tension with Man/Change/Earth, we argue for a mode of Anthropocene studies that draws attention to human and nonhuman heterogeneity. Our contributors use anthropology’s strength as a deconstructive minor science to inform a critical engagement
with planetary structures and systems. We both contribute to new knowledge and retain a critical edge. To describe a patchy Anthropocene that is politically made, ecologically remade, and uncannily unreal, we need both observations and thought experiments. This is bold research on planetary conditions of livability that addresses the challenges of the Anthropocene by retooling anthropology’s critical attention to specificity, content, and difference. It is not enough to discuss the concept of Anthropocene, a self-limiting “common sense” in our field today. Critical and empirical research into what we have called the patchy Anthropocene is urgently needed.

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Tsing, Mathews, and Bubandt  Patchy Anthropocene


Learning to Read the Great Chernobyl Acceleration

Literacy in the More-than-Human Landscapes

by Kate Brown

The explosion of reactor number 4 of the Chernobyl nuclear power plant on April 26, 1986, is often described as mankind’s biggest nuclear accident. However, describing Chernobyl as an accident works like a broom to sweep away the larger story around it, which is more important. Exploring the larger Chernobyl Zone with the help of two biologists and a centenarian villager, this article shows how the greater Pripyat Marshes, where the 1986 accident took place, was already sullied with elevated levels of man-made radioactivity before the plant was ever built. Major radioactive releases continue in the region to this day. By enlarging the scale and temporal dimension of this history, this article shows how the Chernobyl accident serves as only an exclamation point in a chain of toxic exposures that remastered the landscape, society, politics, and bodies, not just locally, but globally.

There it stood before me, a spindly pine tree growing out of a bomb crater in a former village cemetery in a circa 1960 Soviet air force bombing range in part of what used to be the great Pripyat Marshes, which now is a vast, mottled range of drained swamps, forests, and fields abandoned because of an excess of radioactive contamination caused in large part, but not exclusively, by the Chernobyl accident of 1986. Every territory on Earth is the site of some former ecosystem and of contaminants produced in the Anthropocene. Here in the midst of the marsh where I stood in rubber boots, which I did not need because of the unusually hot, dry spring in a succession of hot, dry springs, I grasped the dramatic environmental changes of the past half-century in this place that had been soundly cursed as late as 1939 as an immovable impasse of land and people lost for centuries to a primitive existence (Bürgener 1939; Mankivell and Loch 1924). The sickly tree was a clue, a small piece of evidence on a quest to discover the origins of the great demolition, yet to be written, of the Pripyat Marshes, straddling Ukraine and Belarus. The tree also confirmed that I had gained a small bit of literacy in more-than-human landscapes.

I was in central Europe to research a history of the Chernobyl disaster. As historians do, I went to the archives to see what I could find out about the medical and environmental consequences of the spillage of an estimated 50 to 200 million curies of radioactive waste from the blown reactor number 4 at the Chernobyl nuclear power plant in northern Ukraine on April 26, 1986. When I asked at the Ukrainian government archives in Kiev for the files on Chernobyl, the archivists laughed at me. “That was a banned topic,” they said. “You won’t find anything.” I asked to look anyway and quickly located whole collections labeled “The medical consequences of the Chernobyl catastrophe.” I started reading and have not been able to stop since.

The files of the Ministry of Health described how thousands of medical personnel spread out across the contaminated countryside and looked at bodies of people who sat under clouds of radiation in the weeks after the accident. Officially, Soviet leaders reported that 299 adults were hospitalized, and 137 had radiation sickness. I counted at least 40,000 people in the records hospitalized. In Belarus’ half of the 11,500 people checked into wards were children, of whom hundreds were diagnosed with radiation sickness. Counters detected radioactive iodine in more than half of their patients. Among children, numbers ranged from 30 to 1,500 rads. That later number is a hair-raising dose. They reported during the summer of 1986 weak, lethargic children with enlarged thyroids working on overdrive, children who suffered from anemia, infections, and strange neurological tics. They noticed a sharp rise in anemia among pregnant women and complications in pregnancies and births, and birth defects. These problems persisted, and local doctors continued to report in classified documents a steady and alarming rise in chronic medical problems among rural people living in contaminated regions. By 1988, reports show that majorities of residents of contaminated regions were chronically ill. In short,
doctors in contaminated zones had a public health disaster on their hands (Brown 2016a, 2019).

I checked the official accounts of Chernobyl damage published by the Chernobyl Forum and on websites of UN agencies. Those sources report a range of 31 to 54 fatalities and predict a future count of 4,000 to 9,000 deaths from Chernobyl-induced cancers (https://www.iea.org/newscenter/focus/chernobyl/faqs). Really? Does anyone believe that a mere 54 people died from the Chernobyl catastrophe? Evidently they do. These are the numbers the Washington Post and the New York Times most commonly cite.

I kept working, moving from archives in Kiev to the provincial cities of Zhitomir and Chernihiv, then to Minsk, Mogilev, and Gomel in Belarus, and on to Moscow. Nearly everywhere I found the same alarming story, against a backdrop of official denial on the part of Soviet leaders and international experts in radiation medicine. Which version was closest to the truth? Trying to solve that puzzle, I started to read literature on radiation medicine in English and Russian. I found, strangely, two distinct silos of knowledge splitting roughly along Cold War lines.

Radiation medicine in the United States and Europe relied on doses derived from environmental monitoring. With a radiation map recording sievert or roentgens in air and on the ground, radiologists consulting for UN agencies ran radiation measurements against charts they had devised from the long-running atomic bomb survivor life-span studies. Extrapolating from one nuclear incident to the other, they concluded that compared to Hiroshima, doses were too low to see damage among people exposed in Chernobyl-contaminated regions. United Nations consultants made short trips to the region, but those were often directed at allaying public fears. The western science of radiation medicine meant that health physicists who had environmental data could do their calculations from a desk anywhere in the world.

Soviet doctors had a different approach to radiation medicine. During the many nuclear accidents that occurred secretly during the Cold War, doctors were denied access to radiation measurements, data the KGB closely guarded. Instead, Soviet doctors learned to determine doses by detecting damage in nervous systems, blood, and hormonal levels in their patients. They got good at reading bodies and learned to discern damage at very low doses (Ichikawa 2015:86; Petryna 2013:119–120). I checked out more records from the ministries of hydrometeorology and agriculture, trying to track the vectors of radiation as they headed toward bodies. I noted on my own map places of high levels of contamination. They often did not track with the accepted radiation map. That puzzled me.

In July 2016 I rented a car, piled into it a suitcase of documents, and hit the road with my research assistant, Olha Martynyuk, who had drawn up a list of addresses to visit from people and places I had located in the archives. We went to a wool factory in Chernihiv, where mostly female workers had jobs in the 1980s sorting and washing wool delivered from radioactive pastures. The women had no way of knowing in the summer of 1986 that picking up the most radioactive bales of wool was like hugging an x-ray machine while it was turned on. They started to catch on when they saw blood trickle from the mouth of a young coworker. Soon others had nose bleeds, felt dizzy, and lost consciousness, and one young woman checked into the hospital so anemic that she needed blood transfusions. Two hundred wool factory employees received doses of radiation high enough to qualify as “liquidators,” a status given to emergency workers who battled the flames and cleaned up the accident. When Olha and I showed up, 10 of the 200 women were still at their stations on the factory line. They said the rest of the women on the list had died or retired on invalid status. The women, none of whom had more than a high school education, told us a great deal more than the managers with whom we had already talked. They knew, for example, where the factory’s radioactive wastewater went—into a municipal reservoir that cycled back into city pipes. They knew who had died of leukemia a year after the accident. They knew that cesium 137 aggregated in flesh and that plutonium 239 and ruthenium 106 settled in bone marrow and joints and never left the body. They pointed to their body parts that ached or failed to function properly as proof of that scientific fact.

After the wool factory, Olha and I kept going. Driving west 200 kilometers from the nuclear power plant, we stopped in Rivni, where a local sanitation inspector, Alexander Komov, described how he found in 1986 that although cesium 137 levels in soils in the northern part of the Rivni Province were relatively low, cesium 137 in local milk was above permissible levels. It took him 3 years to convince his bosses in Kiev that he was not making that puzzling fact up. We drove to northern Rivni Province and found thousands of people at the height of blueberry season picking berries, all of which the monitors in the warehouse told us were radioactive (Brown 2016b). Liubov Yevtushov, a medical researcher, showed us charts tracking the rate of birth defects in the province that were three to six times higher than the European average (Wertelecki 2010). In vil-

2. The International Atomic Energy Agency founded the Chernobyl Forum in 2003 and invited other UN agencies to join. It issues assessments of the health and environmental consequences of the disaster.


ages, we saw children born after 1986 whose limbs twisted and spiraled in ways that look similar to the trees in the Chernobyl Zone, which were disoriented from exposure to radiation.

From Rivne Olha went home to Kiev, and I kept going north into Belarus to the town of O’lshany, where I met a forester, Ivan Gusin, who agreed to give me a tour of the marshes. We climbed up into a large-wheeled jeep that plowed past a control point into the Almany swamp, the last patch of the great Pripyat Marshes that had not been dried out for farmland and so was still swamp, wetland, and bog. We stopped at the headquarters of the former Soviet air force bombing range. I scrambled up the rusting steel tower that generals once used to observe pilots practicing. Below me stretched a watery landscape where 17 rivers and streams met and entangled across a bowl-shaped mire spreading for 255 square miles. Until the late 1960s, spring floods flooded most of the ground to create a vast, shallow, seasonal lake. Towns such as Pinsk and Stolin were cut off for several weeks each year by water that seeped nearly everywhere.

When creating the bombing range, Red Army officers ordered 10 villages in the swamp cleared. In one site of a former village, the cemetery was the only thing left, standing on a raised knoll, the highest ground for a mile. The pine tree was about 50 years old, Grusin, confirmed. It grew from the bomb crater uncertainly, its needles disorganized, curling in rounds rather than straight from the branch. A number of factors can cause trees to mutate. Pines, however, are especially vulnerable to damage from radioactive energy (Sorochinsky 2003). I asked Grusin if he saw many trees like this. He shook his head, looking a bit disturbed. There were a lot of other pines around that were not growing out of a crater. They did not have mutations; see figures 1 and 2.

The sickly pine told me something. I placed a photo of it in a file with unverified accounts about the testing of nuclear weapons in the early 1960s in the ecologically sensitive marshes (Adamovich 2006:73). I could not find confirmation of the event in the archives because the records of Soviet nuclear weapons testing, stored in Moscow, are off-limits to researchers. That is the nature of state power. It can make the past go away, if it so deems. But I had other clues that I could document. In that file, I had a note from an interview with a Belarusian doctor, Valentina Drozd, who told me she noticed an unusually high number of birth defects in the regions bordering the bombing range. The strange thing, she said, is that the big spike occurred among people born before the Chernobyl accident.6 In the mid-1960s, the radiobiologist Alexander Marei led a team of scientists to conduct a study in and around the marshes (Marei 1974). Marei’s appearance in a village was an ominous sign, akin to the grim reaper knocking at the back gate. He specialized in nuclear accidents and showed up almost everywhere in the USSR where a nuclear accident took place.

From 1966 to 1970 Marei and his team circled the marshes, measuring radioactive cesium 137 and strontium 90, which they said in their later, censored publication came from global fallout from US nuclear bomb tests. They found that the swampy, sandy soils were the most conducive of any soil type for transmitting radioactive isotopes into the food chain. Swamps in conditions of continual resaturation accumulate peaty soils that are rich in organic substances but poor in minerals. Plants searching for potassium, iodine, calcium, and sodium readily take up radioactive cesium, iodine, plutonium, and strontium that mimic these elements. Efficient indigenous plants—berry bushes, mushrooms, herbs—recorded the highest transfer coefficient of radioactive isotopes from soils to plants. The scientists also discovered that seasonal floods spread radioactive isotopes everywhere the flood waters crept. As the boggy soils delivered ra-

dioactive nuclides to plants, grazing farm animals magnified radioactive elements in the milk they produced. Quizzing villagers, Marei discovered that swamp dwellers’ diets consisted almost exclusively of wild game, berries, mushrooms, and milk—lots and lots of milk, 2 liters a day. In other words, nearly everything the villagers ate contained man-made radiation. Marei’s team ran 1,000 people through whole-body counters. They recorded levels of cesium in villagers that were 10 to 30 times greater than those in nearby Minsk and Kiev (Marei 1974:113). He surmised that he swampy soils made the difference.

Marei’s study ended the same year that the Soviet Ministry of Energy decided to site Ukraine’s first nuclear power plant in the middle of the swamp, which Marei’s study had just shown was the worst possible ecology for nuclear spills. Ukrainian party boss Volodymyr Shcherbitsky fought the decision. He did not trust Moscow scientists’ cavalier attitude toward nuclear power. He watched in horror in 1972 when a team of scientists from Russian closed research institutions tried to put out a gas-well fire with an underground nuclear explosion. Shcherbitsky was not able to change the siting of the power plant, though he was a powerful party boss. Perhaps Marei’s study arrived on the desk of architects at the Soviet Ministry of Atomic Energy too late to change the location of the proposed 10 reactors, or perhaps they chose the Pripyat Marshes as a sacrifice zone because it was already contaminated by earlier bomb tests.

Staring at the crooked pine tree, I realized that the perforations of radioactive isotopes into the cellular structures of organisms of the swamp long predated the day of the Chernobyl explosions. Clued in by transformations of plant morphology, I realized that Chernobyl might better be conceived of as an “acceleration” than a one-off accident (McNeill 2016). Chernobyl sits on a timeline of events involving a tangle of high-modernist plans that were appended by emergency solutions that hydrologists and engineers introduced to deal with emergencies, but those patches added yet more toxins in a mounting, accelerating chain of events that produced an ecology in an extreme state of stress, one so complex and confounding that human-devised solutions appear to make no inroads.

Most likely, the results of Marei’s 4-year investigation were not ignored. Rather, planners realized they could fix the problem of installing 10 nuclear power plants on boggy ground that recirculated and magnified radioactive isotopes through the ecosystem by transforming the swamp into something better and more productive. This had been the unattained goal of regional reformers—whether czarist, Soviet, German, or Polish—for nearly a century (Blackbourn 2006:239–241). From 1961 to 1969, hydrologists overcame the marshes’ radiological shortcomings by ameliorating them. They dug canals to drain land for farming, built dams to form reservoirs for fisheries, elaborated a network of roads, schools and shops to serve the swamp dwellers who lived cut off from modern consumer markets, hospital, and educational services. In less than a decade, the land amelioration bureau of the Belarusian Republic dried out 1.9 million hectares of swampland. On the improved ground they planted crops such as rye, buckwheat, and flax, and to keep the crops healthy in the mineral-poor soils they added nitrogen fertilizers (Drozd et al. 2015; Marei 1974:26). The giant reactor complex worked as part of this larger vision. From it crews strung electrical lines and built a radius of roads and rails to serve a new nexus of logging and brick enterprises that were to transform subsistence swamp dwellers into modern producers and consumers.

Reactor number 1 at the Chernobyl plant started up in 1980. It soon started to emit radioactive isotopes as part of the daily

7. The Gomel Oblast, on the northern edge of the swamp, recorded an average of 35 nanocuries in human organisms and Chernigov in northern Ukraine 45 to 78 nanocuries, while people residing in Kiev and Minsk had 3 nanocuries.

8. The flame was 1,000 meters high (Chernogor 2008; and Olha Martynyuk interview with Leonid Chernogor, Kharkhiv, October 18, 2017).
operating order and because of “normal accidents” at the plant. Charles Perrow (1999) argued in his study of the Three Mile Island accident that nuclear power plants were so complicated to run that accidents were, rather than the exception, a normal feature of the working order of nuclear power generation. In the first 5 years of operation, the Chernobyl plant had 104 accidents, the largest one in 1982 at the troublesome reactor number 1. KGB officers monitoring the plant found that radioactive waste leaked into the cooling pond, which doubled as a fishery, and that the fish sold commercially had above-permissible counts of radioactivity (see fig. 3).

When reactor number 4 blew in 1986, Soviet scientists privately expressed two observations. The first was surprise that the “exemplary” number 4 reactor had exploded instead of the more troublesome reactors numbers 1 and 2. Second, they expressed relief that a major accident had not occurred sooner, given the design flaws of the Chernobyl RBMK-style reactor.10

As I pointed out above, the 50 million or more curies ejected from reactor number 4 in 1986 accelerated a longer process of fouling the surrounding territory with radioactive isotopes. After the accident, clean-up crews sped up the process of amelioration that had begun in 1961 after the first contamination event. Crews rushed in to build dams to stop the flow of radioactive wastewater toward rivers and underground reservoirs. They dug canals to redirect the drainage. They doubled and tripled the use of chemical fertilizers on crops to avert the uptake of radioactive mimics and to prevent farmers from fertilizing as they were used to with ash and manure, both of which had become radioactive. They stretched the electrical lines to power up new freezers and fridges placed in village shops in order to sell “clean” food (the word “clean” in quotation marks in Soviet documents).11 They extended gas lines so that villagers would cook and heat with gas instead of the traditional masonry stove powered by radioactive wood or peat. They rolled asphalt over dirt and gravel roads to keep the dust down. Billions of rubles and hundreds of thousands of people were tossed at servicing this ambitious project, which would have looked like high-modernist progress if it had not been in response to technogenic disaster.

The repetitious quality of this history reveals how long it has taken humans to acquire the ability to visualize toxins that imprint on ecologies and bodies. In order to become literate in the confusing, mottled landscape, I read in archives, in historical, ecological, and engineering literature. In attempting to reconstruct the destruction of the Pripyat Marshes I kept running into road blocks caused by the paucity of my imagination, the descriptive shortcomings of people who created the documents, and at times by a sheer wall of secrecy.

I was not the first to seek this education. Learning to visualize radioactive toxins, as Marei did, led to the search for solutions to them, which in turn inspired a march toward greater disasters, a process that ended in a full stop, for the engineered solutions to disaster failed. Despite awe-inspiring efforts to cleanse the landscape of radioactive isotopes, Soviet scientists had to concede a few years after the Chernobyl accident that cesium

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137 and strontium 90 and 10 other isotopes persisted in the food chain and in the bodies of residents. But before most of the new round of evacuations occurred, the USSR collapsed and money ran out for either resettlement or amelioration. As the post-Soviet economic crises deepened, subsidies for clean food, medical monitoring, and extended vacations away from contaminated land withered away. People who remained on contaminated ground, several hundred thousand people, were left to carry on alone, the welfare state dissolving around them. Bare life lay ahead.

I puzzled over the relationship between expert knowledge, the kind I make a living purveying, and destructive events that attend it in the name of improvement. My hope is that there is another kind of literacy in landscapes we can develop that carries with it more temperate repercussions. In several snapshots to follow, I will explore how I tried to imagine an education to gain literacy in posthuman landscapes. The following two episodes are from fieldwork I carried out with an elderly villager in a nearly depopulated village in northern Ukraine and with a team of international scientists working in the Chernobyl Power Plant Zone of Alienation.

* * *

Halia is 98 years old and lives in Nedanchichi, a small, mostly abandoned village in northeastern Ukraine that was not evacuated after the Chernobyl accident. For a while the villageotted on a fulcrum between existence and disappearance until villagers, given the choice, voted against resettlement. In the years that followed, young families left. Established elsewhere, they collected middle-aged and elderly family members. In the three summers I visited Halia, four households remained for year-round residence. The average age of villagers was well over 70.

What I found fascinating about Halia was her persistence. Except for a short stay in Kiev, she remained in the region for nearly a hundred years. Holding on in one place does not sound remarkable until you consider the violent history of the region surrounding the Pripyat Marshes. The vast littoral dissected by rivers. Strategic hillocks were entangled with barbed wire and, in places where the fighting had been intense, bleached bones lay exposed on sandy clearings (Mankivell and Loch 1924:53–66). Halia was up in the morning to see to animals in the shed and out in the garden while the morning was cool, hoeing, sowing, pulling weeds. As children do on the farm, she matured rapidly. She disappeared into and out of the forest, ranging surprisingly long distances. Sometimes children were with her. More often, as time passed, she was alone. Halia’s peregrinations changed seasonally but over 98 years remained steadfast: to the pasture and back, to the forest and back, to the river, to town and return, to the village square. There she was, over the seasons, across the decades, her figure bending and shrinking with time but her perambulations surprisingly resistant to change. What changed was everything else around her.

The WWI German army arrived from the east. It retreated. The czarist army surged up from the south and withdrew. A third rebel army appeared on the flat horizon with many soldiers in civilian dress. As the armies swept in, they quartered and requisitioned food, animals, bodies. They packed up families and sent them away. Eventually, all the armies retreated. Halia remained, leading the cow to the river bank, staking it, and searching the grassy bank for greens to make a sour fermented soup. Nearby a fisherman pulls from his net a giant sturgeon, a seasonal migrant to Pripyat Marshes from the Black Sea. A man on a flat-bottom canoe plies by silently on velvet-brown water. His horse stands impassively in the boat, the water so still that the horse and farmer are perfectly reflected on the stream’s smoky surface.

In the depth of the great famine, I see Halia walk a long way, slowly and emaciated, to a bakery where a woman gives her three loaves of bread to bring to her family. As she walks home, she furiously and guiltily devours one whole loaf.


14. For Soviet maps that show the military campaigns of World War I, Civil War, and Polish Soviet War, see http://www.rkka.ru/maps/gv5.gif. For interactive maps of the famine in Ukraine, see http://gis.huri.harvard.edu /historical-atlas/the-great-famine/about-the-great-famine-project.html.

15. US Army Aerial Maps, September 1943, RG 373 GX 16058 SK, National Archives Research Administration (NARA), College Park, MD.
Halia appears a few years later in the village center full of flesh. At a gathering, she raises her arms to dance, drawing her hands to her hips, moving with them. A young man appears at her side. On a grassy embankment, their limbs are entangled.

Halia and the young man emerge from a cottage in sheepskin coats. They leave on a packed sled. The couple return a few months later on foot. The man, now in the uniform of a WWII Red Army soldier, departs. Her stomach begins to bulge. She places a hand on it, as she leads a cow to the meadow to be staked. She looks up to see a reconnaissance plane flying low overhead.

The unfamiliar roar of a combustion engine breaks the bird-song Polesian peace. A heavy German tank tilts half-sunken in the morass. Soldiers curse and rev their engines. An officer with a swastika on his arm disembarks. Halia lines up with other women and children on the sandy expanse of the village square. They are searched, manhandled. Dogs bark, men shout, and people emerge from a cellar. Shots ring from the forest.

The village burns. Later, Halia stands alone amid the smoking remnants, pulling her toddler toward her.

Red Army soldiers arrive. They ask questions and take notes. As during the war, now after the war, people are hanged between poles in the village square. The bodies swing, slight and dripping, in a drenching rain.

After 3 years of war, the village is finally quiet. But in the decade, the tanks return. These are retrofitted as bulldozers to clear land. From the ashes of burned villages, construction crews lay out new settlements that no longer follow the rising earth and ebb and flow of seasonal floods. Now they match the geometric lines of a cadastral survey. In the WWII American reconnaissance photos taken over Halia’s village, hydrologic forces worked like brushstrokes on the yielding terrain, marking it with the fuzzy graininess of abstract expressionism. The landscape swirls like the flank of Franz Marc’s blue horse or gyrates like Van Gogh’s night sky—unfinished, raw, laid open. In the postwar decades, the wildly curving waterways are corrected, like a hand snapping a rug straight. Construction crews with heavy machinery remaster the landscape. The magical machines shrink distances and modify terrain. They pull the curling rivers into canals flowing in straight lines toward concrete dams. The canals drain water from the boggy land. In the newly girdled waterways, the indigenous river fish disappear and commercial breeds multiply. The water table drops. The annual floods become less encompassing. As Soviet reformers toil, the wild expressionism of the ebbing and flowing Pripyat Marshes transforms into the controlled geometry of Malevich: square fields superimposed over rectangular blocks.

And Halia is still there. Middle-aged, she walks to the square. Voices float up. Around her, the collective farm elongates, swelling across the former swampland. Pastures silt up with thousands of cows, sheep, pigs, and goats. Small vehicles and buses appear on freshly graded gravel roads. Solid brick structures take shape—a school, clubhouse, office building, a store. The good years of “planned farming” are aided by the farm chemical service. New crops—sunflower, corn, rapeseed—spring from the mineral-poor, sandy soils. The plants, enriched with chemical nitrates and phosphates, grow toward the sun as they never had before, but so too do fungi and insects. Planes dash by, trailing great clouds of sweet-smelling DDT.

Halia walking, almost always walking, often barefoot. By 1965, she had acquired a new pair of rubber boots. She hops over a drainage trench and disappears into the forest. As the years wore on, she ranges more widely for herbs and edible plants, having more trouble finding them (Lukasz et al. 2013; Movchan 2015). The ice dams mount in spring, the floods arrive, but not as they used to. The plants that needed the wet, flooded grasslands die off. Birds too are fewer.

Years of peace match years of drought. As water rushes through canals, lakes shrink. Ponds disappear. Gullies emerge in former stream beds. Halia no longer arrives home with her legs covered in mud. Near the new dams, the sweet, brown water has become crusted over with a green film of algae growing wildly on nitrate-enriched water.16 Midsummer, the flowering heaths dry out and turn a sun-bronzed brown. Forest fires flare up, sweeping across stands of pine and birch. The fires leave sandy deserts in their wake. As lakes and land drain, rivers and canals swell.

Nuclear reactors are thirsty for water to cool them. Forty kilometers southwest from Halia’s village, a massive construction site mounts. Construction crews toiled for a decade. They heaved monumental concrete blocks onto reclaimed ground, girdled by ramparts of steel plates. Surrounding them, more dams and reservoirs take shape. As they dig foundations, they unearth spent shells and grenades and the bodies of three WWII officers. In 1980, from enormous hourglass towers, columns of hot steam issue forth. A city, the likes of which the region has never known, springs up next to the plant: five-story, concrete-block apartment buildings and wide, straight boulevards lined with exotic flowers. Buses shift nicely, like on a model train set, up and down the streets. No mud, no thorns, no swampy ground. People wear shoes and Sunday clothing every day. At a library meeting in Pripyat, a woman with an Auschwitz tattoo on her arm tells young people, “We are building the first atomic station so that it brings us happiness and beauty, so that there are no more sirens and no more children’s screams.”17

The city alongside the Chernobyl plant existed for only 6 years. Late on a warm, spring night, the earth shuddered and thunder rolled from a clear sky. The world might have stood still for a moment during the Chernobyl explosion.

But it did not. The next day, buses labored up and down the country roads as always. Shepherds poked sticks at the backs of livestock heading to pasture. The animals hungrily tore at the sweet, spring grass while fallout fell around them. In the coming

17. V. Giorgianko, Utro atomograda, Ukretelefilm, 1975.
weeks, shepherds sheared their sheep, as they did every spring, and sent the wool, measuring 3.2 milliroentgens per hour, to the wool factory in Chernigov.18

Two weeks after the accident, soldiers arrived in a village near Nedanchichi. They ordered farmers to pack up and load bedding and tools in waiting trucks. They pushed the family cow and goats into pens and began shooting.19 Everyone cried. The soldiers, the tears, and bedding stuffed on carts reminded many of WWII 30 years before.

Halia’s village could stay, but in the years following, the community unraveled around her. A young couple packed up and left. Then another. A maintenance man shuttered the village school. At the village medical clinic, the staff piled files into the trunk of a battered car and drove off. Halia and a few elderly neighbors walked to and fro as before, from house to garden, from garden to meadow, in and out of the forest.

When Halia stopped speaking, my imagination drifted back to ground level, to the dark kitchen where we sat in the gathering twilight.

“How did you do it?” I asked. “How did you survive all that?”

“Live,” Halia leaned forward, looking at me suddenly sharply with her half-blind eyes. “Live! I just wanted to live, live, live.”

I had a similar sentiment, standing in a bleak forest, sweating in a Tyvek suit and mosquito netting, while I fumbled to shut off the piercing alarm of my Geiger counter that was measuring 1,000 microsieverts per hour. We were in the notorious Red Forest, which took the largest blast of radiation in the days following the 1986 explosions. Normally the Red Forest sent off gamma rays measuring at 50 to 100 microsieverts per hour, but a fire had swept through the forest 9 months before.20 Over 30 years, the trees had worked as cleaning agents, taking up radioactive nuclides and storing them in their trunks.

The hot flames of the forest fire denaturalized the wood, turning it into gas and ash to release radioactivity once again so that my Geiger counter was jumping in alarm, I with it. Like Halia, I too just wanted to live through that long, sweaty afternoon as I followed biologists Tim Mousseau and Anders Møller, who have been working in the Chernobyl Zone since 2000. We were there to retrieve nylon bags of leaf litter they had left in the woods the previous fall. Mousseau and Møller were testing a makeshift lab in the town of Chernobyl, the biologists dried, weighed, and measured the leaves for radiation.

The two biologists used the Zone of Alienation as a living laboratory. Mousseau and Møller argue that the beauty of doing research in the Chernobyl Zone is that it is not one uniformly radiating smudge on the planet. Chernobyl clouds missed some areas in the Zone, which today have naturally low levels of background radiation. Other spots are extremely radioactive, places, like the Red Forest, where a body should linger no more than a few hours. Meanwhile, some territories outside the Zone, where people live and farm, are far more radioactive than those inside the Zone.

Moller and Mousseau set up their research differently than most of the western scientists who have worked on Chernobyl topics and mostly have done lab work (Beresford and Copplestone 2011; Garnier-Laplace et al. 2015; Webster et al. 2016). What happens, they wanted to know, in the wild, when biological organisms are exposed to man-made ionizing radiation? This simple question is difficult to answer because of the innumerable variations on the landscape and within bodies of mice, voles, birds, and insects. Many field scientists study one creature—which ants or barn swallows. By narrowing their field of vision they can try to account for the most important variables a natural habitat and genetic variations serve up. Møller and Mousseau differ from the usual field scientists in that they are interested in most everything they can count and measure that pops into view. For this reason, their field lab is a cluttered place: mice in cages in the parlor; frozen butterflies in the aging fridge; mushrooms stacked in the hallway; fungi samples, sliced tree cores, collections of invertebrates on the porch. When the two scientists notice something odd, they set out to study it, to bring their observation beyond the anecdotal, which is the charge they level against the journalists and scientists who assert the Zone is a thriving nature preserve. Moller and Mousseau, in the words of Anna Tsing, appear to be trying to perfect the art of noticing (Tsing et al. 2017).

Mousseau, when he took a first walk in a forest of the Chernobyl Zone in 2000, was surprised to notice something odd. His face was clean. He was not clearing spider webs from it. Spiders normally string webs between trees across a path so that a person walking down it gets a face full of sticky webbing. Why no webs? Mousseau went actively looking for spiders and found few. When he and Møller made a formal count over 3 years in 700 sites, following line transects, they discovered that at very low levels of radiation (at below 100 times greater than normal levels) spiders decreased significantly (Moller and Mousseau 2009).

20. For a video showing the excursion and measurements, see https://www.youtube.com/watch?v=EP2Ycv8j7fA&feature=youtu.be.
Next, the two scientists searched for fruit flies. For geneticists and evolutionary biologists, fruit flies are the jam to their occupational bread and butter. Fruit flies have giant chromosomes and reproduce quickly so they make perfect subjects to trace genetic mutations. In the Chernobyl Zone, the two researchers had trouble finding *drosophila* (fruit flies) outside the town of Chernobyl, where radiation levels are below normal background. That too was startling. Most people have trouble getting *drosophila* out of their kitchens in the summer. Fruit flies feed on fruit. Møller and Mousseau discovered that fruit trees—apple, pear, rowan berry, wild rose, and cranberry bushes—in highly contaminated areas produced far fewer fruit. Wondering why, Mousseau and Møller looked for pollinators that fertilize fruit trees. They found few bees, butterflies, or dragonflies. The pollinators, they realized, had been decimated by the release of radiation in soils where the insects lay eggs. They found at 898 points around the Zone an average of one-third of a bumblebee and half a butterfly. With fewer fruit, not just fruit flies, but fruit-eating birds like thrushes and warblers suffered demographically and declined in number (Møller et al. 2012). Frugivores or fruit eaters, in turn, serve as seed spreaders, eating seeds and taking them elsewhere. With a decline in frugivores, fewer fruit trees and shrubs took root and grew. And so it went. The team investigated 19 villages in a 15-kilometer circle around the blown plant and found all of two apple trees that had seeded after the 1986 explosion. These two apple trees exhibit the tapering end point of the cascading effect of extinction. The peril of a few species of small, winged creatures magnifies to threaten the entire surrounding ecosystem.

Noticing the absence of fruit flies led to Mousseau’s Silent Spring moment. Rachel Carson’s 1962 blockbuster, *Silent Spring*, documented that DDT, sprayed commonly to kill suburban insects, was also decimating wildlife, especially birds, in communities across the United States. In her preface, Carson wrote that she noticed one day that the birds in her lush District of Columbia suburb had gone silent. This simple act of observing changes in her environment sent her on a quest that led Carson to write the seminal text that inspired the American environmental movement.

On a previous trip in 2014, I had observed a team of biologists that included a group from a Finnish university as they worked on voles they had trapped in parts of the Zone. After catching the animals, the scientists measured and weighed them and ran them through a mass spectrometer to record the animals’ bodily levels of cesium 137. They then tagged the rodents with pea-sized crystal gamma counters and released them where they found them.

As we drove around the Zone, escorting the voles home, I practiced reading the postnuclear landscape by reckoning approximate radiation levels and matching my guess to the counter. It became a kind of game, if a dispiriting one. In the shtetl of Chernobyl where visitors stay in a makeshift hotel, the birds in June started to sing at 3:00 a.m. and increased in volume and intensity by sunrise to a riotous barrage. In some places as we dropped off voles, I listened for birds and heard only a few shrill calls that were left unanswered. I would check my counter to find high rates of radioactive decay (30–40 microsieverts per hour). The forests themselves differed from place to place. Pine trees are especially vulnerable to radioac-

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21. Bees, butterflies, and dragonflies lay their eggs in herbs just above the soil or in the soil. Most radiation around Chernobyl is in the topmost 10-cm layer of soil. The decrease in abundance ranged from 72% for bumblebees and 40% for butterflies. Møller, Barnier, and Mousseau 2012.

22. Carson had engaged in fieldwork for decades before she wrote *Silent Spring* (1962). Her literary reporting of her moment of insight might be just that.
tive decay. Few pine grew in places of radioactivity higher than 40 microsieverts. When they did, as I mentioned above, they tended to have mutations. In the Red Forest, most of the new growth was in the form of birch trees. The pines trees that were growing had become shrubs. Instead of the lush green undergrowth in radioactively cooler areas, the floor of the Red Forest had little vegetation. The ground was brown from undecomposed pine needles and fallen leaves. These forests did not smell like a forest, most of which is the smell of decomposition (see figs. 4 and 5).

At the second drop-off spot, the dosimeter measured 10 microsieverts on the road. As we stepped into the forest, it gave off a warning beep at 30–35, then rose to 42 microsieverts per hour. I did not relish the feeling of walking through woods knowing they were “hot,” though I knew that by current radiation standards I was in no danger unless I remained in that spot for months, ate and drank from it, and burrowed in the top layer of soil, as insects and voles did.

As we turned over the cages, again the frightened voles made a dash for it. One vole with a handful of pups moved quickly to use the hay inside the cage to form a nest. We left the cage behind so she would not abandon her pups, pink, embryonic creatures that made surprisingly loud peeps. We made quick work of it and headed back to the road, where the dosimeter reading dropped in half. Radioactive isotopes concentrate in biological organisms, which means the more living organisms, the higher the readings. In contrast to everyday life, asphalt in the Zone is safer than the quiet forest.

Some biologists are critical of Mousseau and Møller’s work because they say their experiments are not double-blind. Double-blind trials call for the researcher to have no information that may influence his or her behavior while carrying out a trial. Obviously, scientists in the Chernobyl Zone know they are on a radioactive landscape and so, critics say, they look for evidence to confirm their preexisting ideas about radiation’s effect on biological organisms. My skittishness, for instance, under the field of a beeping monitor could manifest in skewed research results. Mousseau answers this charge by pointing to the ranging and mottled quality of contamination levels in the Zone. It would be impossible to have experimenters who did not know they were in the Chernobyl Zone, but once there, scientists are ignorant of the extent of the surrounding field until the dosimeter tells them. Mousseau and Møller set up experiments where they gather information blindly. They take a census, for example, by first counting the number of butterflies or birds and then measuring for radiation levels. A second biologist makes a second count, also blind to radiation levels, to check against the first census. They believe their science is sound, their methods tried and true. “Taking a bird census is not rocket science,” Møller noted. “Not much can go wrong because so many people have done it for decades in Europe so we have validation of the method from a multitude of studies.”

Even so, rival scientists contest their results. They contend that Mousseau and Møller do not take into account genetic diversity, that their calculations are wrong, that they need more radiation readings to link their results with radiation levels (Beresford and Copplestone 2011). Mousseau and Møller change their studies to answer their critics and they keep working. In 2015, the physicist James Smith made headlines by publishing a letter stating that long-term census data reveal abundant wildlife populations in the Chernobyl Zone (Deryabina et al. 2015). I contacted Smith to ask if I could follow him on his next trip to the Zone. He replied that he had no immediate plans to visit though he had visited the Zone in the past and would go again. He did his work at his desk with data collected by Belarusian researchers in the past or derived from camera traps his assistants set up around the Zone. On meeting him at a conference in Florida, I told Smith about the records I had found of rashes of illnesses in contaminated regions around the Zone. Smith asked me repeatedly about radiation dose levels. With a dose level, he could tell without having to go to the Zone about estimated damage from radiation to plants and animals. He did not need to perfect the art of noticing. Computational studies combined with radiation levels told him all he needed to know.

Figure 5. Mutated pine tree. (Photo by Kate Brown.) A color version of this figure is available online.
The media took up the promise of the “thriving Chernobyl Zone” and pitted it against the gloomier picture Mousseau and Møller present. This is called “balance,” but in the case of Chernobyl, it means that the opinions of scientists who have limited experience working in the Zone get equal print space as those who are logging long hours in radioactive forests. The debate over whether the Zone is thriving or not is a nonstarter for Mousseau and Møller because the evidence is overwhelming. “Every rock we turn over,” Mousseau said, “we find damage.”

The evidence is etched in the ecosystem of the Zone, into the bodies of mice, the leaf litter of the forest floor, and the tumors that cloud the vision of barn swallows they catch. Møller noted that in 16 years working in Chernobyl, he has encountered fewer other scientists. Perhaps because the work is tedious, repetitive, and unglamorous, not many scientists have been willing to pose the long-overdue questions about the effect of chronic low doses of radiation on biological organisms even while these questions are germane in more and more places around the globe.

Mousseau and Møller are practicing the kind of science left to more-than-human landscapes, a science that is dirty, painful, and hazardous as much as it is creative and invigorating. Theirs is a branch of knowledge that looks for new forms of literacy. Halia, meanwhile, is the survivor on a raft she rode through a charred remnant pitted with destructive forces powered by a vision of reform and national security on a larger stage of events. Forcing ourselves to look at that ugly tree in a bomb crater makes for the start of a new kind of literacy that takes us into the future.

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The Tree Snail Manifesto
by Michael G. Hadfield and Donna J. Haraway

Focused on the lives and deaths of Pacific Island tree snails, the crafting of apparatuses and practices for their study in laboratory and field, and the diverse people engaged in the work, this double-voiced essay by two long-term friends and colleagues joins science, politics, and culture to contribute to multispecies environmental justice and island biopolitical geography. In part 1 Hadfield tracks his own trajectory, beginning with professional life as a “pure scientist,” fascinated by patterns of development of marine animals, and then finding that fascination moving to efforts to stop the extinctions of native Hawaiian land snails, conservation efforts across the Pacific, and ultimately teaching and practicing resistance to political suppression of science and military takeover and destruction of islands around the world. In the idioms of science studies and anthropology, part 2 by Donna Haraway plays cat’s cradle games with Hadfield’s land-and-sea EcologicalEvolutionaryDevelopmental biology and activism. Haraway explores the complexity of practices crucial to life-altering scientific caring in the patchy Anthropocene. Parts 1 and 2 are linked by Satoru Abe’s print Parting Trees B, which is a vital hinge for collaborations in the Tree Snail Manifesto.

Preamble
Writing by one of us reaches into writing by the other to symbiogenetically shape a manifesto that is simultaneously scientific, political, personal, and cultural. The shared infection is love of the mortal earth and its vulnerable but hardy living beings. The TSM tells of real places, where structurally shaped patchy links along multiple temporal and spatial scales form mosaics typical of the Anthropocene. The TSM explores how conditions of unlivability develop for both humans and for other species, so as to emphasize also practices for nurturing more hopeful patterns of relating (Tsing, Mathews, and Bubandt 2019). The symbiosis linking the authors of the TSM is part of contemporary movement toward multispecies environmental justice, for humans and nonhumans alike, in situated places for particular beings, in times of manifest destruction and injustice. Like most trajectories in life, the cross-hatched lines of thinking in this manifesto were full of surprises biographically and intellectually, reconnecting the writers in a shared project that neither anticipated. Our two-voiced paper might itself be a patch of the holobiome of Pacific Island tree snails living on a damaged earth.

Through his life and professional trajectory, Michael broadened his scope of inquiry from one field within biology to others, which required resistance to the wanton disregard of both science and nature underway in many parts of the world. Making string figures with EcologicalEvolutionaryDevelopmentalHistorical biology (EcoEvoDevoHisto), Donna diverged from practicing biology directly into an exploration of what both natural and social scientists do and how it matters. The inner tissues of Donna’s way of doing science studies changed in concert with Michael’s reshaping his biology into what Donna calls biogeopolitical science as the core of his practice.

We hope that readers join a dialogue through reading both sections together, in reciprocating resonances, linked by Satoru Abe’s magnificent print Parting Trees B that appears between parts 1 and 2. The almost-but-not-quite mirror images of skeletal trees, blown into beauty in light and dark, yearning together and apart, are stark but also intensely elaborated forms that embody what we are trying to write.

This dialogue reveals our shared belief that we live on a bountiful earth as and among vibrant beings. Living in peace requires protecting and restoring an earth that can be a home for all. The year of the composition of the Tree Snail Manifesto threw dangers at this homeworld like few before it. We have watched willful governmental changes in the United States to undermine rational respect for and use of the careful scientific information available to us concerning climate change and historically situated human actions as the cause of it. We have seen cold plans to put in place physical and legal barriers to the flow of desperate people into our country from around the world. We have watched in dismay the political dismemberment of programs designed to assure adequate health care for all. Amid resurgent racist and misogynist language and policy, we have counted new extinctions and extractions across the earth. This must be reversed, and we are dedicated to this reversal in whatever ways are available to us.

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Together, in just one small story in one place extended in time and space, we explore the complexity of practices crucial to life-altering scientific caring that ties research to colonial and decolonial institutions, population surveys, incubators, predator fences, websites, angry letters, fierce colleagueships, and a host of organisms. The Tree Snail Manifesto is an invitation to join us on the slime trails of resistance and rebuilding.

The Ecological Evolutionary Development of a Pacific Island Tree Snail (Marine) Biologist: The Tree Snail Manifesto, Part 1

Michael G. Hadfield

I. Trained to Be a Marine Biologist, Focusing on the Development and Reproduction of Marine Invertebrate Animals: From Washington State to Hawai‘i, with Major Stops in Between

I became addicted to marine labs in the spring of my junior year at the University of Washington, when, on a field trip to the university’s Friday Harbor Marine Laboratories (fig. 1), I simultaneously discovered what great and beautiful places marine labs are for work and that you could actually do that kind of work for a living. I have subsequently spent most of my life studying and teaching at marine labs around the world. Within those labs, I focused my interests on the life histories of marine invertebrates—snails, sponges, worms, corals, crabs, etc. However, as will become abundantly clear below, a result of learning a lot about the life histories of marine snails eventually led me to a major involvement with land snails as well.

After earning bachelor’s and master’s degrees in zoology at the University of Washington, I was awarded a Fulbright fellowship to study for a year at the marine laboratory of Copenhagen University in Denmark, where I could focus, full time, on studying marine larvae. Leaving Denmark, I went to Stanford University to pursue a PhD, spending most of my time at Stanford’s Hopkins Marine Station in coastal Pacific Grove, California. By the time I arrived at Stanford, I had carried out research on a variety of different marine invertebrates, including small and interesting animals in the phylum Phoronida for an undergraduate project, a strange sea cucumber for my MS thesis, and the larvae of nudibranch gastropods in Denmark.

Thus, it wasn’t strange that I would try several different research projects at the Stanford lab before finally focusing my dissertation studies on the reproductive biology and development of some amazing coastal snails, the Vermetidae. After short, free-living larval lives, these snails cement their shells to a surface, give up coiling, and live in shells that greatly resemble worm tubes (fig. 2, left). Anchored to rocks, they cannot crawl around to find food but instead secrete long, sticky
mucous strings from glands just below their mouths, which stream out into the seawater and trap floating detritus (fig. 2, right). Periodically, they haul in the threads with a rough, strap-like tongue and swallow them. Being glued to the rocks also requires special adaptations for breeding, and one of my discoveries was that the snails make complex capsules to contain their sperm, spermatophores, which are released into the sea where they disperse and, with good fortune, get stuck on another snail’s feeding mucous strands. When the snail hauls one in, its teeth puncture the spermatophore, causing it to “explode” and literally toss an inner sperm bundle into the water, where it is drawn by respiratory currents into the mantle cavity—a lung-like space along the snail’s back that houses the gill—and then into a special receptacle designed to hold the sperm. Remarkably, these stuck-down snails manage to have internal fertilization even though they cannot get together to mate.

The development of the vermetid snails was also fascinating, beginning with eggs encased in capsules that remain in the mantle cavity until they hatch. Amazing things happen within those capsules. In one vermetid species, all the eggs develop into small larva that hatch and swim in the ocean for days or weeks before settling to the bottom, attaching and completing metamorphosis. Another species I studied packs around 100 eggs into each capsule, yet only a single small snail emerges! All but one of those eggs serves as “nurse eggs,” to be eaten by the one that develops, and that individual passes right through its larval stage and hatches as a small crawler with a shell a millimeter or so in length. My dissertation described all of this, plus details of sperm formation gained with the electron microscope (and if things weren’t already bizarre enough for these snails, they also make two kinds of sperm, one of which is a giant that has nothing to do with fertilizing eggs!) (Hadfield 1970; Hadfield and Hopper 1980; Hadfield et al. 1972). It was clear to me as I left graduate school that I would spend my life, one way or another, studying the development, and especially metamorphosis, of marine invertebrates. And so I have.

Directly from graduate school, I taught at Pomona College in Claremont, CA, an outstanding undergraduate school with excellent students. However, during my first year I found that I badly missed time for intensive research, and so with excitement, in 1968 I accepted an offer for a faculty position in the Pacific Biomedical Research Center at the University of Hawai‘i. The center had received National Science Foundation funding to build a new marine laboratory on the coast in an ideal location in Honolulu. The university had hired a noted cell biologist from Dartmouth College, Robert E. Kane, to oversee construction and to direct the new lab, as well as hire a research faculty to staff it. The focus of the lab was to be on employing Hawaiian marine animals as models for basic research in cell and developmental biology. Five of us made up the faculty when we occupied the Kewalo Marine Laboratory, and our research spanned a range from the kind of work I did on reproduction and development, pretty much whole-organism biology, to that of a biophysicist colleague doing fundamental research on the subcellular mechanisms of ciliary beating.

Although 4 years passed before the new lab was ready for use (fig. 3), I had already launched a series of experiments on several Hawaiian marine animals, some in the family of vermetid snails. However, I soon found a very useful nudibranch gastropod, Phestilla sibogae, which was to be the focus of many of my lab’s studies on development and metamorphosis for most of the next 30-plus years. These hermaphroditic sea slugs feed on an abundant local coral, mate there, and lay their eggs in jelly-like ribbons attached to the coral skeleton (fig. 4). The eggs develop into swimming larvae in about a week and then must spend at least another 3 days swimming in the ocean until they are developmentally capable of settling to the bottom, attaching, and undergoing a dramatic metamorphosis into small slugs (fig. 5, left) (Bonar and Hadfield 1974; Hadfield 1978). In doing so they shed calcified larval shells and, within a few hours, lose the ciliated organ, the velum, that allowed them to swim and feed in the plankton. In less than 20 hours they transform from small swimming hermaphroditic larvae that feed on single-celled algae into bottom-dwelling carnivorous slugs that eat coral.

Because it is easily maintained in the lab from egg until senescent death, P. sibogae proved to be an outstanding model
organism for studying a wealth of questions pertaining to larval development, metamorphosis, and the hydrodynamically tricky processes faced by a tiny larva (0.2 mm long) that must settle only on the “right” coral to complete its life (Hadfield and Koehl 2004; Hadfield and Pennington 1990). My research team and I have published more than 40 papers dealing with aspects of the development of this nudibranch and have established it as a model for exploring the induction of metamorphosis of marine invertebrate animals by dissolved cues (Hadfield 1977, 1986b; Hadfield and Paul 2001; Miller and Hadfield 1990). While we now understand where and how the larva receives the coral cue for settlement, how that cue activates all the processes of metamorphosis and what those processes are, we still have no answer to the question, What is the substance produced by corals that induces all these changes in a sea slug larva? We are still trying.

Since 1990, we have also studied the settlement and metamorphosis of the planktonic larvae of a worldwide marine “fouling species” (animals and plants that create major problems because of their accumulation on the hulls of ships, docks, and pilings and in the pipes that bring seawater to cool coastal electrical plants and factories), a tubeworm named Hydrodides elegans (figs. 5, right, and 6). These worms live in warmwater bays and harbors around the world, and their larvae settle in response to cues from bacteria resident in biofilms that are ubiquitous on all surfaces submerged in the sea. This research has led my lab into an entirely new and exciting sphere of marine microbiology and animal-microbe interactions. More than 25 papers from my lab group to date focus on experiments with H. elegans, its larvae, and their complex interactions with specific marine bacteria (Hadfield 2011). Collectively, studies on development and metamorphosis in my lab have formed the basis for theses and dissertations of 32 graduate students and a host of papers by postdoctoral fellows and myself. This remains a very active research area in my lab, producing exciting discoveries, mostly on the role of bacteria in inducing larval settlement and metamorphosis (Carpizo-Ituarte and Hadfield 1998; Freckleton et al. 2017; Hadfield et al. 1994, 2014; Huang and Hadfield 2003, 2012; Nedved and Hadfield 2009; Pettengill et al. 2007; Shikuma et al. 2014). Altogether, we have published on eight marine invertebrate phyla, spanning the range from sponges to crustaceans. These studies continue to dominate my professional life.

II. Entering the Field of Evolution and Extinction: Studies on Hawai‘i’s Unique and Vanishing Tree Snails

If she or he didn’t know it before moving to Hawai‘i, any biologist would soon learn about the many amazing evolutionary radiations that produced many unique plants and animals here.

Figure 3. Kewalo Marine Laboratory, University of Hawai‘i at Mānoa. A color version of this figure is available online.

Figure 4. The nudibranch Phestilla sibogae on their prey coral Porites compressa; two adults and an egg ribbon are above the animal on the left. These slugs are about 2 cm long. A color version of this figure is available online.
Among them are 11 families of land snails, including many that live exclusively above the ground on bushes and trees. I began observing the Hawaiian tree snails out of curiosity, knowing already that their handsome shells and great diversity had been recognized and publicized since the mid-1800s. John T. Gullick, a Congregationalist missionary and shell collector, had proposed a theory for the evolution of the many species in the tree snail genus *Achatinella* that proved to be correct, although not based on Darwinian evolution by natural selection (Gullick 1905). Forty-one species of *Achatinella* once graced the native bushes and trees of O‘ahu, from the seashore to the mountain tops (fig. 7) (Pilsbry and Cooke 1912–1914). Unfortunately, by the time I first saw the snails in 1973, at least two-thirds of them were extinct due to the combined pressures of habitat loss (sandalwood trees harvested for export to China; large hardwood trees cut down for ship masts and spars; understory destroyed by introduced pigs, goats, and cattle; and forests cleared completely for agricultural development), shell collectors (Hawaiian tree snail shells number in the millions in the collections of museums in Hawai‘i, Europe, and North America), and finally, introduced predators (three rat species, carnivorous snails from the US Southeast introduced for biological control, and most recently, Jackson’s chameleons, escaped from the pet trade). As far as anyone has been able to determine, the large and richly diverse Hawaiian land snail fauna evolved in the absence of predators, so the invasion by many different species and types of snailivores had a devastating impact on the defenseless snails.

Seeking to understand why the remaining snail populations were in such bad shape and wishing to contribute to understanding of the snails beyond knowledge of their shell variations, we undertook classical mark-recapture studies on snail populations in the field that eventually spread to four of the main Hawaiian Islands. With this approach, an investigator selects a delimited area inhabited by the study species and attempts to benignly mark all of the individuals within it. For us, marking was relatively easy, because the snails’ hard shells provided firm surfaces on which to inscribe “names” such as “A5.” On each visit to the study quadrat, we timed ourselves to collect all the snails we could find in, say, 1 hour in a particular sector of our field site. We then, one by one, took notes on each snail, such as the color pattern, the direction of its coiling, and whether or not it had a thickened lip around the mouth of the shell, which indicates that the snail has quit growing and has become sexually mature. We measured each shell in two dimensions and assigned it an individual letter-number name, which we wrote on the shell in India ink and coated with a clear, waterproof lacquer. On each subsequent visit—usually spaced at 2-month intervals—we repeated the entire process. For each snail previously seen, we recorded its number and measured it again. We also marked and measured any snails that we had not seen previously.

Over time, the data collected from such studies allowed us to accumulate a large amount of demographic information about the snails, such as the size of the total populations, size at birth and maximum size, growth rate, fecundity, and life span. While it had long been known that the achatinelline snails gave live birth to relatively large babies 4–5 mm long (fig. 7, lower right), the understanding we gained of very slow growth resulting in very late maturity (4–6 years before first offspring), exceedingly low fecundity (4–6 offspring per year),
and relatively long lives in the absence of predation (15 years or longer) was startling. No other such snail life history had ever been reported, and we found it repeated for population after population and species after species of Hawaiian tree snails. It also began to reveal why the alien predators were able to decimate entire populations in short periods of time; the snails are vulnerable to predation for up to 5 years before they add even a single offspring to the population. Learning from scratch how to analyze and illustrate the results of demographic studies was no mean task for someone not trained in ecological methods. Still, in 1982 we published the first paper to ever describe the surprising life-history details of the Hawaiian tree snails. Our subsequent papers noted the roles that both life histories and predation by alien species (including humans) were playing in the great extinction rates of the snails (Hadfield 1986a; Hadfield and Miller 1989; Hadfield and Mountain 1980).

Politics delayed Endangered Species designation for the Hawaiian tree snails. As early as 1976–1977, the US Fish and Wildlife Service (USFWS) had begun considering the addition of the *Achatinella* species to the US List of Endangered Species (referred to as the ESA, Endangered Species Act, list). As part of this effort, I began presenting our data, as well as our field observations on disappearing snail populations, to local and federal agencies in support of the listing. The listing proposal was complete and had received favorable recommendation within the USFWS by 1981. However, in January of that year, Ronald Reagan was inaugurated as president of the United States, and one of his first acts was to suspend any new listings for ESA list.

Interestingly, I had accepted a contract from the Hawai‘i State Department of Transportation in late 1981 to survey for tree snails (assuming they would be listed in the immediate future) in a valley through which a major freeway was proposed. Although billed as a route to relieve traffic pressure on existing O‘ahu highways, the planned route directly connected two major military installations on the island, and indeed the funds to construct it had been transferred from the US Department of Defense to the Hawai‘i Department of Transportation (DoT). As it turned out, my team and I found no living achatinellid snails along the planned freeway route (although shells from extinct populations were there), which we reported to the DoT. Very soon thereafter, the White House allowed the Hawaiian tree snails to be listed, including all 41 species in the genus *Achatinella* (Federal Register 1981, 46:3178–3182). This is the only group of organisms ever listed at the genus rather than the species level, in great part because it was impossible to know which of the 41 species were already extinct.

I had a strong suspicion that, had we found living snails along the planned highway route, because of the contentious politics around many Endangered Species designations, the Hawaiian snails would not have achieved listing until perhaps many years later. An inevitable result of our successful listing efforts was the...
necessity for us to obtain federal and state permits for all of our future research on the snails. And, sadly, the highway was built (fig. 8) despite great resistance from Native Hawaiians who valued the cultural heritage of North Halawa Valley and many ancient sites located there.

Soon after our first paper on tree snail demography appeared and the snails were ESA listed, I was contacted by state agencies and private groups to request that we conduct field surveys for the presence of the endangered snails along proposed electrical line routes and wind farms, areas subject to intense military practices, and other construction projects that would impact native forests potentially harboring snail populations. In addition, a massive hurricane hit the island of O‘ahu in late 1982 and extensively damaged forests in some places, stimulating my students and me to survey those places to determine the wind’s impact on the endemic snails. We were also asked to survey areas on the island of Moloka‘i recently acquired for management by the Nature Conservancy and on Maui on privately owned lands where snails had been noted. Each site required more mark-recapture investigations to understand the stability of populations and the absence or presence of snail predators. In several places we initiated studies that lasted 15 years or more, with visits at 2-month intervals (Hadfield and Miller 1989; Hadfield, Miller, and Carwile 1993; Hadfield and Saubler 2009). Not only did these studies inform about urgent conservation issues but they also provided much greater understanding of the biology of the snails and, importantly, their evolutionary history.

For example, our studies of a series of single-tree populations of an achatinellid species, *Partulina redfieldii*, whose shells show great variation in color and banding patterns, scattered across a high-elevation meadow on Moloka‘i (fig. 9), enabled us to recognize that the populations were relatively recent, only 15–20 years old, and that the populations in each tree were recognizably different from each other. A study by one of my graduate students revealed that these hermaphroditic snails were capable of self-fertilizing, meaning that each one-tree population could have been founded by a single or very few individuals and...
explaining why all or most of the snails in each tree had shells of only a single pattern and color randomly "selected" from the forest surrounding the meadow (Kobayashi and Hadfield 1996). These observations supported Gulick’s hypothesis that the large number of snail species found on O‘ahu and distinguished only by their shell shapes and colors arose by geographic isolation of local variants of single species over sufficiently long periods of time that the differences became fixed and the variants were no longer capable of interbreeding if the populations eventually spread to a point where they overlapped. That is, typical processes of natural selection appeared not to be part of the speciation process. Recently we learned that we can extract useful DNA from the old shells we collected from the ground during our visits to the Moloka‘i meadow in the 1980s and 1990s. With this DNA, we are examining the number of potential ancestors for each tree’s snail population during the years of our studies (1982–1995). That is, we are still learning new things about these snails from shells gathered in the field more than 45 years ago.

Another study we contracted was a survey of Mākuʻa Valley, a beautiful valley on the northwestern coast of O‘ahu that had been progressively taken by the army for live-fire training beginning in the 1920s (Kelly and Aleck 1997). Once a home area for many Hawaiians who farmed the valley bottom, the steep sides and back of the valley had also been home to a wide variety of native plants and animals, including O‘ahu tree snails. Conducting the searches was strenuous, in part because we could only get road transportation (in itself almost a 2-hour drive from town) about half-way up the valley and had to hike several more hours to get into the areas where the snails might be. Additionally, because of large amounts of unexploded ordnance known to be present, we were required to undergo training to recognize shells, bombs, and rockets and to understand the dangerous features of each, including more than 90 different types of exploding devices. Some ordnance was pointed out as exceptionally dangerous, for example, fist-sized golden shells shot from cannons mounted on helicopters and typically fired almost horizontally at structures. Because of the incredibly dense cover of “elephant grass” over much of the amphitheater-like back of the valley, we were told, the shells could hit the flattened grass and bounce along like rocks skipped across a lake, and not explode. However, such shells would be armed and ready to explode with any kind of disturbance, even the heat shift that could occur if one of them was shallowly buried under grass where one of us might choose to urinate! Due to these dangers, we were required to be accompanied by Army EOD (Explosive Ordnance Device) specialists, enlisted men who would precede us at every move we wished to make.

Picture trying to search a forest for tree snails where, before each move, you must tell another person, “I want to look at that tree over there,” and have that person walk ahead of you to the tree. It made for very slow going. However, we did see evidence of the danger several times, such as when we spotted an unexploded rocket lying in a dry streambed, with its fuse partly burned, and a 1,000-pound bomb we found high up in a side valley. (We subsequently noted in the local newspaper a warning to nearby residents of the area that the army had found a large bomb left over from WWII practices and would blow it up on a specified day.) And we found the snails, Achatinella mustelina, some in trees with bits of exploded rockets in them. Their persistence was made even more precarious because the army’s maneuvers sometimes caused the grasslands to catch fire and the fires to burn up into the native forest. Each year more forest habitat of endangered snails, birds, and plants disappeared, to be replaced by the 8–10-foot-tall stands of invasive elephant grass.

One of the field sites we had established early in 1982 was above the north rim of Māku‘a Valley, which gave us an opportunity to track the destruction of army practices in the valley from year to year (fig. 10). My alarm at the rate the forest was disappearing led to one of my first “acts of resistance.” I escorted a talented lawyer from the Sierra Club Legal Defense Fund (now Earth Justice) to the valley rim and showed him what was happening. Eventually, the organization filed suit against the US Fish and Wildlife Service to force ESA-Section 7 consultation between the USFWS and the army over violations of the Endangered Species Act and, after a lengthy period of legal arguing, to a now long-standing cessation of live-fire activities in Mākuʻa Valley.
Figure 9. The Snail Meadow on Moloka‘i where we tracked single-tree populations of tree snails for more than 15 years. A color version of this figure is available online.

Figure 10. Mākua Valley, O‘ahu, Hawai‘i, where the US Army practiced live-fire training for more than 65 years. Large brown scars running up the ridges are areas where the forest was destroyed by fires started by ordnance explosions. This forest is/was home to endemic snails, birds, and plants. A color version of this figure is available online.
III. Disappearing Snail Populations in the Field Compel Us to Establish a Laboratory Devoted to Their Captive Propagation and to Construct Fences in the Field to Protect Snails from Predators

Our continuing demographic studies and more published papers brought much greater public notice of Hawaiian snails as Endangered Species and recognition that their safeguarding and recovery deserved federal financial support. We began to have our research funded by the US Fish and Wildlife Service. Grant funds allowed us to continue the field studies on three islands and, importantly, to establish a laboratory focused on rescue and propagation of rapidly declining snail populations.

After extensive experimentation on ways to maintain tree snails in the lab through multiple generations, we purchased expensive environmental chambers, roughly the size of large refrigerators, in which temperatures and day-night light cycles could be set to approximate those in the field (fig. 11, right). Nearly all snails ingest their food by scraping it in with a radula, a long strap of tissue bearing rows of teeth that vary depending on each snail’s food: large, tearing teeth for carnivores and smaller and more numerous teeth for herbivores. Because the tree snails feed exclusively on molds scraped from the surfaces of leaves in their host trees, we had to solve the problem of food supply by harvesting leafy branches from the native oh‘ia lehua trees (*Metrosideros polymorpha*) upon which the snails are most frequently found in the forest. Gathered at approximately 2-week intervals for the terraria in which the snails are kept in the environmental chambers, the leaves supplied both food and a more natural substratum. In addition, we isolated a black mold species from oh‘ia leaves and learned to culture it on an agar medium; this is placed in the terraria, along with fresh leaves, at approximately 2-week intervals (Hadfield, Holland, and Olival 2004).

Over a period of 25 years we accumulated lab populations of 16 achatinelline snail species from five islands. The lab populations were started with small numbers of field-collected snails, usually between four and ten. Despite the great similarities of habitats, host trees, and life-history characteristics across the achatinellid species, their survival and reproduction in the laboratory chambers was very uneven. Some thrived from the start and quickly enlarged their numbers by births. Other populations grew very slowly or not at all. Among the latter were species such as Maui’s *Newcombia cumingi*, which never increased in the lab, dying one by one until the lab population was gone. By contrast, the lab population of *Achatinella lila*, which I started from seven snails brought from the field in 1997, grew to 620 by 2009. However, in successive years, with the tree snail lab under a new manager, numbers in all captive snail populations plunged, and by 2014 only 177 *A. lila* remained in the lab. In the field, this species is teetering on the brink of extinction, with the source population now extirpated. With increased state and federal oversight of the lab operations, some of the remaining captive snail populations began to recover, so much so that by summer 2016 there were 272 *A. lila* in

![Figure 11. Preserving snails in field and lab. Left, a predator-excluding fence built around ~120 m² of native forest with tree snails. Under the short roof are a two-wire electric fence (note small solar panel in tree to keep the battery charged) and a trough containing rough salt, both for repelling predatory snails and rats. Right, an environmental chamber in the laboratory where snails are maintained in small terraria with leaves from native trees. The chambers control both day length and temperatures to simulate the field environment, and small hoses bring water for spraying the terraria four times per day. A color version of this figure is available online.](image)
the lab. More recently, we have focused studies on the long-
term impacts of captive propagation of the Hawaiian tree
snails (Price and Hadfield 2014; Price et al. 2015).

From very early in our tree snail studies I was aware of
others deeply concerned with the high rates of extinction of
demic island snails. Snails of the family Partulidae are
known to occur mostly as single-island endemics across the
tropical Pacific Ocean, from the Society Islands in the east to
the Northern Mariana Islands in the west. Excellent studies
had focused on these snails as examples of evolutionary ra-
diation. British and American scientists carrying out those
studies had also noted rapid decline of the tree snails on
many islands in French Polynesia and set up captive breeding
programs in England. In 1994, I first met people at the In-
vertebrate Conservation Center established by the Zoological
Society of London. We began a lively exchange of information
that eventually included details of the design and construction
of barriers erected on Moorea Island to protect snails re-
introduced from the London captive populations in an attempt
to repopulate the island, whose endemic snails were thought to
be extinct. I visited that predator-exclusion fence in 1998 and
observed both its attributes and shortcomings. Although it suc-
cceeded in protecting the snails from London while the ex-
closure was frequently monitored to make certain no branches
or ferns had breached its walls, such care was lost after a year
or so, predators got in, and the tree snails vanished.

From my firsthand familiarity with the Moorean exclosure,
I worked with Hawai’i Department of Forestry and Wildlife
personnel to design and build such an enclosure around a
threatened snail population within one of the state’s natural
area reserves. This predator-proof fence—designed to exclude
both rats and the alien predatory snail—was made of corrugi-
gated roofing material buried in the ground at its base and
4 feet high (fig. 11, left). At the top, an outward-sloping roof
protected two snail-exclusion devices from rainfall: a salt-filled
trough and a two-wire electric fence above the troughs. The
electric barrier was fed by a 12-volt battery kept charged by a
small solar photovoltaic panel. Three lines of barbwire in-
stalled on top of the fence were there to discourage human
hikers from entering the enclosure. We got in and out with an
A-shaped folding ladder that we kept locked outside the ex-
closure. Inside the fence, we maintained rat-bait boxes filled
with poison bait. It worked! The first enclosure surrounded
a snail population we had monitored with mark-recapture
studies beginning in 1982 and had watched it grow from about
100 snails to more than 300 by 1986, when predators moved in
and devoured 75% of the snails (Hadfield, Miller, and Carwile
1993). By 1998, when the enclosure was completed, fewer than
20 snails remained. The fence has continued to protect the
enclosed snails, with a current, population of 40–50, while
snails can no longer be found in the trees outside.

Most recently, my last PhD student, David Sischo, and his
Snail Extinction Prevention Program (SEPP) crew in the State
Department of Land and Natural Resources, have constructed
a predator exclosure on the summit in the north Ko’olau Moun-
tains, monitored it for a year to make certain there were no
predatory snails or rats still inside, and declared it ready for
native snail introduction from the lab. This fence was built close
to the site where the progenitors of the lab population of A. lilä
were collected, although the species had subsequently become
extinct in the area. In July 2016 we carried 50 lab snails—now at
least fifth-generation descendants of the original seven snails
brought to the lab—to the enclosure and placed them one-by-
one onto the good native vegetation there. It was a satisfying
culmination of a process I had started 19 years earlier. The
postscript is that Dave and his crew are continuing to monitor
the snails released into the summit enclosure and have found
that the snails are doing very well and are producing babies.
Importantly, it has taught us all that snails propagated in the
lab for many years and generations can be successfully re-
introduced to field habitats. That’s no small result; it is a germ
of hope.

From the mid-1990s, more of my graduate students and post-
doctoral fellows took on research focused on the conservation
biology of tree snails, and I spent more time in the field with the
students and writing grant proposals to support the research.
These studies of the snails in both the field and the lab provided
important new information on the biology of the Hawaiian tree
snails and much greater understanding of the impacts of long-
term inbreeding in the lab populations (Price and Hadfield
2014; Price et al. 2015; Sischo et al. 2016). Some of these studies
assured us that the snail lab conditions were sufficient to sup-
port growth and fecundity rates comparable to those in the field.
David Sischo and his group have also established a new state-of-
the-art facility for the captive snail populations, including what
remained of all those we had started in the 1990s, and the snails
are thriving there.

IV. Genetic Studies Begin: Are Predator-Reduced
Populations So Small That Inbreeding Has Been
Added as a Destructive Force?

In the late 1990s we took advantage of the gene-amplification
technology called PCR (polymerase chain reaction) to exam-
ine DNA sequences to understand genetics of tree snail popu-
lations. We developed methods to benignly sample tissues
from the snails by trying various approaches with common
garden snails. When confident we could safely get useful tissue
samples, we applied for permission to sample the endangered
tree snails, a necessity under terms of my Endangered Species
Study permit. We allowed a snail to crawl on a sterile surface
and, when it was fully extended, took a minute snippet of tissue
from the trailing tip of the snail’s foot with a sterile blade. We
transferred the tissue to a small vial of 95% ethanol, took it
back to the lab, and extracted DNA from it.

Subsequently both postdoctoral fellows and graduate stu-
dents have used the method to do molecular-genetic studies on
tree snails to explore the degree of genetic separation of small-
field populations (Thacker and Hadfield 2000). The results were
surprising in many ways; for example, populations of Achatinella
mustelina separated by only a few kilometers showed sequence divergences indicative of no gene flow between them for at least 10,000 years (Holland and Hadfield 2002). Such gaps are the result of the snails’ very sedentary habits—one of our studies revealed that most of the snails will move only a few meters in their lifetimes (Hall and Hadfield 2009)—and the steep topography of the O’ahu mountains.

Two doctoral students combined field mark-recapture investigations with genetic-sequence analyses to better understand the genetics of small, isolated field populations and dispersal in these mostly sedentary snails (Erickson and Hadfield 2014; Hall and Hadfield 2009; Hall et al. 2010). Two postdoctoral fellows greatly expanded our understanding of the evolutionary biology of the achatinelline snails, their genetic population structures, and the genetic and demographic causes of decline in some of the laboratory populations (Holland and Hadfield 2002, 2004). A recent postdoctoral associate, Melissa Price, is carrying out pioneering genetic analyses to predict where the snails may persist despite the ravages of climate change on native mountain forests. Based on her data, “assisted colonization” trials are underway, moving highly threatened snails from current locations to higher, wetter forests in the Waianae Mountains of O’ahu. The combined efforts of many people and agencies, including the US Fish and Wildlife Service, the Hawai’i Department of Land and Natural Resources, and the O’ahu Army Natural Resources Program, as well as the people in my lab at the University of Hawai’i, have vastly increased our understanding of the population biology, genetics, evolutionary history, and conservation needs of Hawai’i’s tree snails.

V. Expanding Land Snail Conservation Efforts across the Pacific

Publications from my group brought attention to both the plight of the snails and our efforts to learn enough about them to actually do something to slow or even prevent the extinctions that we were observing in the field. In 2006, I was contacted by Kath Walker, a biologist with the New Zealand (Aotearoa) Department of Conservation (DoC) and asked for advice about how to conserve endemic snails in that country. Aotearoa is home to a very different group of magnificent land snails, the Powelliphanta species, that feed on earthworms and grow shells 7–10 cm across (fig. 12, inset). Like the Hawaiian snails, the powelliphantas are being devoured by alien mammalian predators, including rats, stoats, and opossums, none native to Aotearoa. To make the situation much worse, vast areas of unique habitat for the snails are being removed by massive and growing open-pit coal mines on the South Island. Subsequently, I was asked to come to New Zealand to see the small bit of remaining habitat for one species, Powelliphanta augusta, just before it was removed by the coal miners, and help the DoC biologists develop a plan for conserving at least some of the snails.

It was a shocking experience. From Nelson, at the northern end of South Island, I was driven to Westport on the west...
coast, where we began to ascend a beautifully forested mountainside. Just at the top, the entire scene changed, and I found myself gazing into a giant black valley 10 miles or more across and crisscrossed by roads traversed by truly gigantic trucks filled with extracted coal. Ironically, the local name for this area really is Happy Valley (fig. 12). We drove to the top of a nearby peak, Mount Augustus, where the mine was quickly expanding. There, I was able to see both the last of the snail’s native habitat and a few remaining snails in it. That entire area would be gone in less than a year. We discussed both trans-native habitat and a few remaining snails in it. That entire area related snails occupied most nearby habitat, and moving expanding. There, I was able to see both the last of the snail propagation facility such as we had done in Hawai. From those discussions, the DoC biologists built a very good captive facility for the snails and, aided by enforced assistance from the coal mining company, combed the last habitat of P. augusta to remove the remaining snails. To their surprise, they ended up with a massive job, because more than 6,000 snails were brought to the facility. In this lab, the snails are kept in plastic containers half-filled with sphagnum and fed earthworms of several species, all propagated on-site in large compost bins. The DoC scientists have been successful in maintaining these snails, although a major equipment failure in one chamber caused it to freeze a huge number of the snails. Sufficient snails were in other chambers to keep the species going (Morris 2010). According to colleagues in New Zealand, reintroductions have begun.

In 2011 I served as the external examiner for a doctoral dissertation by Fabrice Brescia at Massey University in Aotearoa, based on research on snails endemic to the islands of New Caledonia. From this excellent dissertation, I learned of yet another group of snails that exist only on a few Pacific Islands groups and are facing extinction (http://mro.massey.ac.nz/bitstream/handle/10179/3219/02_whole.pdf?sequence=1&isAllowed=y). In addition to the habitat loss and rat predation common to all of the islands, these large snails also face a sudden and unsustainable harvest by the large tourist hotels of Noumea, where they are served as “escargot.” The indigenous Kunië people of New Caledonia have long eaten the snails without overharvesting them (Brescia et al. 2008). As on other islands, introduced predators, loss of habitat, and human actions (bombing valleys, digging giant coal mines, and food harvesting) may soon cause the extinction of another unique radiation of life.

VI. Going Even Farther West: An Expedition to Pagan Island Begins a New Odyssey of Fieldwork and Activism to Protect a Beautiful and Culturally Significant Place from Destruction

It is unsurprising that when the US Fish and Wildlife Service planned a series of “biological resource surveys” on Pagan Island in the US Commonwealth of the Northern Mariana Islands, I would be asked to lead a group to survey for endemic tree snails. This group of snails is known to be nearly extinct on Guam, the southernmost Mariana island. Several years earlier, accompanying a graduate student I once advised who lived on Guam, I had seen these snails on Guam and Rota, the nearest island north of Guam. Like the tree snails in Moorea, French Polynesia, these snails are members of the family Partulidae. While most partulid species are single-island endemics, one, Partula gibba, was once abundant on seven or eight islands, from Guam in the south to Pagan Island in the north. However, by 2010 the species was already a candidate for Endangered Species status, having suffered depredations from most of the same predators named previously plus a carnivorous flatworm introduced to Guam from New Guinea sometime in the 1970s. Partula gibba had experienced drastic reductions in numbers and habitat on Guam and Saipan and was entirely extirpated on Agiguan Island. Although the snail was earlier known to occur on Pagan Island, its current status there was unknown.

By May 2010 I had assembled a group of seven well-experienced colleagues, and we were ready to head for Pagan Island. All were familiar with tree snails, how to recognize them, and how to search for them. We first traveled to Saipan, capital of the US Commonwealth of the Northern Mariana Islands, and from there, after waiting several days, we were lifted by small plane and helicopter 320 km north to Pagan Island, where we camped and searched for snails for 12–14 days. Pagan Island is dramatically beautiful (fig. 13; see additional photos at www.savepaganisland.wordpress.com). The island is made up of three volcanoes, the southern two being inactive. We camped not far from the base of the active Mount Pagan, which smoked continuously during our stay. We first searched the forest we could reach on foot, following the collection maps of Yoshio Kondo, long-time curator of mollusks at the Bishop Museum in Honolulu, who had surveyed the island in 1949. We came up empty-handed at the northern sites where Kondo had located P. gibba. However, from our coastal campsite, we were fortunate to get helicopter lifts into the native forest in the large southern caldera, where we finally found the living snails. In addition to the snails, themselves quite beautiful (fig. 13, inset), we saw many beautiful birds, every one a native to the island. The butterflies were also diverse and spectacular, as was the great wealth of native plants. We came to appreciate Pagan Island as a very special, very beautiful, and unique spot on earth, and our reports on the tree snails of Pagan Island are the first written about this notable gastropod fauna (Hadfield 2015; Sischo and Hadfield 2017).

It is vital to stress that Pagan Island has a long cultural history. Archaeological studies have revealed that ancestors of the Chamorro people occupied the island as early as 1,000 years ago (Egami and Suito 1973; Russell 1998). I saw remains of their villages in the form of large stone house posts (latte stones) and a boulder with a deep depression from being used as a mortar for grinding nuts, possibly coconut, and other food
items. Hundreds of people living on Saipan today trace their ancestry to this island, and many of them were born there. Because of this long human presence, Pagan Island is not “pristine” in any sense of being untouched by human activities. Additionally, it is hard to know how long it has been heavily occupied by pigs and goats, and cattle have been abundant on the island since the 1970s. Large groves of tall coconut palms attest to once-thriving copra production.

Beginning in the 1500s, the people of the Mariana Islands have been assaulted by a series of colonizing nations: the Spanish (1565–899), the Germans (1899–1914), and the Japanese (1914–1945). During World War II, Pagan Island was occupied by as many as 5,000 Japanese military forces who constructed the runway still used today and who drilled into the rocky headlands to make gun emplacements. The fewer than 100 native islanders living on the island were forced to serve this military occupation. The Japanese base was destroyed by US bombing toward the end of the Pacific part of WWII, and the remaining Japanese were removed from the island after the surrender. The Chamorro population was moved to Saipan by the US forces at the same time. Sometime after 1950, families began to return to Pagan Island, and farming and copra production were resumed. In this period, cattle were brought to the island and apparently retained by fences in the area around the base of Mount Pagan where two shallow lakes and springs provided fresh water.

In May 1981 Mount Pagan erupted massively, with heavy ash ejection and a lava flow that overran part of the runway. Ships in the area rushed to rescue the inhabitants, and the island was evacuated without loss of human life. The eruption likely destroyed the fences that had kept the cattle restricted to areas around Mount Pagan, and they spread out across all easily accessed parts of the island. Today, the forest understorey within the huge northern caldera from the middle of which Mount Pagan rises is nearly destroyed by grazing cattle. Large expanses of grassland have the appearance of lawns due to grazing by cattle and goats. However, the southern caldera is still home to almost pristine stands of native forest because the feral cattle cannot reach them, because of either the steepness of the terrain between them and the caldera or the absence of a ready source of fresh water. It was within this southern caldera that we found P. gibba, counting a few hundred snails of various colors along five survey routes (Hadfield 2015).

Because of the admiration and respect we had gained for Pagan Island during our stay there, my graduate student, David Sischo, and I were shocked when we learned of a plan being floated in Saipan to use Pagan Island as a “dump” for debris accumulated in Japan following the devastating Fukushima tsunami of 2011. The Japanese government was paying corporations to dispose of this massive amount of debris. At the same time, industrial interests in Japan had learned of the presence of large quantities of volcanic ash on Pagan Island. This ash, known as pozzolan, is a desired component of light and strong cement blocks used in housing and industry. The Japanese group proposed bringing ships filled with tsunami debris to Pagan, dumping the debris, and then filling the same ships with pozzolan, which can be mined simply by shoveling it from the surfaces around the volcano. Dave and I were so dismayed by the thought of turning this wondrous island into a garbage dump and a mine that we went “active” and created the save-paganisland website (www.savepaganisland.wordpress.com). On
it, we posted many of our photos from the island, links to news articles on the Japanese plan, and a petition resisting the plan. We set out to inform as many people as we could, urged friends and colleagues from near and far away to sign the petition, and worked to get the petition known on Saipan. Our petition quickly gained several thousand signatures, many from people in Saipan, including influential people in the legislature. The dump-and-mine plan quickly went quiet. We were feeling good.

But the “other shoe dropped” in March 2013, when the US Navy published in the Congressional Record its intention to take all of Pagan Island and much of Tinian Island, immediately south of Saipan, for Marine Corps live-fire training. Dave and I quickly edited our website to be a source for information to save Pagan Island from the US Marines. Then signatures really started rolling in around the world. I also started writing op-ed pieces for local newspapers and speaking on the importance of Pagan Island at every possible opportunity. Not surprisingly, the navy’s supporters tried to counter our effort, but we found the media in Hawai‘i, Saipan, and Guam more than willing to publish rejoinders to letters written by, for example, a Marine Corps officer who wrote, “The Marines always leave a place better than they found it.”

To dare a statement like this in the Pacific was absurd, where the people of Hawai‘i are terribly familiar with the status of Kaho‘olawe Island, bombed and torpedomed by the Navy and Marines for over 60 years and then returned to the Hawaiians mostly posted with Do Not Enter signs because of massive amounts of unexploded ordnance buried beneath the surface. Citizens of the Republic of the Marshall Islands know all too well the histories of their Bikini and Enewetak atolls that were atomic bombed into never-enter lands and their inhabitants exposed to radiation levels so high that they suffer from many types of cancer generations later. In the Marshalls’ largest atoll, Kwajalein, the residents are crowded onto one small islet with polluted waters, inadequate schools, and income available only as workers for the US base on the largest island. Kwajalein lagoon continues to be used by the US Air Force as a target for testing missiles launched from California.

Our website and my newspaper writings caught the attention of people on Saipan, who then contacted me to begin long dialogues and collaborations. For them, I have traveled to Saipan to participate in public education and have written more news pieces. In October 2014 I spoke there in a forum on the cultural and biological importance of Pagan Island and another in Honolulu titled “Bombs in Paradise.” I have also been interviewed on the threats to Pagan Island by local and international media, for example, Radio Sputnik in Moscow, Radio Australia in Sydney, and Talk Nation Radio in the United States. Other groups picked up on our website and circulated petitions of their own, for example, the Sierra Club, RootsAction.org, and Care2.org. Together, these petitions garnered tens of thousands of signatures. All but one of these groups were willing to send us their lists of signatories, which we concatenated with our own to create a huge list, which we included in comments on the Draft Environmental Impact Statement that the Navy released in April 2015. It has been heartening to see the strong resistance to the military takeover and destruction of Pagan Island, and it has been an exceptional and gratifying pleasure to meet and work with these individuals.

Civil Beat, a Honolulu-based online news service, reported on March 9, 2017, that the Navy received 27,000 comments on the Draft EIS and that it will not release its Revised Draft EIS until late 2018 and deliver its final decision until about 2020. I remain hopeful that the people of the Northern Mariana Islands will prevail in their resistance to US military plans to take and destroy more of their ancestral lands, islands that are also home to an amazing endemic biodiversity.

VII. Training Pacific Islands Students and Faculty to Join Environmental Efforts in Their Home Islands

Focusing on the rich human Pacific Island community, I backtrack to 1999, when the US National Science Foundation (NSF) announced a grants program titled Undergraduate Mentoring in Environmental Biology (UMEB). The grants supported research experiences for undergraduates both during intense summer internships and in year-round programs. We successfully applied for a 5-year UMEB grant to focus on training the underrepresented minority students from Hawai‘i and the eligible Pacific Islands. The latter include the “US flag” territories, Hawai‘i, American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands, plus three independent Pacific Island countries that hold compacts of free association with the United States: the Republic of the Marshall Islands, the Federated States of Micronesia, and the Republic of Palau. Our program started small, with funds for only about five students per year, but grew steadily, as I was able to renew the grant and transition it to a new program when UMEB changed into URM, Undergraduate Research Mentoring in the Biological Science, with a broader scope, and to augment it with funds from an NSF Centers for Ocean Science Education (COSEE) subgrant (fig. 14).

Over 16 years, we supported more than 120 students with summer internships, including about 40 who continued in a year-round program for the academic year. A major effort in a weekly colloquium with the year-round students aimed to prepare the students for graduate school entry and completion. Most of these students earned baccalaureate degrees, at least three now hold PhD degrees, and several more have MS degrees in the life sciences. Nearly all the interns have returned to their home islands where many hold positions in schools, colleges, government agencies, and NGOs, where they contribute to the training of their people and environmental and resource management.

A major gain for me from these internship programs was building a network of colleagues at the community colleges and 4-year campuses across the Pacific. In addition to the student programs, we secured funding for faculty training programs during four summers, and focused on topics such...
as genetics for conservation goals, microbes in the sea, and genetic connectivity across the Pacific Ocean.

In 2017 I successfully applied for a grant from NSF’s REU (Research Experiences for Undergraduates) program aimed at increasing training and participation of underrepresented minority people in STEM. We began our program, titled REU—Environmental Biology for Pacific Islanders, with 12 island interns at the University of Hawai‘i in the summer of 2017. Throughout the 18 years I have been associated with undergraduate internship programs, my goal has been to produce a cohort of young island people who take on the identity of scientists and who recognize the huge threats that climate change, overfishing, and pollution, etc., pose for the islands, make their fellow islanders aware of these realities, and work toward mitigations and solutions.

In addition to these internship programs, in 2005 I began to teach a senior seminar for students at the University of Hawai‘i titled Science and Politics. I was stimulated to create this successful course by the assaults on so many aspects of science that came about during the presidency of George W. Bush: stem cell research, evolution, reproductive rights, and climate change, etc. It was amazing, but gratifying, to watch an excellent group of undergraduates become aware that elected officials too often are working not from a standpoint informed by science but instead from a reductive economic and frequently white Protestant Christian standpoint. The students got angry; I hope they stay that way.

VIII. Meanwhile, Still in the Marine Lab, We Begin to Understand How Bacteria Make Larvae Settle and Metamorphose

Our lab studies on the settlement of invertebrate larvae have led us deeply into analyses of marine surface microbial communities. From these complex communities composed of thousands of bacterial species, we have isolated single bacterial species that induce settlement in our tubeworm larvae and have examined them to determine what they make that induces settlement. We are employing the latest tools of molecular biology and genomics. To our surprise, we are finding this is not a project to simply identify chemical compounds found on bacteria or in their secretions but, rather, to examine complex structures that result from the actions of many genes. In one case, the structures, dubbed “tailocins,” are genetically derived from tails of certain bacterial viruses and used by them to infect bacterial cells with their genetic material (Shikuma et al. 2014). Other stimulating bacteria lack these structures and instead release spherical “outer membrane vesicles” (OMVs) that cause the larvae to settle and metamorphose (Freckelton et al. 2017). Utilizing an array of the latest techniques of biotechnology, our focus now is on understanding how, at the larval side, this stimulation takes place.

We have also initiated studies on the complexity of biofilms from different marine environments using the developing tools of metagenomics and their bioinformatics analyses. We
are focusing on the relative abundance of known inductive bacterial strains and finding them consistently in the “rare” category. This has led us to explore the possibility that more abundant biofilm-bacterial species may play a role. We are studying these species to determine if they are inductive for settlement of worms, snails, sponges, corals, and many other types of marine invertebrate animals.

It is exciting to be at the forefront of a developing field, although convincing the world at just this time that a marine surface microbiome is as important as that of the human gut is a daunting challenge (McFall-Ngai et al. 2013). In a time of global climate crisis, when all the characteristics of the sea are changing, what could be more fundamental than understanding the basis by which all marine communities are established and maintained through larval recruitment, from mud flats and mangrove swamps, to coral reefs and the bottom of the sea?

IX. Postscript

Our work continues in the lab, the field, and the protest lines. In all three patches our work tries to draw together beautiful, fascinating, valuable-in-their-own-right animals and habitats in very special places on Earth—the Pacific Islands—and the best ambitions of people, including indigenous islanders, students, and scientists both native and western. Global warming is about to accelerate due to the antienvironmental, proffossil fuel policies of the new administration in Washington, DC. Funding for basic research is being cut, meaning the competition for remaining funds will become even worse; pity young scientists trying to earn tenure at American universities in coming decades. At our end, we will continue to carefully monitor the navy’s plans for the Northern Mariana Islands and lend our expertise and protests wherever they appear useful. Whether we will be funded to carry through on the exciting discoveries recently made in our labs on the roles of biofilm bacteria in determining the content and survival of marine communities for more than a few more years is in question. Nonetheless, as curious and determined as ever, we will train new Pacific Islands interns and raise our voices when and where we can.

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A recurring theme of internationally recognized sculptor and painter Satoru Abe’s work is the tree form, with which he expresses many things. We found this etched print to beautifully express our shared vision of life, science, engagement, and so much more. A color version of this figure is available online.
Following the Slime Trails of a Pacific Island Tree Snail (Marine) Biologist: The Tree Snail Manifesto, Part 2

Donna Haraway

I. Introduction by an Ectoparasite on the Trail of a Pacific Island Tree Snail Biologist

Michael Hadfield and I have been symbionts for 45 years, beginning in a run-down wooden World War II barracks hut on Coconut Island in Hawai‘i, then housing for University of Hawai‘i marine biology researchers, where we lived in a kind of collective family or nest of friends in 1972–1973 (fig. 16). We moved into a commune with our oddkin in a big white house in Mānoa Valley on O‘ahu the next year. These kin-making practices shaped us both. Human nonbiogenetic kin making was afoot, but many other beings settled and developed on the eager surfaces of our minds and bodies then as well. Our Tree Snail Manifesto (TSM) is a tale of those unexpected and life-changing multispecies EcoEvoDevo (ecological evolutionary developmental) events in complex natural-social holobiomes. Remember, “holo-” does not mean complete and entire, finished and whole; it means good enough to hold things together relationally, meaningfully, and dynamically at heterogeneous scales of time, place, and matter. That is what the “patchy Anthropocene” requires.

I prefer the term “hologent” to “holobiome” because the living are always entangled with the nonliving, in furling and unfurling natural-social “things,” or, to be Greekish, “ents.” In “hologents,” human beings become with each other and other beings without the killing category separations of nature, on one side, and culture or society, on the other. Nature is relentlessly historical, and history is relentlessly earthly, mundane, full of entangled critters. In the TSM I trust my readers to understand holobiomes in this extended, patchy, and capacious sense.

My job is to join the TSM in the register of a science studies scholar who also resides in anthropology and biology. I situate myself as a hungry ectoparasite on Michael’s narrative, sending probes into his text to provide nourishment for mine, but giving back some trace nutrients too, so that our manifesto becomes something neither of us could do alone.

Michael’s Tree Snail Manifesto begins and ends with falling in love. His are exuberant invertebrate love affairs that decompose and recompose beings, including himself, in ways that perhaps only Papua New Guinea Melanesians could adequately theorize with their dividual (not individual) makings and unmakings of persons through material exchanges—yams, pigs, Land Rovers, cell phones, people to marry, cash, etc.—that, when done properly, make things grow and transform in thick relationality (Strathern 1990). These exchanges are always more than human. This is a structured, patchy relationality of a kind familiar to those who have recently transformed the biological sciences with their empirical-cognitive proposal of holobiomes. No bipedal hominin of the modernist individual persuasion stuck outside holobiomes could begin to understand Michael’s rapturous fascination with weird California coastal snails. They shaped his youth and changed his life, as first loves do. These mollusks belong to the heterodox family of the Vermetidae (worm snails), which, lodged in habitats accessible from Stanford’s Hopkins Marine Station, taught him everything he needed to know for his PhD thesis.

And such things he came to know! Even the name of these mollusks, appealing to worms categorized in wholly other taxa, suggests their virtuosity with form and development. By the time he had his PhD, Michael was committed to beings that did things like throw out long, sticky, mucous strings that trap their food, as well as trap the sperm packets tossed out by males intent on internally fertilizing distant females without budging from their glued-to-the-rocks positions, on which they had given up typical molluskan shell shapes for more comfortable worm-like tubes. Michael tells us that some of the Vermetidae make egg capsules in which 99 eggs nourish the single egg that will become a new snail, which will look like a worm before it is finished developing. Add to all this the compelling questions about how in the world—actually in the world, not in fantasy or science fiction—vermetid larvae swimming in the open ocean somehow respond to cues telling them to come settle on a distant bit of bare rock, metamorphose entirely, and start casting their mucous lines for food and sex. What is sending those cues? How are they perceived in such unpromising turbulent, dilute conditions? Why do the males make two kinds of sperm, one of which does not seem to have any function in fertilizing eggs? What kinds of laboratory apparatus, including electron microscopes, enabled

Figure 16. Snail slime trails. Max Pixel, Creative Commons Zero, CC0 Public Domain, free for commercial use. http://maxpixel.freegreatpicture.com/Slimy-Snail-Shiny-Slime-Trail-Mucus-Carpet-474286 (accessed October 9, 2018). A color version of this figure is available online.
Michael’s love and knowledge to grow? What cyborgs are afoot here? Where did marine biological stations around the world come from? How DO these mollusks make a living, make babies, make companions both technical and organic, and make their scientists? Michael was caught on the sticky threads of snails that make life-changing and paradigm-changing oddkin. Eventually, they propelled him into ohia trees on land to make life-changing commitments to Pacific Island tree snails.

I was a graduate student in the embryology course at the Marine Biological Laboratory in Woods Hole, Massachusetts, in the summer of 1967. The intellectual, emotional, and natural/social experiences with marine critters grounded my own subsequent work in acts of ongoing love and curiosity in ways similar to Michael’s story. There is no way to swim naked after dinner in luminescent waves and then retire slightly stoned with one’s grad student colleagues to the lab to watch throughout the night the first magical cleavages of an octopus egg, or cheer on the pulsating squid in the tank in their collective mating rituals, without knowing at the core of one’s being that the living world is beyond measure beautiful, complex, and vulnerable.

My point is obvious: love and knowledge co-shape biology that matters. Cognitive work is affective and vice versa, or else we are in fatal trouble. Love and knowledge of exuberant complexity, and vulnerability.

II. A Word on Models as Work Objects for Geoecoevodevohistotechno Biology

Michael’s story also begins with curiosity about signaling between and among organisms that result in dramatic developmental events in the life histories of marine invertebrates. The vermetid larvae must be responding to cues to settle out. Here is such a deceptively simple fact, one that took extraordinary equipment, labor, institutions, and unexpectedly cooperative marine mollusks to establish. Happily, this is the kind of fact that can be marshaled to stand in the way of yet more violent simplifications of the living world. Situated histories and technologies are key to these practices of love, knowledge, and action. EcoEvoDevo is in string figural relationality with HistoTechno. These are patchy, cyborg worlds.

Another intensively cultivated branch of Michael’s work crafted a second model system establishing the fundamental processes of co-shaping across taxa in holobiomes. Here, animal-bacterial communications between a ship-surface “fouling” tubeworm and several specific kinds of bacteria forming layered biofilms are the subject of attention, in ways the Office of Naval Research and many shipping companies find riveting. By the summer of the Tree Snail Manifesto’s composition, eight marine invertebrate phyla from sponges to crustaceans had been shown to engage in necessary developmental communications with bacteria in their life histories. Signaling major changes in the conceptual foundations of biology, Geo-
EcoEvoDevoHistoTechno is full of looping multitaxal cuing and shaping. Call that metamorphosis. My point is simple: protect holobiomes in their temporal and spatial complexity, which takes a great deal of scientific labor, or say goodbye to human and nonhuman biosocial diversity. This is the lesson guiding us through the story of Pacific Island tree snails in damaged worlds.

III. Situated Histories in the Colonial and Postcolonial Pacific

By the time Michael established his research in the new Kewalo marine lab in Honolulu around 1970, he had already worked at the Friday Harbor labs of the University of Washington, Stanford’s Hopkins Marine Station in Pacific Grove, and the marine lab of the University of Copenhagen. Embedded in the history of European colonial exploration and expansion, marine stations in the Pacific are central to the story of biogeography and of developmental, evolutionary, and ecological biology. Darwin’s observations on islands in the Pacific are famous, as should also be the exploits of surveying, collecting, classifying, and experimenting throughout the Pacific that are so crucial to processes of destruction and extraction as well as to protection, partial healing, and postcolonial and indigenous conflict and collaboration for flourishing worlds. In distinction from Atlantic-centric “indoor” science, historians have called the natural and built laboratories of the Pacific a vast and consequential invention of “outdoor science.”


These historians argue that the seas and lands of the Pacific became a collecting ground and laboratory for testing much more than evolutionary theories. The Pacific became key testing grounds for the expansionist, extractivist, and war-saturated Plantationocene and Capitalocene with their simplifications and feral proliferations, extending histories of appropriation and of human and nonhuman genocides and displacements deep into nuclear times (Dibblin 1988; Firth 1987; Kuletz 2001; Teaiwa 2005). Although I don’t think either of us thought about it then, Michael and I met each other on Coconut Island in 1971 because of these histories. I was an assistant professor hired to teach “general science” to so-called “non-science majors,” the great unwashed of technoscientific knowledge industries. My students were fashion design majors and tourist management majors who were supposed to learn science as the exemplar of objective, rational knowledge, free of the pollutants of religion and politics.

The problem was, this was the middle of the Vietnam War, when the electronic battlefield and its systems-apparatus of Command-Control-Communication-Intelligence became the paradigm for militarist cyborg worlding across domains of science, politics, and culture. This was also the Pacific in which nuclear weapons testing had already blasted Bikini and Eniwetok atolls, consigning their human peoples and nonhuman beings to permanent dislocation and dispossession. Then there was the matter of technoscience-fueled monocropping agriculture (sugar and pineapple, soon to be supplanted by their successor crop, namely, endless tourist hotels), which took particularly virulent forms on Pacific islands, including Hawai’i, complete with labor systems for people and plants (and hotels) that define the racist Capitalist Plantationocene. So-called invasive species are the proliferating companions of colonizing Plantationocene and Capitalocene peoples. “Introduced pests” is much too weak a term for the historically situated human beings (not humankind) who turned the Sea of Islands that is Oceania into a theater of war and extraction (Hau’ofu 1993).

Recently arrived from graduate study in Yale University’s biology department, with its serious opposition to chemical and biological warfare, and from Science for the People, Civil Rights, Anti-War, Anti-Nuclear, Gay Liberation, and Women’s Movement science critiques, I found it impossible to teach general science in the way I was supposed to do. Walking around downtown Honolulu the day I arrived from Yale New Haven in 1970, I was disoriented; somehow the actual layout of the New Haven green was physically replicated in Honolulu. Slowly, I learned that I had indeed landed where my own elite colonial education, paid for by post–World War II federal funding that turned even Irish Catholic girls’ brains into national resources, prepared me to go: the islands where the sugar-planting families and Protestant missionaries of New England paved the way for a long history of dispossession in
the Pacific. Many of us did everything we could to reeducate ourselves for more emancipatory alliances, politics, and knowledges for partial healing and still possible flourishing on a damaged planet.

I have been instructed by the offspring of a couple hundred giant neotropical cane toads (Rhinella marina) that had been introduced into Oahu in 1932 to control sugar cane pests. Companion species of agribusiness production science in the ongoing Plantationocene, joining the colonial destroyers of endemic species, these toads multiplied exuberantly and ate with abandon. Our home on the Islands, the repurposed barracks on Coconut Island, with its huge and scary, cautionary cane toads sitting sentry by the toilets at night, became a provocation for remaking kin and kind.

I also had begun to learn something else while I was still a graduate student in biology, under the life-changing mentorship of G. Evelyn Hutchinson, a true polymath best known for groundbreaking theoretical ecology and limnology, who fed his students on art, literature, freedom of the imagination, astonishingly diverse critters, love of place, and mathematics (Hutchinson 1978, 1979; Skelly, Post, and Smith 2010). I learned that nature is relentlessly both, in both human and nonhuman metamorphoses; and history is relentlessly earthly, diverse, and mortal. I learned that historically situated natures are made but not made up, that engaged relationality is not skeptical relativism, and that human beings and their technologies are not the only actors.

Initially unsettled by the collapse of the categorical division between nature and history, I learned that conventional cells and organisms are—actually are—systems of production and reproduction organized by a hierarchical division of labor, and that they had recently become cyborgs, information systems at every level of their being. I learned that demography, cost-benefit calculations, and life tables are essential to the students of coral reefs, as well as to the analysts of life insurance companies. I learned that political economies and natural economies are much more closely co-shaped and co-shaping than terms like "nature" versus something else, something "supernatural" (Puig de la Bellacasa 2017). The actual material-semiotic entities of biology are historical; that is how they can be shaped into models and engaged in situated projects. Catholicism and Marxism both preadapted me for these kinds of ideas; nonetheless, I found them terrifying. But also, in “Western” naturecultures and elsewhere, critters are partners in knowledge making, not raw materials.

I learned that differently situated human beings and their apparatuses do living beings in their worlds differently, and critters do human people differently, with important consequences crucial to decolonization (de la Cadena 2015a, 2015b; Kohn 2013; Lyons 2014). The difference is not one of rationality versus something else, something “unscientific.” The difference is about how to do the world in sympoietic material-semiotic relationality, where love, knowledge, and rage rekindle possibilities. These things are inconceivable outside the histories I have sketched above. For decades I have tried to work through the implications of knowing that nature is historical, and that much of that history is crafted by the relations—cognitive and material—of racist, misogynist capitalism and colonialism.

Rooted in such histories, Michael and scientists like him fiercely claim other forces of love, knowledge, and rage nurtured from the beginning in marine laboratories in order to expand them now for the work of holding open space for possible multispecies, including human, flourishing in the face of past and ongoing destruction. Multispecies environmental justice is the goal. Making peace (for snails as well as people) in the Pacific requires a militant practice. Perhaps the most important implication of realizing that nature is historical and vice versa is that revolt is both possible and necessary. The tree snails are not the only ones depending on this fact.

IV. Holding Open Space for Partial Resurgence: The Materialism of Caring

Revolt has many registers; caring requires many materialisms (Puig de la Bellacasa 2017). Apparatuses of caring are a fundamental matter in feminist science studies (Barad 2007). Paradigm earthquakes like those proper to GeoEcoDevo-HistoTechnoPsycho and to entities like holobiomes and holonts indicate some of those registers, materialisms, and apparatuses. They have diverse roots that do not follow the supposed nature-society divide. When I was a graduate student in the biology department at Yale, action against chemical and biological warfare, critique of scientific racism, and working with Science for the People and the Women’s Health Movement were normal activities for many of us. Science, politics, and culture did not exist in separate universes, even if we did not quite know how to speak them in the same sentences. Michael’s career is full of intense thinking and action tying science and politics together for barely still possible human and nonhuman flourishing on a plundered planet.

The political awakening of Mike’s students was an important part of their formation as proper biologists. I have some of his syllabi from his senior seminars that he taught for many years on Science and Politics. The class originated with concern over antiscience, especially antievolution, politics in the G. W. Bush administration, but soon also took up climate change science and politics. The popular undergrad seminars were taught annually until Mike retired in 2015.

Helping write the original statement, developing the website, organizing petition drives, staffing information tables, and arranging forums at national meetings, Mike labored hard in conjunction with activists in the San Francisco Bay Area to launch and sustain the Defend Science initiative (http://www.defendscience.org/statement.html). Defend Science was initiated in 2005 in response to a massive wave of attacks on science unleashed during President George W. Bush’s administration. These attacks occurred on many fronts and included at their core attacks on the very foundation of science—scientific
method and thinking. Circulating the statement and petition, Mike tapped a global network of scientists, mostly biologists, whom he knew personally. In his own words, Mike and his allies “decided to take the Defend Science effort to the annual meetings of the Society for Integrative and Comparative Biology.” To continue the email communication, “Carolyn [an astute socialist activist and theorist and Mike’s life partner] and I got ourselves very organized, signed up for a booth at the meetings from 2005 until about January 2015. . . . The booth turned out to be VERY popular. We printed out tons of articles on climate, evolution, reproductive rights, . . . and passed them out at the meeting. The booth was continuously crowded with people wanting to talk about all of this stuff. Our e-mail list grew and grew” (personal email, June 9, 2017). In 2007 Mike, Carolyn Hadfield, and marine biologist John Pearse “organized a near revolt within the Society for Integrative and Comparative Biology, when John and I were President (Pearse in 2007) and Past-President (Hadfield in 1996), to support a major statement about the reality of evolution. This was, of course, at the height of G.W. Bush’s totally ignorant anti-science efforts, which pale in current circumstances” (personal email, June 6, 2017). For better and for worse, the election of Obama quieted action for a time, but with the election of Trump and ensuing developments, Defend Science is again a strong part of scientists’ resistance.

Remembering the materialism of Michael’s and my own roots and branches in Science for the People, Defend Science, teaching science and politics in the same courses for graduate and undergraduate students, and other personal radical science histories, I want to assemble the practical things required to cultivate effective scientific caring. The job is to hold open space for possible multispecies futures in the midst of escalating extractions and extinctions (Tsing et al. 2017; van Dooren 2014, 2015). I want to examine more closely the registers of revolt that have to do with things like designing predator fences against hikers, predatory snails, and rats and like mentoring Pacific Island students for decades so they have the tools to repossess scientific knowledge and policy for their own lands, seas, and ecologies. Michael’s paper is full of compelling narratives and details, and so I will call attention to a few that especially touch my heart.

I enumerated things and practices crucial to holding open space for threatened Pacific Island tree snails—all of which constituted a third line of investigation, initially unexpected research and action, sustained over several decades out of urgent love, curiosity, and rage, in addition to an overfull, full-time university teaching and marine research center job. All these things happen in a holon of researchers, apparatus, organisms, and other things. The weave of collective work is breathtaking and completely normal in Michael’s world.

My abbreviated list: designing incubators in the lab for captive propagation; determining how to feed snails in the lab with the right kinds of molds on the right sorts of leaves; gathering the correct types of leaves every 2 weeks for years; building and testing fences and barriers in the field to hold off human and nonhuman predators; assessing enclosures and exclosures; capture-mark-and-release work; repeated surveys; organizing and analyzing life-history data; practicing assisted colonization, assisted introductions, and assisted reintroductions; making Endangered Species filings; endless research permit filings; endless grant applications and reports; hiking to out-of-the-way places; flying to distant sites; cultivating international biological colleagueships; engaging state and federal apparatuses in advance of highway projects; following bomb squad technicians to avoid stepping on explosives on the way to a tree that might host a snail; studying museum collections of shells; observing habitat-wrecking coal mining operations in Aoteoroa/New Zealand; working with and training graduate students; finding and counting snails in individual trees in remote areas; not finding snails in areas where they previously were and managing the emotional consequences of repeated losses and disappearances; using the latest molecular technologies for genetic relatedness studies to understand tree snail populations and their evolution; learning to snip bits of snail tissue without damaging the animals; witnessing still more snail populations and species come under new as well as old threats (e.g., becoming restaurant escargot or further habitat destruction); and just plain putting one’s whole self in the way of the destroyers. There is more, but one gets the idea about just how materially practical research has to be to make a difference for another. The materiality of caring is richly mundane.

Solidarity for decolonizing the Pacific, this Sea of Islands, and for an emancipatory politics of the living world, human and more-than-human, demands many kinds of practices from differently situated allies. Michael’s work strengthens several decolonial threads, but perhaps the most consequential is his hands-on mentoring of Pacific Island undergraduate students since at least the late 1990s, concretized in the NSF grants for Undergraduate Mentoring in Environmental Biology. He and his colleagues continue that mentoring into subsequent study and jobs. I have been in Michael’s home in Honolulu many times over the years when he stays up nights and works weekends to nudge reluctant NSF administrators to move the bureaucracy to keep the grants coming for these students. Mentoring means intense, sustained, invisible work, like drawing on numerous scientific colleagues to visit or teach, picking up students at the airport and making sure they get continuing emotional as well as other support, hosting students in his home, responding to all sorts of emergencies, comforting students whose families experience a crisis while their young person is off island and far from home for the first time in their lives, encouraging and inspiring students to stay with their study through degrees, and addressing the state of scientific education on the islands for K–12 youngsters. In understated prose, Michael recounts the network of colleagues he has nurtured at community colleges and 4-year campuses across the Pacific. This is a network that holds open the possibility of multispecies, including human, futures on an ill-used earth.

In early June 2016, Michael organized a 2-day NSF-funded workshop at University of Hawai’i at Mānoa to better un-
understand the reasons Native Hawaiians and Pacific Islanders encounter great difficulty in entering and completing STEM studies. The report to the foundation on the workshop noted that participants were drawn from colleges in Hawai‘i, the US-affiliated islands of American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands, and the compact-of-free-association Pacific Island countries (Republic of the Marshall Islands, Federated States of Micronesia, and Republic of Palau). Many of these participants were members of the indigenous peoples of their islands, as well as science teachers in their colleges. The practical details of what the participants discussed are moving for their concern for the students and their explication of structural barriers, including ongoing colonialism across the islands and lack of quality primary and secondary science education. Lack of teacher training, lack of laboratories, geographical distance and lack of transportation from isolated islands where many students live to a high school or community college on a main island, financial obstacles when wages are so low, and more. Among the barriers discussed was the fact that “the Marshallese of Kwajalein Atoll are forced to live on the single islet of Ebeye by the U.S. military that uses the atoll lagoon as a target for missile practice from California, and [the military] is the sole source of income for the islanders. Very few Ebeye high-school students even graduate” (http://hellomarshallislands.weebly.com/education.html).

The workshop organized itself to foreground participants’ ideas to address the problems concretely. For example, focusing on how skeptical students might come to trust scientific education, a participant from Hawai‘i stressed, “Students pursuing environmental science, biology, and ecology see the need for native perspective in resource protection.” Indeed. And so the Pacific Island tree snails have led their scientist to ideas, places, and practices that the graduate student enthralled by the vermetid mollusks could not have imagined. The geopolitical scientific practice of care changes lives across species, including across Peoples.

V. Island Geopolitical Natural Social Biology

Pagan Island is the final place in this story for the metamorphosis of an island geopolitical biologist committed to multispecies environmental justice in the Pacific. Tracking the slime trails of vulnerable tree snails, the story moves from pure science to geopolitical natural social biology and sustained scientific activism across many worlds of knowledge and politics. Frank activism was not new to Michael’s scientific practice by the time he was asked to lead a biological survey of Pagan Island in 2010. Michael’s account of that survey and subsequent developments is for me the most riveting part of his writing for the TSM. Focusing on Partula gibba turned out to require attention to the astonishing surviving biodiversity of this special island; the history and ongoing struggles of displaced Chamorro families who claim Pagan Island as their home island; the devastation caused by proliferating escaped cattle after a volcanic eruption; and politically slimy plans involving government officials on Saipan and Japan to dump “low-level” nuclear debris on Pagan from Fukushima, as well as to mine vast quantities of pozzolan.

I first became aware of the nuclear waste dumping and mining when Michael and his then graduate student David Sischo “went active” in their anger and determination to protect the holobionts of Pagan Island. Joined by signers from around the world, many of my friends and colleagues at the University of California, Santa Cruz, signed the savepaganisland.org petition. The impact of a multifaceted, coordinated publicity campaign was fast and impressive—but not permanent.

Three years later, the US Navy made plans to turn Pagan Island and other nearby areas into a practice free-fire zone. The “pivot to Asia” of the Obama administration was the context for expanded US militarization of the Pacific, which continues beyond Obama. This struggle will be long and hard, and Pagan Island is only one small place on the map of immense forces of international capitalist conflict in the Pacific. But it is a place that matters. What has followed for a marine invertebrate developmental biologist in love with tree snails and their knotted, entangled worlds has been a storm of sustained activism in league with diverse allies who refuse to cede this place, with its human and nonhuman beings, to destruction. Again, Michael’s understatement in the TSM: “I remain hopeful that the people of the Northern Mariana Islands will prevail in their resistance to US military plans to take and destroy more of their ancestral lands, islands that are also home to an amazing endemic biodiversity.”

Here, both traditional and contemporary knowledges of the sea-loving peoples of Oceania surge to the surface. Modern scientific marine labs are latemores in crafting fundamental knowledge of the oceans and interrelated human and nonhuman beings of the Sea of Islands. Native Hawaiian and other island peoples’ knowledge making and marine practices—in navigation, fishing, human-nonhuman relatedness, aquaculture, and more—were important in the past and remain important now for Hawaiian and other sovereignty movements, for recovery of indigenous ways of living, and also for crucial decolonial alliances for multispecies environmental justice and conservation.2 The friction of names is important; the colonial, postcolonial, national, and transnational Pacific are not the same kinds of entity as the Sea of Islands. But the contact zones of allies are formed from the intersections, and the healing arts of living on a damaged planet require all the players.

Coda

The Pacific Island tree snails and the biologist are oddkin (Clarke and Haraway 2018; Haraway 2016). Not biogenetic kin, but something that must be even stronger in our times. Kin is about sustained relationality, about who and what are accountable to whom and what. If Michael has a snail, a snail has him; that is kinship. Donna has a colleague-friend; a colleague-friend has her; the snails have both, and vice versa. Making oddkin for multispecies environmental justice is part of an emancipatory scientific politics of and for the living world. GeoEco EvoDevo Histo Techno turns out to be about a holobiome—a holon—in which the threads of the pattern are relentlessly historical, patchy, natural-social, and entwined in love, knowledge, and rage. This is the geopolitical scientific practice of actually caring.

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Coffee Landscapes Shaping the Anthropocene

Forced Simplification on a Complex Agroecological Landscape

by Ivette Perfecto, M. Estelí Jiménez-Soto, and John Vandermeer

Coffee was introduced to Mexico in the late eighteenth century, but it was not until the late nineteenth century that wealthy European immigrants purchased “unregistered” land and invested in coffee cultivation. Displaced farmers, mostly indigenous, returned to the region as plantation workers and learned how to cultivate coffee. After the Mexican Revolution and when land reform reached the southern states, small farmers began cultivating coffee. Coffee transformed landscapes and people in southern Mexico and today continues to do so. Focusing on the Soconusco region of the state of Chiapas in southern Mexico, we examine how coffee landscapes affect people and nonhuman nature. In particular, we discuss how “technified” coffee landscapes affect biodiversity and created the conditions that may have led to the coffee rust outbreak in 2012. We also discuss the impact of the plantation system on social relations and the impact that this system has on permanent and temporary farmworkers. Finally, we explore potential connections between the ecological and social impacts of the plantation system in the Soconusco region.

The coffee landscape in southern Mexico is a patchwork of managed coffee farms that range from large-scale monocultural plantations to small-scale diversified small farms, intermingled with patches of forests. Nonetheless, the monocultural plantation form has come to dominate, reshaping human and nonhuman life in very dramatic ways. This simplification of the patchy Anthropocene has important implications for biodiversity as well as the livelihoods of people that live and work in these environments. Significantly, in the coffee landscape, the simplification has led to the loss of biodiversity and the proliferation of pests and diseases. In this paper we analyze how the process of landscape simplification occurred in southern Mexico and the consequences of the resulting “technified” coffee plantation for human and nonhuman life. We implicate this landscape simplification with the proliferation of coffee leaf rust, a fungal disease that arrived in the Americas in the 1980s and today continues to do so. Focusing on the Soconusco region of the state of Chiapas in southern Mexico, we examine how coffee landscapes affect people and nonhuman nature. In particular, we discuss how “technified” coffee landscapes affect biodiversity and created the conditions that may have led to the coffee rust outbreak in 2012. We also discuss the impact of the plantation system on social relations and the impact that this system has on permanent and temporary farmworkers. Finally, we explore potential connections between the ecological and social impacts of the plantation system in the Soconusco region.

At the heart of the landscape simplification in southern Mexico is the plantation system, and therefore it becomes an important unit of analysis. Plantations are highly specialized, large-scale agricultural operations characterized by their intensive use of capital investments as well as the exploitation of wage labor (Young 1970). The colonial character of plantations in Latin America, as well as the influence of European powers through the exploitation of fertile and ecologically rich lands, represents a particularly unique mode of relating land, people, and nonhuman life. The way in which plantation agriculture has developed in Latin America has determined the ecologies of places, including the interaction among humans, nonhuman organisms, and their environment, potentially in a more exploitative manner than has peasant agriculture (Bartra 2015).

To discuss this exploitative relationship, historians and political economists have analyzed the trajectory and socioecological effects of the plantation economy in the context of colonialism (Bartra 2015). On the one hand, the process of European colonization has taught us the extraordinary ability of humans to deploy natural resources through exploitative relationships with their environment and people (Oslund 2011). On the other hand, this same process has more recently originated new forms of relating people and their surrounding environment, precisely through the commoditization of nature in the form of ecolabels and through the adoption of conservation ideas into the process of agricultural production (Anker 2001; Grove 1995).

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1997). Although the latter is secondary to our discussion in this article, it is important to consider it as it is key to the development of ecological principles and the agricultural and forest management and conservation we see today, without which it would be impossible to understand the global history of the environment (Oslund 2011).

The essence of the plantation economy—that of a tightly centralized political structure with defined social stratification and a controlling character, that allows full labor control and the transmission of agricultural management instructions from top to bottom (Young 1970)—continues to have a presence in agricultural production in the Americas. In its origins, plantation economies were entirely controlled by foreign capital, and labor would be primarily imported, but profits would be invested overseas. Knowledge and technology were also imported from the “central” countries, often by sending the owner’s offspring to their country of origin to study as part of the colonial emulation of the plantation economy (Young 1970:344). Part of its original modus operandi has disappeared in most places in Latin America, giving place to communal land and small holdings that followed land reforms and land takeovers led by organized displaced peasants, or to more “modern” forms of intensive large-scale agriculture with high levels of mechanization such as soy bean plantations. However, old-style plantations continue to shape the landscape and the lives of people that live in, of, and around them (Lurtz 2014; Toledo-Tello 2002). This is particularly true in the Soconusco region of Mexico, the focus of this paper.

Coffee plantations represent an important sector of the coffee production in Central America, both historically as well as in contemporary times. According to the Comision Económica para América Latina y el Caribe (CEPAL 2002), the largest plantations in Mesoamerica (up to 300 in the case of the Schussed region in the southernmost state of Mexico)³ account for 3.5% of the farms but concentrate large portions of the land, accounting for 48.6% of coffee land and around 57.8% of the region’s coffee production. In Nicaragua from 2000 to 2001, only 2.4% of the largest farms produced 52% of the national production (Union Nicaraguense de Cafetaleros 2001).

In this paper we explore the current coffee plantation system that has developed since the nineteenth century in the southernmost part of Mexico during the Porfiriat period (1876–1910)—manifested by the demarcation of land for foreign capital investment—to analyze the ways in which this economy has shaped people and nonhuman nature and how neoliberal policies impacted, in surprising ways, large- and small-scale coffee farmers in Mexico. Coffee production under a plantation system represents only a small portion of all the coffee production in Mexico; nevertheless, coffee plantations still have an important influence in the region’s environment and its people (Lurtz 2014), especially in the Soconusco. Plantation owners represent the coffee aristocracy, own significant amounts of land, support hundreds of families year-round as wage laborers, and influence neighboring ejidos and small property.²

The Introduction of Coffee to Mexico, the Transformation of the Landscape, and the Interaction between the Social and the Ecological

The adoption and development of coffee production in the Americas and its vast cultivation in tropical and subtropical environments, mostly within biodiversity hot spots, helps us understand the effects of the expansion of European colonialism, commodity production, and capitalism on human and nonhuman interactions (West 2012). Coffee production in the Soconusco region, one of the most important coffee-producing regions in Chiapas, Mexico, is particularly interesting, as it played a key historical role in incorporating the state into the global capitalist market while dramatically transforming the landscape and social relations it reached on its path (Lurtz 2014; Pohlenz Córdova 1994). By the end of the nineteenth century, factors such as economic policies of the Mexican government (led by Porfirio Díaz), strong foreign capital (primarily German), and adequate ecological conditions allowed the expansion of coffee plantations in the Soconusco region (Renard 1993). In its expansion, the coffee plantation economy became not only a powerful mode of production but also a way of life for both plantation owners and laborers, as has been described for other regions in Chiapas (Toledo-Tello 2002), and that remains a reality today in Soconusco.

Coffee arrived in Mexico from 1790 to 1795, although it had already been adopted by European colonies in America, such as Brazil, which had been cultivating coffee since 1784. The subsequent low production in Brazil toward the end of the 1800s, the opening of new commercial port centers in Chiapas, as well as the vast and fertile lands in the slopes of the Sierra Madre, made the Soconusco the prime coffee-producing region in the country and boosted coffee production in Mexico. The first coffee plants in Chiapas, of the variety Bourbon and Tipica, were brought from Guatemala and were first adopted in small-scale operations under the shade of the native trees (M. E. Jiménez-Soto, personal conversation with a finquero, September 2016), following the mode of production in its center of origin, Ethiopia, by the “old aristocracy,” which remained after the partial depopulation of this region (Renard 2011) driven by the Spanish colonization that left behind mostly cattle haciendas in the lowlands of Soconusco (García de León 1979; Spencer 1988). Photograph by Eadweard Muybridge in the

1. However, sometimes large plantations (about 900 hectares) are ostensibly divided into smaller units under different family members to meet land regulations (M. E. Jiménez-Soto, personal field notes).

2. An ejido is a communal land-use system established in Mexico after the Mexican Revolution in the early twentieth century. It consists of an area of communal land used for agriculture in which individual families have designated parcels and collectively manage the rest of the communal land.

3. The name in Spanish for “plantation” is finca. In Mexico the word has the connotation of a large plantation managed in a very hierarchical way with hired laborers that work and live within the plantation property. A finquero is a finca owner.

4. A hacienda is an estate in Spanish.
1870s portrays a coffee plantation in Guatemala, where coffee was grown under mature forest where the understory was cleared for coffee planting (Rice 1999) (fig. 1).

The old aristocracy, as well as families that arrived from Mexico and Guatemala to repopulate this tierra de nadie (land of nobody) in the mid-nineteenth century (Ponce Jiménez 1985), constitutes the first wave of migration in an attempt to stimulate economic development in the region (de Vos 2002). However, the most important wave of migration to this region was the establishment of German fincas, primarily dedicated to coffee production. Due to the high requirements for labor, these fincas, adopted a system that provided housing for workers, both permanent and temporary (for the harvest season) that bound the workers to the farm owner (the patrón) in a permanent dependent relationship.

Coffee production in large volumes was done primarily by large plantations, which had access to commercialization routes and the required capital investments (Bartra 2015). By the time of its introduction to Chiapas, most agriculture was devoted to the production of corn, wheat, cacao, sugar cane, tobacco, indigo plants, chilies, maguey, pineapple, zapotes, etc. (Soto-Pinto 2001). During the agrarian reforms of the 1920s, indigenous communities that neighbored large coffee plantations received land that already had coffee, which allowed for the continuation of coffee production in the region (Soto-Pinto 2001). However, these new small coffee production units were not entirely independent, as they still needed to sell their coffee in advance, guaranteeing large exports and profits to large plantations. The production of coffee managed by indigenous and peasant families did not have major importance in the region until after the revolution and the agrarian reforms of Cardenas in 1939, thanks to an increase in international prices (Soto-Pinto 2001). However, peasant coffee was still subordinated to the private sector until the 1970s. The adoption of coffee by peasant (both indigenous and mestizo) farmers was dependent on the availability of technology, but also on their way of life. Therefore, coffee in this sector was produced with the same indigenous technology used to produce corn, and it was mixed with other family crops. The subsequent establishment of plots specifically to produce coffee was done by a selective clearing of the acahual (secondary vegetation) in the forest, conserving trees in the high stratum and part of the lower and medium strata, something that later Moguel and Toledo (1999) described as rustic coffee (Soto-Pinto 2001).

The intensification (also called “technification”) or semi-intensification of the coffee sector in Mexico began in the late twentieth century thanks to neoliberal economic policies that favored the modernization of agricultural production (Rice 1999). It consisted of planting new, higher-yielding coffee varieties, eliminating or considerably reducing the shade trees in the plantation, and applying agrochemicals, mostly synthetic fertilizers and herbicides. This intensification process was possible due to the plentiful demand generated in the years after World War II and the subsequent green revolution, which brought new coffee varieties and chemical inputs to the Socoo-
nusco (M. E. Jiménez-Soto, personal communication with a finca owner, September 2016). Progressively, coffee became closer to an industrial system with less shade or sometimes with no shade at all (Rice 1999), but the encouragement to renovate coffee plantations—a process that requires eliminating old coffee shrubs and replacing them with new ones—or adopt a fully intensified production a pleno sol (under full sun), only started with full strength in the 1980s, after coffee leaf rust—a devastating fungal disease caused by the fungus *Hemileia vastatrix*—threatened to devastate coffee production in Central America, the Caribbean, and Colombia. Throughout the process of intensification, governmental and international institutions played an important role. In Mexico, the now extinct National Coffee Institute (INMECAFE), and elsewhere in Latin America, the World Bank and USAID, promoted and incentivized coffee intensification (Rice 1999). These institutions also promulgated a modernist ontology associated with the green revolution (Gutiérrez 2017).

However, not all coffee *fincas* and adjacent small family units adopted the same level of technification. This push to modernize coffee production has produced the diverse matrix or “patchwork” of traditional, rustic coffee and more technified coffee systems that persist today (Rice 1999). The environmental diversity in which coffee was produced also rendered a patchwork of social relations. On the one hand, there are the *ejidos* and small properties managed by mestizo or indigenous farmers that use their own family labor and that sell their coffee through small peasant cooperatives (Martínez-Torres 2006) or continue to sell their coffee either to the neighboring *fincas* or to big transnationals. On the other hand, there are large coffee plantations, which dominate the landscape and continue to reproduce their old social organization based on a centralized political structure and the employment of wage labor (both permanent and temporal), regardless of their ecological configuration. Today, these *fincas* continue to export their coffee to Europe and the United States, and more recently also to Japan, primarily within specialty markets, to accommodate their product in an increasingly competitive environment and overflowed market. This has been possible due to the exploitative relationship with the land and people that often reproduces the old colonial ideal, including a dualism between people and nature. However, it is important to point out, as Toledo-Tello (2002) distinguishes, that the owners of *fincas* are also a heterogeneous group and that the mechanisms of exploitation that are often explored in the literature are part of a more complex process, configured throughout multiple social and historical factors.

The Coffee Intensification Gradient, Biodiversity, and the Web of Relations That Sustain Life

The Gradient and Syndromes of Production

The patchwork of coffee management systems can be found not only in the Soconusco region but also throughout the world. At one extreme is the rustic system where coffee is planted in the understory of a forest and no agrochemicals are applied, and at the other extreme is the “sun coffee” system that consists of monocultures with substantial applications of pesticides and synthetic fertilizers. Between these two extremes there is a wide variety of systems that have different levels of density and diversity of trees and herbaceous plants. Almost 2 decades ago, Moguel and Toledo (1999) classified the coffee production systems into a gradient that goes from a very diverse agroforestry system to coffee monoculture based on the common practices in Mexico (fig. 2). The most obvious feature of this coffee taxonomy is the arboreal component (i.e., the density, diversity, and heterogeneity in the height of trees), but there are other features that tend to follow the gradient, including density of coffee plants, use of agrochemicals, and, to some extent, size of farms (fig. 3). There is quite a variation in this gradient, and not all follow the trend described in figures 2 and 3. In addition, due to certification programs that provide markets or higher prices for “shaded” or “ecological” coffee, some large plantations in the Soconusco region and elsewhere have maintained a certain level of shade and minimized the use of synthetic agrochemicals in spite of the general trend toward intensification (Jha et al. 2014). There are also some large organic plantations that are monocultures, although this is far less common.

The various types of coffee management systems could be considered syndromes of production (Vandermeer and Perfecto 2012). A syndrome of production is a set of management practices that usually go together (Andow and Hidaka 1989). For example, coffee monocultures tend to include high planting densities of so-called improved varieties of coffee and applications of fertilizers and pesticides. These farms also tend to be large (>10 hectares and frequently hundreds of hectares), employ hired labor, and are characterized by a hierarchical structure in the way labor is organized. These characteristics can be recognized as the “plantation” syndrome, or what in Mexico they call the *finca*. Another syndrome of production is the multifunctional coffee farm. This syndrome tends to be characterized by having diverse shade trees that serve multiple purposes (including the provisioning of shade to protect the coffee plants, nitrogen fixation, production of firewood, production of fruits and other food, and the production of medicines), traditional varieties of coffee planted at low densities, and little or no external inputs (Toledo and Barrera-Bassols 2008). These farms tend to be small (<10 hectares and frequently <2 hectares) and use mostly family labor. These farms frequently adopt agroecological management schemes that rely on biodiversity to maintain the ecosystem functions necessary for the productivity and sustainability of the farms (Altieri 2018; Perfecto and Vandermeer 2015). These two syndromes correspond to some extent to the two extremes of the management systems described in figures 2 and 3.

Ecological Complexity and the Web of Interactions That Sustain Life

With higher density and diversity of shade trees, there are higher levels of biodiversity and, therefore, more potential for ecological interactions, including higher-order interactions such as indirect trophic interactions and trait-mediated indirect in-
teractions. In other words, with higher biodiversity, the ecological complexity of the system will increase (Vandermeer and Perfecto 2017). A very simple example of how this occurs is diagrammed in figure 4. Consider, for example, what happens in a coffee monoculture where everything is controlled (weeds, herbivores, etc.). In such a simple system, the only aboveground interaction is intraspecific competition among the coffee plants. If you introduce a pest, say, the green coffee scale, then you add herbivory of the scale on the coffee plants. But since not all coffee plants are attacked by the scale insects, rather than having just these two direct interactions (competition and herbivory), you also add a higher-order interaction because the scale insect causes the plants that are not attacked by the scales to have a competitive advantage over the ones that are attacked (in other words, the presence of the herbivore alters the rate of competition among the coffee plants). Now, assume that a new herbivore, a grasshopper, is introduced to the region. Then, rather than adding one more interaction (herbivory of the grasshopper on coffee plants) for a total of four interactions, we end up with seven interactions: the previous three, plus herbivory of the grasshopper on plants that are attacked by scales, herbivory of the grasshopper on plants that are not attacked by scales, a higher-order interaction caused by the grasshopper changing the rate of competition among the coffee plants, plus another higher-order interaction that emerges because the green coffee scale causes coffee plants to produce more caffeine, as a defense.
mechanism, and that caffeine has a negative effect on the grasshopper (fig. 4). It is easy to see how adding species adds interactions in a nonlinear fashion. Since diverse coffee farms can have thousands of interacting species, the potential for ecological complexity and nonlinear dynamics is enormous.

Higher levels of biodiversity can also imply higher levels of ecosystem functions, some of which can directly benefit humans, regulation of herbivores (pest control), pollination, and carbon sequestration, and others that are necessary to sustain nonhuman life. A recent meta-analysis linking biodiversity with ecosystem functions and life-sustaining processes shows that the balance of evidence is positive but nonlinear (Cardinale et al. 2012). In other words, the ecosystem benefits provided by biodiversity increase with the species richness in a saturating fashion, and after a certain point, additional species become redundant. Although the conventional wisdom is that there is a trade-off between crop yield and other beneficial ecosystem functions such as biodiversity conservation, carbon sequestration, and pollination, the few studies that have examined trade-offs in coffee or cacao farms have found little evidence for that. For example, a study that examined the relationship between yield and species richness for nine taxonomic groups in cacao farms with varying levels of shade in Indonesia found that of the nine taxonomic groups examined, only one, herbaceous plants, showed a statistically significant negative relationship (Clough et al. 2011). Furthermore, when only endemic species of birds and butterflies were considered, there still was no significant negative relationship with yield. A study conducted in Puerto Rico examined trade-offs among a variety of ecosystem functions including coffee yield, pest control, pollination, and carbon storage and similarly found no evidence of strong trade-offs among them.

**Impacts on Biodiversity**

Empirical evidence accumulated over several decades shows convincingly that biodiversity declines along the coffee intensification gradient (for an overview, see Perfecto and Vandermeer 2015). Although it is clear that rustic and diversified agroforestry systems harbor more diversity of many taxa than coffee monocultures, it is less clear what the pattern of diversity loss is along the gradient. While some taxa seem to be fairly resistant to intensification and do not show strong effects until very high levels of intensification are reached, others are much more sensitive. The patterns of diversity loss are also related to the actual sys-
tems that are being compared, and there could be thresholds related to the diversity and density of shade trees as well as with the applications of pesticides within the system (Perfecto and Vandermeer 2015). One of the most debated issues in the conservation-related literature is whether diverse coffee farms can maintain diversity of organisms that require forest for their populations to prosper (i.e., forest specialists). For example, some conservation biologists argue that although studies show that shaded coffee farms maintain high species richness, the species composition is very different, with shaded coffee supporting mainly generalist species, and therefore, it cannot substitute for mature forests (Donald 2004; Komar 2006; Tejeda-Cruz and Sutherland 2004). However, from a long-term conservation perspective, this argument is misplaced. The relevant questions should be whether diverse coffee landscapes serve as high-quality matrices that allow the movement of forest specialists among forest patches and therefore promote the conservation of forest specialists as metapopulations (Perfecto, Vandermeer, and Wright 2009). Unfortunately, very few studies take this long-term dynamical perspective or even examine movement of organisms through agricultural matrices of different qualities.

Overall, the role of diverse shaded coffee farms in the conservation of biodiversity can be considered to be twofold: (1) they can provide habitat to a diversity of organisms that would otherwise go locally extinct in a landscape dominated by intensive agriculture, whether coffee or other crops, or (2) in a fragmented landscape, they can provide a high-quality matrix that can allow movement of forest specialists among forest fragments, therefore maintaining populations of these organisms as metapopulations.

**Landscape Effects**

The landscape is important not only as a matrix through which organisms can move, but it also can influence biodiversity at the local level. Although most studies comparing species richness between shaded and unshaded coffee farms find higher levels of richness in the shaded farms, sometimes those differences are not significant. The variation of the results of such studies has been attributed to landscape-level effect (Steffan-Dewenter et al. 2002; Tscharntke et al. 2005, 2012). A growing body of research suggests that the benefits of diversified local management are highly contingent on the structure of the landscape, where improvements in biodiversity are maximized under intermediate levels of landscape complexity; the "intermediate landscape complexity hypothesis" (Tscharntke et al. 2012). At high levels of landscape complexity, with a high proportion of noncrop habitat, biodiversity may be high enough in surrounding habitat fragments to provide high levels of biodiversity even in intensively managed farms (Batáry et al. 2010; Bianchi, Boij, and Tscharntke 2006; Chaplin-Kramer et al. 2011; Landis, Wratten, and Gurr 2000). Contrarily, in areas with a relatively homogeneous landscape (i.e., low system diversity), too few source populations remain to allow success colonization within agricultural areas (Eilers and Klein 2009;
Isaacs et al. 2009; Thies and Tscharntke 1999; Williams and Kremen 2007). So, the prediction is that the effectiveness of diversification in local (farm level) management will be higher at intermediate levels of landscape complexity. Unfortunately, too few studies of coffee have taken this landscape-level approach, and the validity of the intermediate landscape complexity hypothesis is still to be verified.

Farm size may also help explain some biodiversity patterns at the landscape level. If the landscape is dominated by large plantations (hundreds or even thousands of hectares), as is the case in the Soconusco region of Mexico, we would expect lower levels of biodiversity at the landscape level because the owners of the plantations tend to manage their land in more or less the same way throughout the entire area of the farm (Tscharntke et al. 2008). On the other hand, if the landscape is dominated by small-scale farms, the landscape heterogeneity will tend to increase, since many more farmers are making decisions independently about what trees to plant. Small-scale farmers also tend to plant other crops, including milpa, in addition to the coffee and tend to have farms that are multifunctional. This suggests that a transformation from a large plantation ecology to a small-scale farm ecology could increase biodiversity at the landscape level. A study of a heterogeneous coffee landscape dominated by small-scale farmers highlights the importance of these landscapes in biodiversity conservation (Leyequién, De Boer, and Toledo 2010).

Agricultural intensification leads not only to the reduction of biodiversity at the farm level but also to the simplification and homogenization of the landscape, which further affects biodiversity at the farm and landscape levels (Benton, Vickery, and Wilson 2003). This process has been well documented for Europe’s arable lands (Stoate et al. 2001) and Great Britain in particular (Robinson and Sutherland 2002). However, given what we know about the loss of biodiversity in large-scale technified coffee plantations, it is reasonable to assume that landscapes dominated by large plantations would have less biodiversity than those dominated by small-scale coffee farmers.

In summary, the biodiversity contained with the coffee farms supports the web of relations that sustain life, making diverse shaded farms multifunctional farms. Diverse shaded coffee farms contribute to the conservation of biodiversity by providing habitat to some species and by forming a high-quality matrix for species that need old-growth forest to survive and reproduce in the long term. Finally, the landscape structure and the size of farms also influenced biodiversity, with more heterogeneous landscapes with a mosaic of small farms being the most beneficial for biodiversity conservation.

Unexpected Consequences of the Simplification of the Landscape

Case Study of Coffee Rust

In spite of efforts by a variety of organizations that recognized the benefits of shaded coffee for the conservation of biodiversity (Smithsonian Migratory Bird Center, Conservation International, etc.), many coffee landscapes in Latin America, including those in the Soconusco region, have been transformed to more homogeneous landscapes (Jha et al. 2014). This homogenization, which can be considered a process of deforestation at the landscape level, can have unexpected consequences. Indeed, there are some indications that the 2012–2013 outbreak of coffee rust that devastated coffee production in Mexico and Central America may have been caused by the simplification of the landscape (Avelino et al. 2006, 2012; Boudrot et al. 2016; McCook and Vandermeer 2015; Vandermeer, Rohani, and Perfecto 2015).

Coffee rust disease caused panic when it first arrived in Brazil in the 1960s (Cressey 2013). Indeed, panic may have been the rational response given the history of this devastating fungal disease (McCook and Vandermeer 2015). In the late nineteenth century, Sri Lanka (then called Ceylon) was an important economic center for the British Empire, and its economic mainstay was coffee. When curious yellow spots began appearing on the coffee leaves, only a few prescient plant pathologists saw the potential for an outbreak. Yet, only a few short years later, the disease became so widespread on the island that the colonial administration had to take the decision to effectively abandon coffee production entirely. Similar outbreaks ended coffee production in Sumatra and parts of India as well. Indeed, this was one of the reasons that coffee became so dominant in many areas of Latin America.

When coffee rust arrived in the Americas, apparently carried across the Atlantic Ocean from western Africa in stratospheric wind currents, the response by coffee producers was understandable, given the history of the disease in South and Southeast Asia. Without fully understanding its ecology or epidemiology, agronomists rushed to recommend management for the control of the disease. Coffee rust is a disease caused by the fungus Hemelia vastatrix. Since the spores need droplets of water to germinate, as many fungi do, it was assumed that shade trees promoted rust by maintaining a more humid environment. It was also assumed that plants with proper nutrition would be able to better resist the disease. Therefore, in addition to the application of fungicides, the management recommendation given to farmers at that time was to fertilize, to prune the coffee plants (to regenerate new shoots), and to eliminate the shade. Of course, not all farmers followed these recommendations, for a variety of reasons. Yet, after that initial arrival and spread through the region (in the early 1980s to Central America) and after much hand-wringing, the disease never became the disaster that was predicted based on the historical devastations it caused in Sri Lanka and other parts of Asia in the nineteenth century. Although it was a problem for farmers, clearly reducing production to some extent and bursting to epidemic levels in some places, it never exploded to the level of a regional epidemic as it had done in Asia 200 years earlier. As a result, complacency replaced panic.

At around that same time, countries in Central America were acquiring an enormous external debt owed primarily to the World Bank and other international banks. Worried about potential defaults, the United States provided funds through
USAID to promote export crops in the hopes that increased agricultural exports would generate enough capital to pay the debt interest. One of the USAID grants went toward the technification of coffee in Central America. Governments started providing incentives to coffee farmers to plant new “high-yielding” varieties in a denser arrangement and to eliminate shade trees. Coffee rust was used as an excuse to promote this new technological package in spite of the lack of scientific evidence that the elimination of shade trees could help control the disease. As a result of this process of coffee technification, many farmers—large, medium, and small—eliminated or dramatically reduced shade trees in their farms. Furthermore, since shade trees serve an ecological function, including adding nitrogen (if the trees are N-fixing species), suppressing weeds, buffering microclimatic extremes, and increasing diversity of natural enemies that help control pests, their elimination implied the addition of agrochemical inputs, especially fertilizers and herbicides.

In 2012, quite unexpectedly, rust disease made its appearance as an epidemic throughout the coffee-growing regions of Mexico and Central America. News headlines covered the havoc caused by the outbreak, including not only yield losses that in some cases reached 50% but also social consequences such as the loss of farmworkers’ jobs due to the abandonment of farms, small-scale farmers losing their farms, and increased migration to the United States by farmers and workers who lost their livelihoods due to the disease outbreak (Avelino et al. 2015; Kumari Drapkin 2014). The FAO (Food and Agriculture Organization of the United Nations) in collaboration with Central American governments held emergency summits where technical experts were hailed as potential saviors, even though they had failed so many times in the past. The technocratic recommendations emerging from these meetings were predictable: fertilize, prune the coffee plants, eliminate the shade. But this time coffee researchers added two new recommendations: find the next generation of fungicides and breed the next generation of resistant coffee varieties.

Given this history, there are two questions that need to be answered. First, why did the rust not become so devastating immediately after its arrival, remaining a chronic problem, but for almost 3 decades never reaching the level of epidemic it had reached earlier in Asia. Second, what caused the very sudden regional outbreak in 2012/2013? To answer these questions, the basic biology and epidemiology of the disease must be understood.

The tell-tale yellow spots on the coffee leaves are groups of spore-containing organs that emerge from the stomata on the undersurface of the leaves. The spores are then dispersed. Once dispersed, the spore needs a small droplet of water to germinate, whence it enters the leaf tissue through the stomata. It then grows within the leaf, effectively destroying the leaf tissue as it grows, eventually completing its life cycle by emerging through stomata with its spore-bearing structures. There are three interrelated ecological issues involved in understanding the time course of the disease: (1) dispersal of the spores, (2) germination of the spores, and (3) survival of the spores.

The spores are dispersed by three mechanisms: wind currents (both local and regional), leaf-to-leaf contact, and splash. The germination of the spores requires a minimal amount of moisture, and the survival of the spores is compromised by at least two major natural enemies of rust—a mycoparasite, which is another fungus called the white halo fungus (Lecanicillium lecanii), and the larva of a small fly that eats the spores (Myco-diplosis hemeliae) (Hajian-Foroooshani et al. 2016; Jackson, Skillman, and Vandermeer 2012). All of these factors are strongly affected by the production style of coffee, what we have come to call the “syndrome of production.”

In a previous section, we discussed the syndrome of production and described a gradient from shaded, diverse, multifunctional systems to input intensive coffee monocultures. Walking or driving through coffee landscapes, one is impressed with what frequently seems like a bimodality, with many farms containing high levels of shade and others in full sun, with only a few that are intermediate. The common occurrence of shade coffee and, importantly, its gradual replacement by sun coffee starting in the 1980s through the 2010s, along with general deforestation in the overall region, can explain not only the increase in rust disease but also the suddenness of its epidemic status.

As the tree cover in many coffee landscapes decreases (both through deforestation and coffee technification), the winds that formerly were above the tree canopy penetrate to lower levels, increasing the potential for dispersing spores. Furthermore, in the sun coffee syndrome (coffee monoculture) the coffee plants are planted very close together, such that leaves from one coffee plant frequently are in contact with leaves from neighboring plants, thus increasing the probability of transmission through contact. Finally, the two major natural enemies of rust itself, the white halo fungus and the small fly, both decrease in sun coffee, especially when fungicides and insecticides are applied. On the other hand, humidity does tend to be higher in shaded coffee farms, and therefore the probability of spore germination is likely to increase in shaded coffee.⁶

Given this natural history, it is easy to see how either increasing or decreasing the shade in the system could affect rust. If we decrease tree cover, we (1) increase wind-borne dispersal of spores, increase contact-dispersal of spores, and reduce the effectiveness of natural enemies but (2) decrease the rate of germination of the spores themselves. If we increase the tree cover, these effects are reversed. To some extent it is obvious that where we start transforming the system will determine the relative importance of these two contradictory consequences. Presuming that a large region has very little rust and a large amount of tree cover in both the coffee farms and the surrounding landscape, the disease cannot get much of a foothold because of the low efficiency of dispersal. But as the general

⁶. It is not clear weather germination of rust spores is higher in shaded coffee systems since rust only needs a little droplet of water to germinate, and the morning dew seems to be enough for germination even in sun plantations (Graciela Huertas, personal communication).
landscapes become deforested though the elimination of shade cover in coffee farms and deforestation of the surrounding landscape, rust dispersal slowly becomes more efficient, both because of the increase in factors that facilitate rust transmission and because of the slow accumulation of rust at a regional level, which increases the spore load in the air generally. As a result, the process of deforestation continues, the natural history of the system suggests that there will be a tipping point, or critical transition, toward a rust epidemic. The basic process is illustrated in figure 5 and has been modeled by Vandermeer, Rohani, and Perfecto (2015). Furthermore, the application of fungicides is likely to reduce many fungi in the system, including mycoparasites of rusts, like the white halo fungus, thereby accentuating the tipping point.

The system is also characterized by hysteresis, or a lag time in rust incidence with a change in tree cover (fig. 5). In other words, the system follows a different trajectory on its way to a rust outbreak than to go back to the original low levels of rusts. This is important from a management perspective because it means that if a program of reforestation of coffee farms and the general landscape is started, the level of tree cover required to transition back to very low levels of rust will be much higher once an outbreak has occurred than the levels just prior to the outbreak (fig. 5).

Consequences at the Landscape Level

After 5 years of devastating losses due to coffee rust, the outbreak seems to be subsiding in Central America and Mexico. The elimination of older coffee bushes and their replacement with new resistant varieties seems to be working, at least temporarily. Ironically, a consequence of the coffee rust epidemic was the further simplification of the landscape. This occurred by two main pathways. First, many farmers, especially those with capital resources, replaced old coffee bushes with new resistant varieties, and the shade trees were eliminated or dramatically reduced (authors’ observations through the Soconusco region). This happened mainly in large plantations and therefore affected entire coffee landscapes. This is certainly what has happened in the Soconusco areas in the last few years (fig. 6a). The other process of landscape simplification occurred when farmers already living on the edge of economic viability suffered a major blow with the rust epidemic and decided to abandon coffee altogether and plant something else, frequently cattle or some annual crop (fig. 6b).

Regardless of the process, the consequence of the rust outbreak has been further simplification of the landscape, which can lead to future outbreaks, with higher frequency. For example, some of the rust-resistant varieties are susceptible to ojo de gallo, another fungal disease. Furthermore, evolution of rust is inevitable and is already happening, as ‘resistant’ varieties are already showing signs of rust infection (authors’ personal observations; Brown 2017).

The Effects of Coffee Fincas on Human Dynamics in Contemporary Times

Migration, Vulnerabilities, and Inequalities

So far in this article, we have explored how coffee plantations, or fincas, as a historical and ongoing syndrome of production in the Soconusco, have important implications in nonhuman interactions, biodiversity, and ecosystem functions. Specifically, we have presented the effects of intensification of the coffee landscape—epitomized in large-scale operations—on a major disease outbreak, coffee leaf rust. Because coffee landscapes are both socially and ecologically constructed, now we would like to bring attention to the social complexity of these systems in the Soconusco region.

The formation of fincas in Soconusco responds to a unique historical process and environmental conditions and to political processes that have allowed these settlements and social structures to remain since the nineteenth century. In this section, we discuss the most critical characteristics and social processes that make these systems unique, and the ways in which these systems influence the lives of both permanent and temporary farmworkers today.

A central characteristic of coffee plantations is that population settlements are concentrated and often distributed around the processing infrastructure or beneficio, resembling a town (Pohlenz Córdova 1994), where social interactions go beyond mere labor relations, thus creating a whole mode of understanding both owners and workers’ livelihoods, referred to as cultura de finca (plantation culture) (Toledo-Tello 2002). Around such arrangement there is the administrative office, sometimes the church, mechanical maintenance shops, the
store, the patron’s house, commonly called la casa grande (the big house), the houses of the employees of higher rank (mayordomos and caporales), the rancherías, where permanent workers live with their families, and the galleras (shared housing) where single or temporary workers live. In the fincas, the patrón or its employees can own the stores (no longer tiendas de raya), but there are also independent street vendors or independent tienditas, where people sell some groceries and canned goods from their homes or in the street. During payday, itinerant markets coming from Guatemala come to the farms and supply people with other goods from the market, such as rubber boots, clothing, lamps, knives, etc. (Pohlenz Córdova 1994).

The labor intensiveness of the coffee plantation requires the contract of a labor force that today is primarily hired from Guatemala and constitutes an important economic motor for this region (Pohlenz Córdova 1978). Migrant workers complement the population settlements of these fincas throughout the year, but particularly during the harvest season from September to the end of December. At the beginning of the harvest season, entire families and single migrant workers travel through the Sierra Madre to arrive at coffee plantations in Chiapas, transported by a contratista or contractor. People travel at least 8 hours in a redila truck, bringing food from their own plots, bags of clothes, and dishes to make their own food at the communal kitchens within the workers’ shacks during the harvest season. Many of these seasonal workers are peasant farmers back in Guatemala and use the money generated during the three to four months of wage labor in the Soconusco plantations to buy feed for their animals, seeds, tools, and other things that allow them to maintain their plots back home. This constitutes the semiproletarian sector of the labor force in coffee plantations. The temporary goal of semiproletarian families and single workers is to harvest as much coffee as possible during the time they work in the plantation, since workers get paid per amount of coffee harvested and not per day or tarea (assignment). As a result, the involvement of all the members of the family in the harvest of coffee becomes a common practice. Plantations cannot officially hire minors for harvesting coffee or pay them or register them in the payroll, and sometimes these rules are enforced by requiring minors to attend the finca schools. This is often resisted by families, who benefit from more hands to harvest coffee. At the same time, because the region faces labor shortages due to low and unstable prices of coffee and poor exchange rates between quetzales (Guatemalan national currency) and Mexican pesos, it is possible to think that owners of plantations also benefit from the work of entire families, whose work buffers against such labor shortages in the region. This dynamic may present migrant farmworker families with a dilemma since, ideally, they would want to make enough money...

7. The meaning of the patrón, or the owner of the plantation, often carries with it a sense of debt, respect, authority, and sometimes fear. People sometimes refer to the patrón as a “second father” (M. E. Jiménez-Soto, personal field notes).
to make their journey to Mexico worth the effort, and at the same time they would also want their kids to be able to get an education. Unfortunately, under current sociopolitical and economic conditions, they are forced to choose, and they typically choose the economic benefit. Ironically, this pay structure also means that those workers focused on economic benefits alone prefer to work in the more intensive plantations because the coffee is planted in higher densities and the yields tend to be higher (as a result of high agrochemical inputs).

The upsurge of migration has gained some scholarly attention as farmworkers in large coffee plantations experience very low wages, exploitation, structural violence, and food insecurity (Renard 2011). Some authors have considered farmworkers the most marginalized actors within the coffee production chain (Oxfam International 2002). Additionally, the barriers to transnational mobility frequently force immigrants into an undocumented status, which makes them more vulnerable to exploitation (Harvey 2005), mistreatment, and abuse by authorities, with no opportunities for better labor conditions and wages (Renard 2011). Working and living conditions of these laborers are often deplorable, lacking basic living requirements such as clean water and healthy food (Oxfam International 2002; Renard 2010) and exposing them to pesticides (I. Perfecto, personal observation). In addition, seasonal farmworkers might experience higher food insecurity and even seasonal hunger during periods of scarce work (higher during the harvest season), as has been shown for farmworkers in the United States (Brown and Getz 2011; Cason et al. 2004; Grauel and Chambers 2014; Pérez-Escamilla and Putnik 2007; Reeder 2000; Trejo et al. 2013; Weigel et al. 2007).

The subsistence value of biodiverse coffee systems draws on the potential of growing and using a variety of resources other than coffee within the agroecosystem and adjacent plots (Méndez et al. 2010). There is an increasing interest and awareness that biodiversity conservation can have positive effects on food production and livelihoods (Arnold et al. 2011; Méndez, Bacon, and Cohen 2013; Thrupp 2000). Such is the case for traditional coffee polycultures and indigenous agroforestry systems (Bandeira, López-Blanco, and Toledo 2003; Soto-Pinto et al. 2000). But despite the benefits of highly biodiverse coffee plantations, coffee farmers and farmworkers frequently experience seasonal hunger and food shortages (Fujisaka 2007; Morris, Méndez, and Olson 2013; Shriar 2007). Food-related challenges are mostly reported from smallholdings. Yet, farmworkers’ food security on large plantations, which represent a historically and currently important sector of coffee production in this region, have not been sufficiently explored.

Coffee pests and diseases as well as natural disasters in the Soconusco region are also a threat for both migrant and permanent workers. For example, in 2005 hurricane Stan had devastating consequences in Chiapas. Several coffee plantations lost their production, and roads were blocked by landslides and destroyed bridges, leaving entire communities with no land communication (Renard 2011). Therefore, finca owners were unable to provide food and other basic necessities for their workers, and they feared rebellions (M. E. Jiménez-Soto, personal field notes). The devastating rust outbreak in Mesoamerica has also led to scarce work for migrant workers who depend on coffee plantations for the family subsistence. Martínez, Gutiérrez, and Guevara (2013) estimated a reduction of 90,000 seasonal jobs (a 45% reduction) in the coffee industry associated with production losses that followed the rust outbreak in 2012. In addition, in 2013 families of seasonal workers who did not have family plots back at home experienced, on average, a 26.5% reduction in income, and 18% for those with family plots. At the household level, studies have suggested that women suffer the hardship of coffee leaf rust outbreaks, as many times they stay at home or look for off-farm income to provide for their families as husbands migrate to the cities (Rice 2017). This provides some evidence that seasonal farmworkers are among the most vulnerable within the coffee production chain, but even more vulnerable are those that depend solely on coffee plantations for their livelihoods (Martínez, Gutiérrez, and Guevara 2013). Additionally, in the case of semiproletarian families, the fact that they own land back at home allows them to exercise their peasant autonomy; for example, they may ask for family members or friends to bring animals and vegetables from their plots during the harvest season to complement their meals. On the other hand, permanent workers can be considered a more dependent and vulnerable sector, since they do not own land or a house but maintain a sense of belonging to the plantation. If they lose their job, they lose their “home” literally and metaphorically. Some of these workers have a created a sense of belonging with certain plantations, a relationship that sometimes goes back several generations. In the Soconusco plantations, for example, it is common to find workers that were born in the plantation, as well as their parents and grandparents. Since the plantation provides housing to the workers, these permanent workers are also more exposed to becoming homeless workers as they become older and cannot work any longer for the plantation or migrate to the United States or north of Mexico to work for large industries.

Finally, structural inequalities are present not only across the hierarchies of labor in the plantation, but also within the lowest ranks of farmworkers. For example, finca owners would often refer to Guatemalan farmworkers as hard-working people, obedient and strict. These characteristics are preferred for higher-rank positions that require management of groups of people in the fields, such as the caporal, who makes sure that all the assignments are done correctly by lower-rank farmworkers. This reputation often carries an attitude of arrogance that is not well accepted by “the locals” and creates disputes between Guatemalan and Mexican plantation workers (M. E. Jiménez-Soto, personal field notes). This phenomenon makes it difficult for farmworkers to realize that the inequalities experienced are systemic and part of a scheme that justifies structural violence and oppression inherent in the plantation system. A similar phenomenon has been described by Holmes
(2013) for migrant farmworkers in strawberry fields in California, where farmworkers experience both structural and symbolic violence\(^8\) that normalizes racism, translating into abusive work relations and hierarchies, segregation, and unequal living and working conditions among workers with different rankings.

Conclusion: The Socioecological Landscape

The ecological and social relations we have described form part of the socioecological landscape of coffee landscapes. These landscapes are frequently mosaics of different syndromes of production and different social relations of people with nature. Although it is possible to find regions where all of these syndromes of production are mixed with various social relations, for the most part landscapes are dominated by one or two syndromes of production, and these tend to have particular social relations associated with them. In the Soconusco region the landscape is highly influenced by large coffee plantations owned by people of German descent. The majority of these plantations are 300 hectares, the maximum size allowed by the Mexican Constitution, and have the typical exploitative social arrangement and hierarchies associated with the plantation system. However, their management ranges from intensive monocultures with high levels of agrochemical applications to highly diverse organic (or even biodynamic) management. In addition, by the periphery of these large plantations (and as a result of land struggles and land reform), there are a few ejidos with small-scale coffee farmers. Their farms tend to be diverse and their labor tends to be restricted to family members and a few contracted temporary workers for the harvest. This rich fabric of social arrangements creates an ecological landscape shaped by people’s interaction with nonhuman nature. One thing that is clear in this landscape is that the dichotomy of large plantations with exploitative social and environmental arrangements versus the small-scale farmers with family labor and stewardship of the land is not a clear-cut dichotomy and needs to be further explored. However, the presence of coffee rust in the region suggests that the trend toward landscape simplification, through the elimination of shade trees within the plantations and deforestation in the landscape as a whole, generated the ecological conditions for the spread and outbreak of the disease by promoting its dispersal by wind and reducing control by natural enemies. Since the disease had been present since the 1980s and did not become epizootic until the 2012–2013 season, this likely represents an example of a critical transition (from low to high coffee rust levels). Moreover, this transition is also characterized by hysteresis, because the trajectory toward low coffee rust levels will most probably have to follow a different path than the pathway that led to the disease outbreak (fig. 5).

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8. In this context, symbolic violence refers to the subtle naturalization of inequalities arising from the social perceptions of the powerless and powerful, often in benefit of those with higher power (see “Symbolic systems as instruments of domination” in Bourdieu [1979]).
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Livestock Revolution and Ghostly Apparitions
South China as a Sentinel Territory for Influenza Pandemics

by Frédéric Keck

This article develops three ethnographic scenes in Hong Kong reflecting three narratives of pandemic influenza as a side effect of the livestock revolution: an expert’s view of the Hong Kong territory as a sentinel post on the edge of the epicenter for pandemic flu, a farmer’s view of Hong Kong as a colonial experimentation on ways to raise chickens industrially, and a bird-watcher’s view of Hong Kong as a place full of bird spirits. In these different settings, I contrast the logic of indicators with the logic of sentinels and ask what it means to release a bird on the threshold of domestication, considered not as an evolutionary step but as a space of friction where humans and birds enter into an uncertain interaction.

The chair of the Working Group on the Anthropocene, paleobiologist Jan Zalasiewicz, recently declared that fossil bones of broiler chickens accumulated after 1945 could be used as a marker of a new geological epoch in which humans have changed their environment (Bennett et al. 2018; Carrington 2016). These chickens have been genetically selected in such a way that they are twice the size of their wild ancestor, the red jungle fowl (Gallus gallus), domesticated in South China between 10,000 and 7,000 years ago for divinatory and culinary practices (Simmons 1991:298). Indeed, 1945 marks a new threshold in poultry production with the “livestock revolution”: the transformation of small poultry farms into big factories through confinement, concentration, and integration. Such a process has been so successful in North American poultry farms that it was extended to the rest of the world and the food industry. When it was applied in China in the context of the reform policy in the 1980s, this industrial process, also called “chickenization” (Silbergeld 2016:61), dramatically increased the number of poultry raised for meat consumption. Contemporary broiler chickens grow five times faster than meat chickens raised in the 1950s, and their bones are less dense and more deformed. Thus if we look for quantitative indicators of the Anthropocene by considering chicken remains, we could identify three layers with different sizes and densities around three thresholds: the domestication of chickens in China, the industrialization of chicken production in North America, and the expansion of this mode of production in China.

There is another way to tell the same story by including microbes. At the end of the 1970s, virologists warned about the potential of South China as a site of emergence for influenza viruses due to a traditional system of agriculture enhancing the proximity among humans, pigs, and ducks. This warning made sense in the framework of the ecology of infectious diseases relating microbial mutations to ecological changes (Anderson 2004): influenza viruses coevolved with birds, pigs, and humans since the threshold of domestication, and the Industrial Revolution disrupted this ecosystem and amplified lethal viral mutations. The emergence of pandemic influenza viruses was thus described by experts of the Food and Agriculture Organization (2015) as an unintended effect of the livestock revolution (Delgado et al. 2000). It can also be described as a feral reversal of the Anthropocene, every threshold in the history of domestication being related to a change in the coevolution between humans, animals, and microbes. Virologists tell us that viruses emerging in China with the domestication of the chicken have been amplified by the division of labor in North America and returned to China in a monstrous form (Davis 2006; Wallace et al. 2010).

The same story can be told from a third perspective, not from the models of global experts but from the view of South China by its inhabitants. In Han China, “bird spirits” (shen niao 鬼鳥), the most prominent being the phoenix, were considered by scholars as signs of changes and often were associated with tombs (Sterckx 2002:181). In the eighteenth and nineteenth centuries, civil servants sent to South China described it as a place full of miasma (zhang 病) and associated it with “cold diseases” (wenbing 冷病) (Bretelle-Establet 2014; Hanson 2011). Mass killings such as the Taiping Revolution or the Great Leap Forward led to a proliferation of experts in the communication with ghosts, considered as spirits of the dead roaming without a place to rest (Mueggler 2001; Weller 1994). These complex beliefs and practices were associated by Chinese citizens with the perception of flu-stricken chickens with influenza not as commodities infected with a new virus but as ghosts of epidemics (yigui 以鬼) filling the environment and claiming debts from the living (Benedict 1996:111).

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In this article, I combine these three stories ethnographically to describe different perceptions of South China as a sentinel for avian influenza. I define “sentinel,” in contrast with the indicator, not as quantitative but as a qualitative logic of early-warning signals (Keck and Lakoff 2013). A sentinel is not only a technical device of prediction or a military post of surveillance and preparedness: it is also a territory where different actors, human and more-than-human (fowl, pigs, viruses, ghosts), interact in the anticipation of future threats. I thus offer materials for a “patchy” description of the Anthropocene. What if, in the sedimented layers of chicken bones taken by geologists as indicators of the Anthropocene, there were not only viruses but also ghosts? A bird can be perceived either as an indicator of a geological age technologically defined, or as an industrial commodity whose risks must be managed, or as a living entity endowed with intentions. The shift from the logic of indicators to the logic of sentinels leads me to study how beliefs and models are embedded in practices when humans interact with a bird potentially infected with influenza. Since models of influenza pandemics are tinted with colonial and secular histories of public health and surveillance, I want to show that the modes of perception of sentinels capture alternative ways to think and live through the Anthropocene, thus opening paths for postcolonial and nonsecular histories of the livestock revolution.

An ethnography of avian influenza moves from the global models of the livestock revolution to a local territory such as Hong Kong, where viruses emerge and ghosts appear in the interactions between humans and birds. Analyzing the different meanings of the term “release” as it is applied to potentially infected birds, I describe how these different modes of emergence grow out of an uncertain interaction. If the concentration of chickens in industrialized poultry farms has led, following experts, to the “release” of emerging viruses as well as bird spirits, we can ethnographically describe the gesture of releasing a bird from a farm or a market. To what extent does releasing a bird replay the threshold of domestication in an ethnographic setting? What kind of hope does it leave in the ruined landscapes of farms eradicated from live poultry infected with avian influenza? How do sentinel birds appear as phoebes emerging from the ashes of poultry slaughtered as a preemptive measure against avian flu?

This article thus develops three ethnographic scenes in Hong Kong, reflecting the three narratives of the Anthropocene presented in this introduction: an expert’s view of Hong Kong as a sentinel post on the edge of the epicenter for pandemic flu; a farmer’s view of Hong Kong as a colonial experimentation on ways to raise chickens industrially, in which unvaccinated chickens are used as sentinels of avian influenza; and a bird-watcher’s view of Hong Kong as a sentinel territory full of bird spirits. In these different forms of the sentinel, the military post, the industrial device, and the environmental territory, I ask what it means to release a bird on the threshold of domestication, considered not as an evolutionary step but as a space of friction and trouble (Haraway 2016; Tsing 2005:176) where humans and birds enter into an uncertain interaction.

Hong Kong as a Sentinel Post for Influenza Viruses

My fieldwork in South China, intended to understand the different meanings of influenza pandemic preparedness between 2007 and 2014, started with an ethnographic study of the department of microbiology of the University of Hong Kong created by Kennedy Shortridge in 1972. He had been trained at the school of microbiology founded by Frank Macfarlane Burnet in Canberra with Robert Webster, considered “the pope of influenza” for his prophetic claims about the next pandemic virus (Caduff 2015). With his colleague Graeme Laver, Webster had observed that the antibodies to flu viruses he was modeling in the lab could be sampled from wild birds found dead in the Australian seashore. He consequently hypothesized that flu viruses circulating among humans first mutate among birds, and that waterfowl, diversified in many species living in the same environment, constitute a perfect “reservoir” for the emergence of new viruses that can cause pandemics among humans. Webster collected viral samples from wild birds all over the world to compare their antigenic information and trace their evolution. His lab in St. Jude Children’s Research Hospital in Memphis, Tennessee, concentrates the diversity of flu viruses in the world and has become a reference center for the World Health Organization (WHO) when it must identify a new influenza virus.

If Webster was the pope of influenza, Shortridge became its military officer when he moved to Hong Kong to create the department of microbiology as an outpost to perceive the signals of the enemy on the front line. An influenza virus called H3N2 had emerged in Hong Kong in 1968 and caused a pandemic that killed 1 million people. But because the People’s Republic of China was not a member of the WHO, there was a gap in the surveillance of the mutations of flu in China. Shortridge built networks of personal relationships (guanxi) with veterinarians in Guangdong and collected samples of flu viruses among ducks and pigs in the area. He had observed that rice paddies of South China used wild ducks (Anas platyrhynchos) as biological pest controls, a system known as daotian yangya (Zhang et al. 2009), thus bringing them in close proximity with humans and pigs. Pigs are genetically considered as a “mixing vessel” where flu viruses “reassort” between humans and birds, because they have receptors in their respiratory tracts for bird and human viruses (Webster and Campbell 1972), while ducks are described as “sane carriers” because they shed flu viruses through their digestive tracts without being infected by them. Shortridge asserted that this traditional ecology was an “influenza epicenter” for the rest of the world. “The densely populated intensively farmed area of Southern China adjacent to Hong Kong,” he wrote with the renowned British influenza expert Charles Stuart-Harris, “is an ideal place for events such as interchange of viruses between host species” (Shortridge and Stuart-Harris 1982:812). To support this hypothesis, he remarked that the Chinese character for house (jiā 家) contains a pig under a roof—as if one could see the mutations of viruses coming from animals when looking at the various traits of this traditional character.
In the ecology of infectious diseases, a school of medical thinking initiated by Burnet (1953), microbiologists have borrowed concepts such as “avian reservoir” or “influenza epicenter” from other fields of knowledge, such as nuclear physics and seismology, to describe the antigenic shifts they observe in their viral samples. But these ecological concepts also have practical consequences because they allow microbiologists to intervene as public health experts. Shortridge was both an observer of and an actor in the “livestock revolution”: he recommended biosecurity measures to control the proliferation of microbes by making an opposition between dirty tropical landscapes and clean interventions of the government, but this recommendation privileged big industrial farms who can afford to implement these biosecurity measures in compliance with governmental rules.

Influenza research in Hong Kong was the outcome of a colonial and postcolonial history of science in the Asia-Pacific area, which applied immunological concepts to Asia from Australia, conceived as the vanguard of the Western world (Anderson 2002). Following an outbreak narrative that distributes blame for epidemic events, it stigmatizes groups and places as traditionally unclean (Wald 2008:8). It conceives the colony of Hong Kong as a reduced model of South China, where viral mutations can be observed on a regular basis and an alarm can be sent to the rest of the world. Because Hong Kong is situated at the end of the Pearl River Delta, it has many wild birds coming to roost in the shallow waters and many immigrants crossing the border in the hope of a better life. The mutations of viruses that accompany the movements of birds and humans can thus be simulated in Hong Kong as an experimental live model, contrasting modern Hong Kong and traditional China.

This colonial configuration was confirmed in 1997, when Hong Kong was returned to Chinese sovereignty. A new flu virus named H5N1 appeared in the poultry markets of Hong Kong, killing 5,000 chickens and one child. By contrast with ducks, chickens die massively and rapidly from highly pathogenic influenza, and by contrast with humans, their symptoms appear in the digestive tract rather than in the respiratory tract. Shortridge set up an inquiry in the thousand poultry markets of Hong Kong as a reduced model of South China, where viral mutations can be observed on a regular basis and an alarm can be sent to the rest of the world. Because Hong Kong is situated at the end of the Pearl River Delta, it has many wild birds coming to roost in the shallow waters and many immigrants crossing the border in the hope of a better life. The mutations of viruses that accompany the movements of birds and humans can thus be simulated in Hong Kong as an experimental live model, contrasting modern Hong Kong and traditional China.

Poultry were killed market-by-market as signs became evident, leading to the preemptive slaughter of all poultry to prevent human infection. Early detection and reaction was the order again in 2002 and 2003. Thus, there now lay the prospect for influenza-pandemic preparedness not only at the human level but, better still, at the baseline avian level with the ideal that if a virus could be stamped out before it infected humans, an influenza incident or pandemic will not result. In 1997, the world was probably one or two mutational events away from a pandemic, while in 2002, with earlier detection, it was probably three or four events away. (Shortridge 2005:10)

The idea that the early detection of viruses in their animal reservoirs and rapid intervention led to stopping a pandemic would have been impossible without the San Francisco Bay Area, conceived as the vanguard of the Western world (Anderson 2002). Following an outbreak narrative that distributes blame for epidemic events, it stigmatizes groups and places as traditionally unclean (Wald 2008:8). It conceives the colony of Hong Kong as a reduced model of South China, where viral mutations can be observed on a regular basis and an alarm can be sent to the rest of the world. Because Hong Kong is situated at the end of the Pearl River Delta, it has many wild birds coming to roost in the shallow waters and many immigrants crossing the border in the hope of a better life. The mutations of viruses that accompany the movements of birds and humans can thus be simulated in Hong Kong as an experimental live model, contrasting modern Hong Kong and traditional China.

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Shortridge’s strategy was to make a vaccine for new flu viruses when they mutate among birds, pigs, and humans. But because this virus was very lethal among chickens, it was impossible to make a vaccine. Flu viruses had been circulated and attenuated in chicken eggs since their process of replication had been studied in this animal model by Burnet in the 1950s. There is consequently a whole industry of egg rearing for vaccination that parallels the emergence of flu viruses in avian reservoirs and that may explain the analogies between labs and farms. Still today, despite research in other techniques such as cell-based and recombinant flu vaccines, 90% of flu vaccines are produced in eggs, which is time-consuming, as three eggs are necessary to make one vaccine for three flu strains. It is estimated that 500 million high-quality chicken eggs are used every year for the production of immunization shots (Caduff 2015:89; Manini et al. 2017).

In November 1997, Shortridge—in agreement with experts sent from the US Centers for Disease Control and Prevention—recommended that the Hong Kong government kill all the live poultry on the territory in order to eradicate the animal reservoir of H5N1. This measure had some efficacy: the H5N1 disappeared until 2002, and when it reappeared, a similar killing was conducted by the agriculture authorities, who became used to putting chickens in bins with gas and then incinerating them. “We didn’t cull; we conducted a slaughter!” Shortridge told me (interview, Hong Kong, February 2009). When I asked him how the massive killing was acceptable to the Hong Kong citizens, he said that 5 years earlier, he had recommended the closure of the horse races in Hong Kong because there was an outbreak of equine influenza, which is lethal in horses but not transmissible to humans. In a city where horse racing provides the only opportunity to gamble, this closure was, in his opinion, more costly to many Hong Kong citizens than the killing of their backyard poultry. This anecdote tells a lot about the differential value of animal life in the context of zoonotic outbreak, and it shows that the closure of livestock activity was in itself a costly measure in a liberal economy that relies on the circulation of persons and commodities. However, it does not tell much about the meaning of the slaughter for Hong Kong citizens, as we will see later.

Shortridge later justified the repeated killings of poultry infected with bird flu as a preemptive measure to avoid a pandemic:
before it happened was confirmed in 2003 with the SARS crisis (Severe Acute Respiratory Syndrome). A coronavirus circulating among bats and transmitting accidentally to humans through the civet cats consumed in Chinese traditional medicine returned to its animal reservoir when civet cats were killed and their sale forbidden. Shortridge then wrote an article with his two colleagues at the Hong Kong University department of microbiology who had identified the SARS virus in animals and humans, Guan Yi and Malik Peiris, in which he concluded: “The studies on the ecology of influenza led in Hong Kong in the 1970s, in which Hong Kong acted as a sentinel post for influenza, indicated that it was possible, for the first time, to do preparedness for flu on the avian level” (Shortridge, Peiris, and Guan 2003:79).

Biosecurity measures applied in Hong Kong were taken as models by WHO when the H5N1 virus moved from Hong Kong to the rest of Asia and then to Europe in 2005, increasing the fear that this zoonotic virus would become pandemic. They belong to a series of techniques of anticipation of disasters invented under the Cold War for nuclear blast and applied to all-hazards management, such as early-warning signals, worst-case scenarios, and stockpiling of emergency equipment (Lakoff 2017). In August 2005, Michael Osterholm, an epidemiologist who had just been appointed secretary of the Department of Health and Human Services and who was appointed to the newly established National Science Advisory Board on Biosecurity, published an influential paper in the journal Foreign Affairs in which he justified the massive stockpiling of Tamiflu, flu vaccines, masks, and protective equipment launched by the Bush administration. His article ended with these figures:

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Pigs in China</th>
<th>Number of Poultry in China</th>
<th>Number of Chickens</th>
</tr>
</thead>
<tbody>
<tr>
<td>1968</td>
<td>5.2 million</td>
<td>12.3 million</td>
<td>790 million</td>
</tr>
<tr>
<td>1969</td>
<td>508 million</td>
<td>13.2 million</td>
<td>13 billion</td>
</tr>
<tr>
<td>1970</td>
<td>790 million</td>
<td>13.2 million</td>
<td>1.3 billion</td>
</tr>
</tbody>
</table>

These statistics were then often repeated in presentations by public health officials, but they are difficult to confirm. It is ethnocentrically more meaningful to ask how the livestock revolution was experienced by actors who faced the growing risk of avian influenza in the poultry farms of South China.

Model Farms in the Hong Kong New Territories

The industrialization of chicken production started in the United States after 1945 with companies such as Tyson, Holly Farms, and Perdue, who reduced the time span to turn a day-old chick into a broiler through intensification and diversified poultry products through advertising. With confinement, animal numbers are not limited by the supply of natural resources or the carrying capacity of a territory (Silbergeld 2016:39). With transportation, they do not need to be raised close to the place of hatching. While in 1929 300 million chickens were widely dispersed across the United States, by 1992 US poultry production was largely concentrated in a few states in the South, hosting 6 billion broilers at an average flock size of 30,000 birds, with increasingly dangerous conditions of life for animals as well as for humans (Kirby 2010; Striffler 2005). In the 1970s, this model was developed in Asia through companies like Charoen Pokpand (CP), run by a Chinese businessman who started his activities in Thailand and Guangdong (Davis 2006). In 2012, CP controlled one-third of China’s poultry production and produced 1 million chickens at the same time in Thailand (Silbergeld 2016:77).

The livestock revolution was brought to Hong Kong as early as the 1950s by two Jewish bankers from Iraq, Lawrence Kadoorie and Horace Kadoorie, who taught Chinese immigrants in Hong Kong—with the motto “Helping people to help themselves”—how to transform chickens into commodities, build cages, select breeds, hatch eggs, ventilate (as backyard poultry was replaced by closed farms), and vaccinate (particularly against Newcastle disease, that killed chickens massively without being transmissible to humans). They particularly raised the yellow-feather chicken (huángmáo ji 黃毛雞), which requires more days to breed but is more appreciated by Chinese consumers than ordinary broilers. Because of the boycott of Chinese products by the United States, this breed was raised in Hong Kong and sold to the Chinese diaspora in North America. While in 1949 there were 145 farms breeding around 1,000 chickens each in Hong Kong (Yeung 1956), this soon expanded to more than 1,000 farms raising around 100,000 chickens each.

The poultry production in Hong Kong relied on the importation of eggs from China, which led British inspectors to control that ducks were actually raised in Hong Kong and not in the communist mainland.

[Many of the] ducks processed in Hong Kong and then exported to America came from eggs laid in China and brought to Hong Kong to hatch. Were the ducks from these eggs communist ducks or true-blue British ducks? The correspondence on the subject was voluminous before a solution was finally reached. Provided that an inspector was present when the duck was hatched, that he forthwith rubberstamped the duckling’s foot, and that on reaching maturity a further marking was put on the duck, then the ducks might be slaughtered, dried and admitted into the United States. (Grantham 1965:166)

After 1997 and the emergence of bird flu, the threat from the border was formulated in terms of mutating viruses and not communist ideas. The new Hong Kong government under Chinese sovereignty decided to rely on massive Chinese imports and strong biosecurity measures to get rid of the threat of bird flu. It made generous offers to poultry farmers who abandoned their activities through a Voluntary Surrender Scheme.

However, consumers were attached to buying local breeds in live poultry markets and were ready to pay twice the price for a Hong Kong chicken. They invoked symbolic reasons (offering...
a live chicken to a guest is considered a sign of honor, based on its ritual consumption in soups during ceremonial meals) but also the fact that Hong Kong live chickens were more healthy and tasteful by comparison with chilled imported poultry that “tastes like wood” (Liao et al. 2016). The import of live poultry from China declined from 30 million in 2002 to 10 million in 2007, while the import of chilled poultry increased in reverse proportions, but the production of live poultry in Hong Kong was not entirely stopped, and there were 30 farms raising around 1 million chickens when I started my fieldwork in 2007. All these farms, located in the New Territories (the part of the continent between Hong Kong island and the border with China), kept their chickens confined, as it was forbidden to raise free-grazing or backyard poultry or to buy live poultry directly at the farm. All live poultry raised in Hong Kong or imported from China had to be transferred and controlled at the Central Market of Cheung Sha Wan before being sent to retail markets where consumers could buy them. Live poultry markets had to clean their stalls every night and stop their activity for one day per month so that viruses would not accumulate there. They were separated from the rest of the market, and customers were informed of the risks of consuming live poultry. The possibility to buy live chicken locally had been an integral part of the value of poultry consumption in South China, and it persisted as a form of resistance to the livestock revolution.

For comparison, Poyang Lake, in southern Jiangxi Province, is also monitored as an “influenza epicenter” because over 14 million ducks are raised there (Fearnley 2015), almost one-fifth of China’s total duck production—it is forbidden to raise ducks in Hong Kong. For farmers in this area, the pertinent distinction is not between wild and domestic ducks, as in the discourse of flu experts, but between sideline ducks, which are raised free-range for personal consumption and which display a wide variety of species, and husbandry ducks, which are raised indoors with standardized species and sold to the market (Fearnley 2018). The threat of avian flu (qinliugan禽流感, in the words of Chinese farmers), exposes this local production to a global environment, transforming poultry from sources of food and income into signs of potential loss for the household.

In August 2009, I worked in a farm that had been infected by H5N1 6 months before, situated in the village of Yuen Long, in the north of the Hong Kong New Territories. The owner of the farm, Wang Yichuan, was the head of the Hong Kong Poultry Farmers Association. He communicated regularly with the media, who described his enterprise as a “model farm” (mofan nongchang模范农场). Accepting an anthropologist to work in his farm was probably part of his media communication. A former truck driver, he had bought this farm in 1994 after he read in the newspaper about a Chinese man from Singapore who became rich by raising chickens. His wife, originating from a poultry-breeding family, advised him not to engage in this business, which she found tiring and risky. Wang’s first difficulties came from the treatment of the waste, which triggered complaints from the neighborhood. Then, after 1997, they came from bird flu. It was a common occurrence to find 10 dead chickens per day, he said, but when he found 200 on December 6, 2009, he realized that there was something wrong. Even more alarming, half of these dead poultry were “sentinel chickens” (shaobingji哨兵鸡): unvaccinated chickens placed at the ends of the rows of cages, with a rate of 60 sentinels for a flock of 3,500 broilers or 500 breeders. Their death signaled that the H5N1 virus was in the farm.

Consequently, he was obliged by the government to kill and bury the 70,000 chickens living on the farm as well as 25,000 fertilized eggs, clean all the equipment, and change the nets. “There is not one feather left,” he proudly told me. He was promised compensations but never received them. When I worked at his farm in August 2009, he raised 30,000 chickens (his license allowed him up to 100,000) and only employed four workers; but he had bought another farm in mainland China, where he employed four other workers, and he was regularly crossing the border for his business. “Bird flu is a risk I am ready to take,” he told me, “because I like the poultry business. You can lose a lot, but you can also earn a lot!”

Working on Wang Yichuan’s farm made me realize that biosecurity is not only a global technique of preparedness for future epidemics but also “a more banal present-tense, enacted regime of corporate governance, alongside a subtly inculcated ethic for living amid industrial animals” (Blanchette 2015:651). Most of the measures recommended by the government after the outbreak had not been implemented. There was a pond for truck wheels to avoid viral import from other farms, but ponds for boots between the buildings of the farm were bypassed by workers. Wire nets to avoid contact with wild birds had been bought, but they were still lying on the floor, and sparrows were entering the buildings easily. Experts had also recommended mixing ordinary chickens and sentinel chickens so as to avoid the concentration of viral load at the end of the rows, which led workers to be more attentive to their distinction in the absence of separation by space or species. Sentinel chickens were sold to the central markets at the end of the week just as ordinary chickens if they were not sick. They had become part of the daily life of the farm and could even be eaten at the end of the day by poultry workers.

When I followed the truck driver from the farm to the central market, we passed by a series of containers prepared to leave on boats and inscribed with the motto “We carry, we care.” Poultry farms have traditionally been places of care in an intermediary space between hatcheries and markets. But because of biosecurity measures, they have been conceived as confined spaces where commodities are carried under a growing state of vigilance. The “carrying capacity” (Swanson 2019) of the Pearl River Delta had been put under stress by the threat of avian influenza: once a coexistence between humans, poultry, and wild birds (Liu 2008), it is now a competitive economy in which the Hong Kong brand maintains its value.

If Wang Yichuan’s farm, at the edge of the delta, was still running activity between hatcheries and markets—and despite its opening to wild birds—the Kadoorie Farm, situated in the middle of the New Territories, kept its chicken population en-
tirely closed. In 1997, with the emergence of H5N1 and the threat on poultry farming activities, the Kadoorie Farm could not sell its poultry products anymore, and it became a center for the conservation of local breeds. Its leaders were proud to say that during the Cultural Revolution, Chinese pure breeds had disappeared from mainland China, thus giving their farm the role of a repository for local breeds that could be sent to China to be raised anew.

The visitor who enters the Kadoorie Farm today sees botanical gardens, wild birds, crocodiles, monkeys, and, preserved from the gaze of visitors, 2,000 chickens with a warning: “The Chicken Display House will be closed until further notice to ensure the chickens at the Kadoorie Farm and Botanical Gardens are protected from any possible outside contamination while bird flu concerns still exist in Hong Kong.” The Kadoorie Farm has its own system of alert, more severe than that imposed by the government to other poultry farms, with three levels (vigilant, serious, urgent). Indeed, in case of an outbreak of bird flu in the surroundings of the farm, the cost of culling would measure not the value of the meat but the genetic knowledge preserved by decades of selection.

I met Shing Tam-Yip when he was the head of the breeding team, taking care of the 2,000 chickens and nine pigs. A passionate bird-watcher and plant scientist trained at Hong Kong University, he had wished to build his own farm, but the environmental impact assessments were too stringent, and he accepted the job offer from Kadoorie Farm. He told me that before 1997, the selection of the purest breed was a public ceremony but that it became hidden after 1997 for safety reasons. Selection consisted in sexing the males from the females, ringing the males who had the highest value, and destroying the rest of the males. Shing contrasted the killing of day-old chicks for selection to the massive killing of poultry as adds preventive measure against bird flu: “We use CO₂. This is not torture. For ten seconds they shake a lot, but after twenty seconds it is silent. When they killed poultry at the central market of Cheung Sha Wan, the quantity of gas was not enough. Poultry died after a very long time. It was really torture. People watching on television felt distress.”

It is interesting to contrast the views of chickens by Wang Yichuan and Shing Tam-Yip. For Wang, chickens are commodities whose circulation must be secured, and the loss of the flock is a risk that must be anticipated. For Shing, they are tokens of a species whose loss would be a disaster and whose preservation justified the killing of young chicks through sexing. Shing told me: “In mainland China, people don’t have the concept of species; for them, it is just meat.” While for Wang wild birds are pests that can introduce viruses in the farm and must be repelled by nets, Shing compared chickens to wild birds as different species to protect. He showed me the refuge where wild birds were healed after being caught in smuggling activities before being released. The Kadoorie Farm raised domesticated chickens as well as wild birds, but only wild birds were released, while chickens remained on the farm.

Thinking about bird release then led me to a different view of birds: not as sentinel devices signaling potentially pandemic viruses or as commodities in a process of carrying and care, but as potential ghosts in an unstable interaction. While I was working at the poultry farm, I constantly thought about the possibility of liberating chickens from their reduction to commodities, which led me to follow their transportation to the market, thinking about the tension between carrying and care. But when I heard about the release of wild birds by bird-watchers, I came to think about what it really means to liberate a bird from the livestock revolution. How can the gesture of releasing birds open new possibilities of interacting with birds, and what does it reveal of the logic of sentinels?

Bird-Watching in Sites of Bird Spirits

Taking the perspective of bird-watchers, I came to think differently about the work of virologists and poultry farmers when they monitor Hong Kong as a “reservoir” for avian influenza. An “avian reservoir” is not only a site of viral mutations under surveillance but also a set of diverse living beings who must be monitored and inventoried. Therefore, sentinels are not only technical devices sending warning signals but also collectives of humans and more-than-humans caring for their environment (Keck 2015). Because they are sensitive to signals, they can detect invisible beings such as viruses or ghosts.

The Hong Kong Bird-Watching Society (HKBWS) gathers more than 1,000 members all over the territory, where more than 500 species can be observed in different environments such as the sea, the forest, or the wetlands. The major site for observation is the Mai Po Nature Reserve run by the World Wildlife Fund, where migratory birds roost in the wetland of the Pearl River Delta. Fishermen used to grow shrimps in the ponds using the sea tide as a regulator (a technique imported by immigrants from South China in the 1950s called gei wai 基圍), but now they are employed by the World Wildlife Fund to preserve these habitats for wild birds. With 10,000 migratory birds feeding in the marshes every year, it became a Wetland of International Importance under the Ramsar Convention in 1995. It shares the properties of the rice paddies—a mix of wild birds, water pests, and interested humans—but for the benefit of birds, not for human consumption.

Mai Po has thus become a model for the simulation and surveillance of avian influenza, within a colonial and postcolonial genealogy of natural reserves. It was a military territory at the time when the HKBWS was founded by British officers in 1953 on shared affinities between “nature lovers” and military soldiers (Tsing 2005:133). While under the colonial rule, British officers looked at birds while preparing for the invasion of the Chinese army into Hong Kong, and postcolonial experts watched over dead birds as signs of a potential pandemic coming from China. The tipping point of the discordant event had changed (Khan 2019), but the function of the delta as a sentinel post had been maintained.
In March 2004, the government closed the Mai Po reserve because a wild bird infected with H5N1 had been found within a 3-km radius of the premises. This decision was highly criticized as an excess of precaution, but it was repeated almost every year, with a 21-day ban imposed on the reserve when infected birds were found in its vicinity. Hong Kong bird-watchers argued that since wild birds found with H5N1 on the territory were resident species and not migratory, it was irrational to close Mai Po and not bird parks or bird markets in Kowloon, where urban visitors might be in contact with bird feathers or feces. Bird-watchers used ornithology and epidemiology to criticize the blaming of wild birds out of fear of avian influenza. They wanted to show that they managed and monitored the reserve in a more rational way than how the government handled avian influenza on the whole territory, thus becoming sentinels of environmental biodiversity rather than sanitary biosecurity.

Chiu Ying Lam was the first Chinese member of the HKBWS in 1976 and was elected chairman in 1997. Trained in astronomy, he was also the head of the Hong Kong Observatory. He made bird-watching a popular practice not just for the colonial military elite but for the new middle class discovering leisure and nature, following the model of Taiwanese bird-watchers (Weller 2006). Chiu Ying Lam told me that he started bird-watching when he was young in the cemeteries of Happy Valley, where tombs are divided into Catholic, Protestant, Muslim, and Chinese areas in a dense urban neighborhood. "Cemeteries are good places for birds and ghosts. It was my first bird-watching, I was 27. Suddenly it was opening a door: I was seeing the living objects. It was opening my heart. Before I was studying physics and mathematics—dead things. I was blind. Our organs are opened but the signals are filtered out. I became an addict of bird-watching, I wanted other people to see, it was like preaching" (interview, Hong Kong, December 2008).

This narrative of eye-opening is interesting to connect to the perception of ghosts. In the Chinese tradition, ghosts are the spirits of the dead who cannot find a place in ancestral lines and receive sacrifice (Sterckx 2002). The perception of birds on the borders of Hong Kong is associated with the death of refugees who tried to enter at the cost of their lives. Hong Kong can thus be compared to another site of bird-watching on the coast of Fujian, the island of Kinmen, used by Tchang Kai-Shek as a garrison to prevent the invasion of Taiwan by the People’s Liberation Army. Because the army has occupied this territory until the lifting of the martial law, the landscape has been preserved from development, and bird-watchers come there from Taiwan and China to see birds that have disappeared elsewhere. There are many narratives about ghosts linked to the perception of birds in Kinmen ( SZonyi 2008 ). Watching birds on the seashore reminds local people of the soldiers who died while defending the territory. They are military sentinels in the sense that, while looking at birds, they perceive the ghosts of those who died in a conflict.

Chiu Ying Lam articulated this connection between birds and ghosts in a specific way. He said the Chinese were interested in birds as meat and the British in birds as species, but he was interested in what happens when he looks at a bird and a bird looks at him. Of course it is rare to be looked upon by a bird, but the gaze of the bird was often mentioned by Hong Kong bird-watchers when they showed me their photographs. While domestic poultry can be killed without looking back, wild birds send back the gaze as a sign of potential revenge. While poultry farmers exchange meat for care, bird-watchers exchange gaze for protection, but both kinds of interaction can turn to violence if the environment is not secured. Geographer Jared Diamond (1997) talks about the “lethal gift of livestock” to describe how animals bring pathogens to humans when they are domesticated too intensely; but this view remains too global and technological as it depends on virologists’ perspectives. If we take the perspectives of farmers and bird-watchers, we can rather say that the ghostly apparitions of wild birds in markets and farms remind humans of the uneven exchange of domestication.

Chiu Ying Lam came to this conclusion when he talked about bird release. Buddhist practitioners used to buy wild birds in the bird market and release them in adjacent parks to produce merits—a traditional practice in China coming from the release of birds by aristocrats to thank them for the quality of their songs ( Handlin Smith 1999 ). Bird-watchers showed that these birds often died from the release because they were kept in cages under stressful conditions and then released in an improper environment. Buddhist authorities launched a public campaign with posters showing a bird flying and gradually becoming a cadaver, thus transforming release life ( 1angsheng 放生 ) into release death ( 1angsi 放死 ). Bird-watchers working at the Kadoorie Farm suggested organizing ceremonies of bird release with wild birds captured on the border for smuggling, sheltered at the farm, and then released with GPS to follow their development. But Chiu Ying Lam noticed that these “scientific releases” were organized on Sunday and that Buddhist practitioners who were invited did not show up. He suggested organizing such releases in Buddhist or Taoist temples to meet the spiritual demands of ordinary people.

Bird release has become a highly debated topic in Hong Kong and Taiwan because it reveals the contradictions of the livestock revolution. If poultry becomes sick from industrial conditions of breeding and threatens to transmit deadly pathogens to humans, why not release birds from the market to diminish the suffering produced by the industry? Such was the reasoning of the ordinary Buddhist practitioners I met. But the Buddhist authorities, advised by bird-watchers, showed that releasing birds rather amplified the threatening invisible entities. Bird release produced viruses or merits depending on the carrying capacity of the lands where they were accumulated. When releasing a bird, one experiences the contradictions produced by the livestock revolution between birds as living beings and birds as commodities, since one does not know if the gesture of release will produce merits or viruses.

After the massive killings of chickens to eradicate avian influenza, Buddhist authorities used to pray for the souls of dead...
birds at the borders of the territory, because the territory needed to be cleaned of its bad energies. While biosecurity interventions appeared as a form of sacrifice that fixed living entities in the central market to clean the poultry industry from its impurities, watching wild birds on the borders of the territory was a way to interact with the ghosts of those who had been killed to preserve the territory. Birds observed on the borders of the Hong Kong territory reminded bird-watchers of the poultry killed to clean the territory from avian influenza and of the refugees killed in trying to join the British colony. While virologists tried to fix migrating birds through lines of viral descent, and while farmers tried to fix poultry through biosecurity measures, bird-watchers were attentive to the uncertain interaction with birds as potential ghosts escaping lines of descent and control.

Conclusion

This paper has multiplied the views of South China as a sentinel for avian influenza pandemics by taking different perspectives on the interactions between humans, birds and viruses and sentinel post, sentinel device, and sentinel territory. South China thus appears as a potential origin of the livestock revolution, which is one of the global indicators of the Anthropocene, and as a site of ghostly apparitions, which is the local perception of the threat of poultry farming. If the accumulation of livestock has produced an amplification of viruses but also a proliferation of ghosts, the gesture of bird release is an attempt to solve this contradiction by transforming livestock accumulation into lines of viral mutations or into personal intentions of ghosts. I have tried not to choose in this alternative between a secular and a nonsecular, or between a global and a local view of the livestock revolution, because I wanted to remain as close as possible to the uncertainties of life under the livestock revolution. Rather than ask how viruses mutate in an animal reservoir, I have asked how invisible entities appear in more-than-human interactions as signs of future threats.

Parallel to the logic of indicators, which follows the risks of the livestock revolution in a quantitative way, I have suggested a logic of sentinels to follow what happens on the thresholds of domestication. The Anthropocene has produced a logic of “too-much-ness” visible in the numbers of poultry raised in Hong Kong farms (Viveiros de Castro 2019). It is a logic of confinement, concentration, and integration in which the increase in the quantity of poultry increases the risk of transmission of diseases. The logic of sentinels, by contrast, is attentive to the possibility that some living beings do not follow the general rule, which can be characterized as a logic of “some-ness.” A saying in the world of influenza experts is “Sick birds don’t fly,” arguing that the transmission of H5N1 from Asia to Europe goes along roads of poultry smuggling rather than migratory routes. This sentence is catching the imagination, and so is the Buddhist poster of released birds turning into cadavers. If some birds released for spiritual purposes are infected with flu viruses, this connection between spirits, viruses, and industrial chickens can be captured by sentinels because they are attentive to the possibilities of bird movements. By releasing birds into the wild, Buddhists and bird-watchers reveal the feral aspects of the livestock revolution in South China, thus exploring the threshold of domestication as a space of apparitions, frictions, and negotiations that can potentially be inhabited as a sentinel territory.

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Cattle, Capital, Colonization
Tracking Creatures of the Anthropocene In and Out of Human Projects

by Rosa E. Ficek

This article considers the long-lasting ecological and social impacts of cattle introduced to the New World by Spanish colonists. First, it shows how cattle aided European expansions by occupying spaces inhospitable to colonization and destroying indigenous landscapes. It then turns to the role of cattle in modern projects of state-making and economic development centered on industrialization. Finally, it moves into eastern Panama in the 1970s and 1980s, where cattle legitimized settler land claims by converting forests into private property. Throughout, it highlights the unintended impacts of this cattle introduction in order to argue that cattle move in and out of capitalist and colonialist projects in ways that are never fully under human control.

Introduction

Cattle are creatures of the Anthropocene. Through the modern meat industry they are implicated in the creation of massive environmental disasters, from the clearing of huge extensions of tropical forest to the large-scale emission of methane and other greenhouse gases (Gerber at al. 2013; Goodland and Angahang 2009). This article considers the environmental consequences of human entanglements with cattle in contexts of capitalist expansion.

Just as the European history of capitalist expansion cannot be fully understood without acknowledging its interconnections with indigenous history (Wolf 1982), human history must be likewise understood as interconnected with the history of animals. The links between cattle and capitalism run deep. For Engels, livestock—domesticated, inheritable animals—were the first private property (Engels 2010 [1884]). Marx argues that the British enclosures of communal agricultural lands to make way for sheep turned peasants into wage laborers, creating the conditions for the emergence of capitalism (Marx 1992). More recently these insights illuminate contemporary questions about the production of wealth through interventions in nature, showing how livestock create new frontiers for capital by supporting other extractive activities in the same location (Grandia 2012) and by creating new opportunities for capitalization through the technoscientific manipulation of livestock genes (Franklin 2007). If cattle enable the accumulation of wealth for some humans through the dispossession of racialized others (Robinson 1983), they do not do so as captives of state or corporate power.

As Virginia Anderson shows in Creatures of Empire (2006), domestic animals do not always act in ways that humans anticipate or desire. They make history with and without human approval and foresight.

This article draws on a selective rereading of the historical literature on cattle that highlights the ecological relations that emerge as cattle and capitalism expand across nonwestern places. It argues that, more than just commodities caught up in the machinations of industrial production, cattle actively transform environments by entering into relations of interdependence with humans and other species. These relations and transformations have consequences for humans and the societies they try to build. As they eat, digest, move, trample, and occupy space, cattle move in and out of expansionist projects in ways that often escape human control.

This historical retelling focuses on the Western Hemisphere because human and cattle histories have entangled across the region in ways that take on distinctive patterns. These patterns emerged in the colonial encounter between Europeans and indigenous societies. As they traveled to the Caribbean and then across North and South America, cattle introduced by Spanish conquerors aided European expansion by occupying spaces inhospitable to colonists, destroying native environments, supporting extractive activities, and transforming relations of property, often in advance of empire. These colonial patterns, as this essay demonstrates, inform how cattle expand the reach of private capital and market relations in the modern world.

The middle section of this article follows colonial cattle into the nineteenth and twentieth centuries. If, as Anna Tsing (2012) argues, capitalist projects expand by replicating systems of production organized around standardized, self-contained units of plants, animals, and people, then the industrialization of cattle is based on the severing of their social and ecological relations. Because the historical sources this paper engages are limited in the extent to which they address bovine landscape ecology, the
third section of this paper turns to Panama as a case study that draws on ethnographic fieldwork as well as historical literature to analyze in greater detail the landscapes made and unmade by cattle. Here, the mutual interdependencies of cattle, peasants, and pasture grass powered colonial and later capitalist expansion. However, as cattle expanded into Panama’s eastern frontier in the mid-twentieth century, they acquired a new ecological relation that overturned the regional development project working to integrate this frontier into the national economy and political sphere. In Panama, as in other cattle landscapes, capitalist expansion depends not on state policy or corporate strategy but, rather, on the predilections of cattle and their uncontrolable ecological relations.

Colonial Cattle

The first cattle to reach the Americas landed on the Caribbean island of Santo Domingo in 1493 after crossing the Atlantic with Columbus on his second voyage. Of the several European and African breeds that arrived to the Caribbean, most came from the salty marshlands of Andalucía where cattle grazed unenclosed across extensive areas with minimal contact with humans (Ginja et al. 2009; Jordan 1993). The same place where this particular form of ranching developed, the Marismas, was also home to many of the Spaniards who participated in the early years of conquest (Bishko 1952:495–498; Butzer:49). In Santo Domingo, cattle found an environment so welcoming that they grew in size than their Old World counterparts (Reitz 1992). As the warfare and famine of human conquest raged, cattle roaming unenclosed occupied the ample, grassy savannas that Taíno hunters had maintained with fire as well as the extensive fields where indigenous farmers planted yucca, sweet potatoes, peanuts, squash, beans, maize, peppers, and other crops (Sauer 1966:51–56; Whitmore and Turner 2001: 128–129). The forest had previously been kept clear in many valleys by human activities. Now cattle kept the forest back by eating young trees that grew in the abandoned fields and savannas. They transformed agricultural fields into pastures by eating the vegetation, creating favorable conditions for Old World grasses and plants accidentally introduced by ships to replace native species (Castilla-Beltrán et al. 2018; Hooghiemstra et al. 2018; Sauer 1966:156). Cattle modified environments in ways that inadvertently benefited Spanish colonization.

In the postapocalyptic landscape that resulted from the genocide of Taínos, cattle relations with humans and other species took on a pattern that would shape colonial society on the island of Santo Domingo and far beyond. The unenclosed herds that concentrated on the outskirts of towns and cities were periodically rounded up and sold, and this generated capital that the Spanish colonists used to establish sugar plantations and import enslaved Africans for labor. Cattle living on the Andalusian-style open range, in occasional contact with slaves who had experience with livestock and savanna management in Africa, became essential to this new way of organizing labor and extracting resources (Sluyter and Duvall 2015). They provided food for slaves and labor to till the fields, transport the sugar cane, and turn the sugar mills (Rodríguez Moré 1992). They also made human expansion possible. From the sale of cattle, many conqueror-ranchers were able to organize and finance expeditions to other places in the Caribbean and the continent, and cattle reached these new colonies by way of the state-controlled haciendas in Santo Domingo (López y Sebastián and del Río Moreno 1999:13–17, 36). The descendants of these ancestral herds would participate in the colonization of North and South America by providing plantations, mines, military outposts, and missions with meat, fat, and hides and by occupying native spaces to an extent that would have been impossible with the relatively meager numbers of Spanish colonists alone, converting areas inhospitable to Europeans into livable—and exploitable—landscapes.

But cattle, so central to the expansion of colonial institutions across the Americas, were also central to the fugitive landscapes that emerged in the “empty” interstitial spaces of empire. In a matter of decades, massive herds of wild cattle dominated Caribbean islands depopulated by colonists who had moved on to new frontiers (Delle 2014; Mendez Nadal and Alberts 1947; Moya Pons 1974). In Santo Domingo the handful of plantations, towns, and cities that remained were concentrated in the southern part of the island, where hides and sugar could be exported through the Spanish port (Moya Pons 1974:110–111). While colonial state power dominated the south, the lands to the north of the island were populated by cattle and humans only partly and occasionally complicit with the Spanish empire. Some of these northern cattle had gone wild after wandering away from their humans. Others became ownerless in the warfare of conquest. In any case, they multiplied in places where indigenous inhabitants had been exterminated. They were called *ganado cimarrón* by the Spanish. *Cimarrón*, a term possibly derived from the Taíno word for plants that grow beyond human control, was also used to refer to native people who fled the cruelties of conquest, to Africans who escaped from forced labor, and to the wild pigs, dogs, and cats that, alongside cattle, lived in these spaces of refuge (Arrom 1983). *Ganado cimarrón* supported an extracolonial society in which marginal humans—commoners, mestizos, mulattos, and blacks—hunted wild cattle and traded the hides with British, Dutch, French, and Portuguese who clandestinely arrived with ships loaded with European products like fabric, wine, shoes, and slaves (González de Peña 2014; Moya Pons 1974:110–124; Pérez Herrero 1987:796).

The lively trade in hides challenged the colonial state’s power, not only because wealth was being redirected to competing empires but also because contraband life in the north subverted the Spanish colonial social order through transgressions of race, class, religion, and political loyalty. From the sale of cattle hides, free blacks were able to dress well and participate in legitimate commerce. Moreover, island northerners’ contact with foreigners went well beyond trade as they baptized their children with Protestant rites and Protestant godparents (Moya Pons 1974:118–119). To control this social unraveling, the co-
olonial state undertook a series of scorched earth campaigns that forcibly resettled northerners in urban areas in the south. However, the burning of homes and fields failed to remove the cattle or eliminate contraband and instead led to the growth of wild populations. Tame cattle joined the growing herds of ganado cimarrón, while slaves escaped to human cimarrón communities (Moya Pons 1974:127–128). The smuggling continued and flourished to such an extent that the sale of these hides supported the operation of plantations in the neighboring colony of Haiti, which in the eighteenth century became the largest sugar producer in the world (Giusti-Cordero 2014). The cattle generated from the appropriation of wild herds that thrived in occupied indigenous landscapes could not be controlled.

Neither could human colonists control the transformations that resulted from cattle’s insertion into New World ecologies. By eating the fruit and pods of native shrubs and trees, which had coevolved with Pleistocene herbivores long extinct, and which before conquest had been controlled by Taino fire, cattle dispersed seeds and promoted the reforestation of savannas (Sluyter and Duvall 2015). Guayabal and orange trees took over pastures and grew so densely that humans were unable to capture and kill cattle from horseback, and the land, too shady for grass, became useless for grazing (Johannessen 1963:94; López y Sebastián and del Río Moreno 1999:33).

Cattle kept close to the route of conquest as they came to New Spain, disembarking at Veracruz soon after the fall of Tenochtitlan in 1521. In the coming years more would arrive at the Gulf Coast, where colonists traded 15 enslaved Huastecans for each Antillean bovine that sailed into port (Doolittle 1987; Matesanz 1964). In addition to literally replacing indigenous peoples, cattle further occupied native space through their grazing. The Spanish colonizers of the Gulf Coast lowlands found rivers and marshes similar to the Marismas of southern Spain, where open range cattle raising had first been practiced. Here, in occasional contact with African vaqueros, cattle moved seasonally between wet and dry savanna in ways that resembled transhumance in the Marismas (Butzer 1988; Sluyter 1996). Unlike the pastures made and unmade in Santo Domingo, cattle altered the Gulf Coast landscape only moderately—the seasonal movements from wet to dry grassland reduced the ecological effects of their grazing (Aguilar-Robledo 2001; Sluyter 2012). Nevertheless, and precisely because of their movements, cattle helped create and then thrive in places whose indigenous humans were exterminated. Enclosed, the cattle dispersed, wrecked cornfields, and multiplied (Céspedes del Castillo 2009:180–181).

Conflicts with indigenous agriculturalists were frequent as cattle expanded farther into Mesoamerica. In the central plateau of what is today Mexico, colonists followed the Castilian custom that considered grazing land common property, including the arid grasslands that were not suitable for agriculture as well as untilled fields and stubble after harvest (Chevalier 1970:86–87; Morrissey 1957). Despite official ordinances protecting indigenous agriculture, cattle also grazed on what was considered the best land: the fertile, well-watered, places planted with maize, beans, squash, and other crops (Chevalier 1970:13; Morrissey 1951; Whitmore and Turner 2001:62–69). Conflicts over the destruction of Nahua crops ultimately led colonial authorities to order cattle and the humans who depended on them to go north—but not before they transformed relations of property. In the late sixteenth century, administrators began granting colonists estancias, livestock resting places. Over time, these grazing rights became rights to the land itself, and estancias became private ranches granted by the government (Chevalier 1970; Matesanz 1964). Open range cattle moved north, leaving behind a new landscape of ranches, farms, and fences dominated by an emerging creole landowning class.

Lands in what is today northern Mexico and the southwestern United States were considered inhospitable to the Spanish colonizers not only because of the aridity of the landscape but also because of the hostility of indigenous societies who ate cactus fruit and mesquite seeds and hunted deer and rabbit—and cattle obtained by raiding Spanish settlements and convoys (Chevalier 1970:9, 14). While colonizers and natives were at war, cattle occupied space in ways that enabled colonists to gain footholds in the region. Large herds of ganado cimarrón that had gown from cattle left behind by early Spanish expeditions greeted later sixteenth-century colonizers attracted to the region by the promise of silver (Dobie 1939:172). The same men who established silver mines also established ranches nearby, bringing livestock from the south and also absorbing the wild cattle already there (Perramond 2010:110). Similar to the Caribbean cattle that made the operation of sugar plantations possible, the cattle that overtook northern New Spain made the operation of mines possible by providing meat for workers, leather for working implements, and, importantly, tallow for candles (García Martínez 1994). By occupying the vast spaces between population centers, cattle helped secure colonial control of more and more territory, their presence acting as a buffer against the Chichimec raids that targeted the mule trains on the highway connecting mines (Baretta and Markoff 1978; Matesanz 1964). Conquest worked indirectly through bodies of cattle taking up more and more space.

European expansion in northern New Spain depended on cattle, and cattle, in turn, also depended on other species for survival and brought them into this web of relations. For cattle, the desert was not exactly a land of abundance, but some parts of it did provide mesquite pods, grass, and other things to eat. To satisfy their hunger, cattle ranged over large areas (Guevara and Lira-Noriega 2004). This occupation of large areas benefited ranchers, who absorbed wild cattle, expanded their land claims, and formed vast private estates out of herds and lands that had been ambiguously communal (Chevalier 1970:42).

Colonial expansion, however, was not fully under human control. Ranches—on the precarious edge of civilization—were sites where the reproduction of the social order could easily be overturned. The cowboys who rounded up sometimes wild cattle were also sometimes wild men, mestizos who rejected and were rejected by colonial society, who were hired to protect the ranch from raids and to raid the ranches of others, and who might
have found among wild cattle at the edge of civilization a kind of freedom (Baretta and Markoff 1978). As for the cattle themselves, the herds beyond human control continued to grow, absorbing thousands of cattle turned loose by ranches and missions abandoned in conflicts with Apaches and Comanches and during the transition to independence from Spain in 1821 (Brand 1961; Dobie 1939).

By the mid-eighteenth century, millions of wild cattle had taken over the southern grasslands of South America and altered their ecology. Cattle had gone to Bolivia in the sixteenth century to support mining in Potosí and migrated to the grasslands south when the silver boom ended. To the Pampas of what is today central Argentina came cattle from Chile and Brazil. Others dispersed from Jesuit missions and colonial haciendas attacked or destroyed by indigenous societies (Giberti 1974; Primo 1992; Rifkin 1992). In the Pampas, ganado cimarrón found grasslands occupied by needle grass, guanaco, ostrich, deer, pumas, and gray foxes (Campetella 2008:21). They replaced native grass with weedy European plants—and altered relations among Pampas species—by carrying seeds on limbs, in hair, and in excrement, and softened patches of soil with their hooves (Soyrinki 1991).

Cattle also attracted humans into the world of the Pampas in the eighteenth and nineteenth centuries. Like in northern Mexico, the cattle released by war and abandoned by shifting colonial extractive geographies supported conquest by occupying space where human numbers and colonial power was spread too thin. Once captured, wild cattle populated creole ranches and allowed them to expand. When killed by hunting expeditions, wild cattle were converted into tallow, fat, and hides (Campetella 2006:86). Wild cattle also offered meat that was salted and exported from Buenos Aires to Brazil and Cuba where it fed slaves (Sluyter 2012). If cattle fed laborers on distant plantations, in South America they were also important to the indigenous societies that thrived on the Pampas during the nineteenth century and who limited the expansion of the emerging Argentinean state. Like Creole ranchers and hunters, indigenous subsistence depended on these herds of wild cattle. But unlike the settlers, indigenous peoples who had remained autonomous from colonial society controlled human access to the grasslands and their resources, like the Salinas Grandes, a salt lake with abundant grass and water where cattle captured by indigenous humans pastured (Davies 2016:133). They also dominated trade networks of cattle, horses, textiles, and slaves that reached the Pacific on the other side of the Andes (Jones 1994:106). Wild cattle and horses from the Pampas, when incorporated into these transregional pastoral economies, allowed for the emergence of indigenous confederacies that brought political stability and prosperity (Davies 2016).

As the population of ganado cimarrón declined and eventually expired, indigenous peoples sought out other strategies for obtaining cattle. The leaders of these sovereign societies negotiated peace treaties with creoles that involved the regular payment of goods in exchange for access to lands they controlled, whether for obtaining wild cattle or salt (Jones 1994). In other instances, the gifts and provisions—which included livestock, herbs, sugar, tobacco, alcohol, and textiles—were considered compensation for military service as allies of the creoles (Foerster and Vezub 2011). Raids on creole ranches were another way of obtaining cattle and horses and reinforcing creole dependency, at least for a while. Juan Manuel de Rosas, the military strongman and wealthy rancher who came to epitomize the foundational frontier violence of the Argentinean nation through accounts of his exploits in Domingo Faustino Sarmiento’s Civilization and Barbarism (1998), led a military campaign into the periphery of Buenos Aires to occupy indigenous land and incorporate it into national territory. But the raids continued. Among the most remembered are the 1871 attacks led by Cal-fucurá, the Araucanian leader who took a legendary number of cattle to trade in Chile. Yet this was a war that would end in the extermination of natives. Ranches continued to expand along with European weeds, and the genocidal military campaign known as the Conquest of the Desert ended with the annexation of the grasslands to Argentina, the transformation of native ecologies, and the destruction of the native social structures that had been built on wild horses and cattle (Bonatti and Valdez 2015; Foerster and Vezub 2011; Giberti 1974; Montoya 1970; Pérez 2007).

Industrial Cattle

Colonial cattle’s indeterminate status as both private property and ganado cimarrón fueled the multiplication of wealth and the expansion of territorial control for colonists, but it also created webs of social and ecological relations that challenged the colonial social order, from the contraband zones of Santo Domingo to the indigenous-controlled grasslands of the Pampas. As the imperial colonization of indigenous lands gave way to the national colonization of indigenous lands, the abundant wild cattle in North and South America provided the raw material on which a new form of expansion emerged: the global industrialized beef economy. Cattle’s role in human projects changed, from supporting the extractive activities of mines and plantations from a peripheral position characterized by the uncontrolled, heterogeneous landscapes of ganado cimarrón to fueling capitalist expansion in landscapes standardized by the importation of pasture grasses, new cattle breeds, antibiotics and herbicides, barbed wire fences, and the design of rationally managed meat processing and transport facilities. If colonial cattle were at the vanguard of the ever-moving frontier of the Spanish imperial state, the descendants of these cattle led lives of confinement and ecological isolation.

The wild herds of Mexico populated what is now the southwestern United States without human intervention (Brand 1961). As in other places in Latin America, warfare between settlers and indigenous peoples created conditions for free-ranging herds to multiply (Dobie 1939). Human conflict and a landscape of wild brush thickets where cattle could hide prevented
ranches from generating profits, at least until a new group arrived (Archer 1989; Ramirez 1979:48). Anglo-Americans from South Carolina, where open range livestock raising had been established with sixteenth-century Caribbean cattle, traveled westward through the coastal pine barrens of the South, through Louisiana where they learned from Mexican vaqueros how to manage cattle on horseback, and reached East Texas in the early decades of the nineteenth century. The “Texas system” that emerged from this confluence of herds and the ranchers who followed them involved interactions with cattle similar to the old Andalusian style—leaving them alone for most of the year on unenclosed pastures (Jordan 1993).

Through this “Texas system,” Americans who occupied the area between the Nueces and Rio Grande Rivers of today’s South Texas were able to accumulate wealth by appropriating large numbers of cattle sometimes abandoned by Mexican ranchers, sometimes claimed by Mexican ranchers (Ramirez 1979:89). With the emergence of Chicago as the leading provider of meat to the northeast United States after the Civil War, ranchers in Texas began rounding up cattle for the growing beef market (Jordan 1993:221). Millions of cattle went north to meet the railroads that would take them to meat eaters east. Along the way, cattle fed off of the abundant grasslands of the Great Plains, and many invaded and eventually followed the grass to the Canadian prairies. Their transit altered western ecologies in ways that led to the extermination of native plants and bison and the displacement of Native Americans onto reservations where they were fed government beef purchased from ranchers who occupied their land (Rifkin 1992; Tucker 2000).

The industrialized landscapes that cattle would help build out of the destruction of indigenous landscapes were critical to the new imperial geographies that spanned the Atlantic in the late nineteenth century. In Victorian Britain, where cattle represented landed wealth and prosperity was tied to empire, fatted beef was a prized commodity and status symbol. Elites experimented with breeding cattle for their size—the bigger, the fatter, the better. Popular enthusiasm for enormous cattle was a way to express patriotism, admire elite power, and accept the imperial social order (Freidberg 2009:53–55; Ritvo 1987). To satisfy the growing demand for beef among working classes, British investors turned to overseas supplies. In the United States they invested in western cattle companies and imported British varieties to cross-breed with American cattle too lean for English tastes, and they poured capital into the transcontinental railroads and steamers that would transport beef to England using new refrigeration technology that would guarantee the meat’s survival across the Atlantic (Freidberg 2009:68). In the United States, as in Britain, the society that emerged around modern meat was based on the domination of indigenous lands and people. New kinds of technology and labor were accepted because the livestock industry successfully linked these innovations to western-US ideas about beef as an important resource and symbol of settler power (Freidberg 2009:51). The wild cattle that expanded beyond the control of the Spanish empire entered British and later US imperial networks in ways fundamental to the expansion of new rationalized modes of organizing nature and labor.

The Chicago meatpacking industry is one of the best examples of these new social forms. The end of the cattle trails coincided with the relocation of feeding areas to cities with rail connections, where cattle could fatten on corn from midwestern farms before moving on to slaughter and packing houses that processed and sent the meat to consumers in Britain and other places where marbled beef was increasingly valued (Lopes and Riguzzi 2012). The American meatpacking model that emerged emphasized efficiency in the production of beef and its distribution to faraway consumers. The supply chain was controlled by four companies that coordinated a system of livestock purchased cheaply in large amounts, cheap labor, and cheap transport to create a cheap product whose mass production generated enormous profits and whose social and environmental costs were obscured from consumers (López-Durán and Moore 2018; Warren 2007). Cattle, confined and commoditized, were fundamental to twentieth-century capitalism and its expansion. The meatpackers—especially the disassembly line in the slaughterhouse where the cattle were transported on hooks through different phases of production where stationary workers performed discrete, repetitive tasks—inspired Henry Ford’s auto assembly lines (Shukin 2009:87). The American model of meat production also spread to new locations.

British capital and American efficiency transformed the relationship between cattle and humans and between humans and the environment in the Pampas grasslands so that in the southern continent as in the northern, settled farming, barbed wire fences, and rising land values transformed the cattle landscape. In nineteenth-century Argentina as in the United States, British companies invested in cattle ranches, railway infrastructure, and meatpacking establishments. Ranchers began crossing their cattle with European breeds and replacing pasture with alfalfa and wheat enclosed by fences (Adelman 1994; Giberni 1974). Cattle, once hunted, raided, traded, and distributed to family and political allies by the indigenous societies of the Pampas, now became an altogether different beast, cut off from the social relations they had acquired over 3 centuries.

The urban landscape changed as well, especially when the form in which cattle were exported changed. In 1900 a massive outbreak of hoof-and-mouth disease led England to ban the importation of live cattle for fear that the virus, which had been introduced to Argentina by way of European immigrants and later declared endemic to the country, would make its way back to European herds (Sheinin 1994). However, cattle relations with the virus did not shut down the beef industry but, rather, prompted a reorientation from live animal exports to chilled meat, which was thought not to carry the disease. It was not long before the Chicago meatpacking companies arrived and overtook the chilled beef trade by waging meat wars that gained them distribution rights for over half the export meat, leaving the rest of the market divided between British and Argentinean companies (López-Durán and Moore 2018). In this rationalized and efficient system of meat production, cattle were trans-
ferred by rail from ranches in the Pampas to city holding pens, then through a maze of canals and ramps where they were sanitized before entering frigoríficos, the refrigerated meatpacking plants. Inside the frigorífico cattle were converted into cuts of meat, inspected for quality, and shipped overseas (López-Durán and Moore 2018). Once a volatile source of wealth on the open range, modern cattle generated new social forms that physically confined them but unleashed great profits for Argentinean elites and overseas capitalists.

As the shift from live animal exports to the chilled beef trade in Argentina demonstrates, modern cattle also unleashed diseases that shaped the international geography of trade. The confinement of cattle with fences may have severed their relations with grasslands and the other landscapes they occupied, but the industrialized landscapes built around and for cattle—stockyards, transport infrastructure, the whole setup of mass production facilities—created conditions favorable for the spread of viruses like hoof-and-mouth disease. Considered one of the most contagious viruses in the world, hoof-and-mouth disease spreads through both physical contact and the air, causing painful lacerations on the mouths and feet of cloven-hoofed animals that in cattle can lead to lameness, a reduced appetite, and lower milk production. Most outbreaks have been contained by the isolation and massive slaughter of animals (Mahy 2005; Woods 2004). To protect its livestock industry from hoof-and-mouth disease, which was endemic in every country south of Panama, the United States banned the importation of South American beef.

Up until World War II, United States cattle interests in Latin America were limited to meat processing. As postwar beef consumption increased, cooked and packaged meat found greater demand. The growing fast food and convenience food industries required cheap beef for hamburgers and frozen dinners. Central American cattle, raised on grass rather than grain, and free of hoof-and-mouth disease, produced lean beef better suited for these industries and enabled their success. Stimulated by the US beef quota, which became a way to reward Cold War allies, cattle raising in Central America accelerated after 1950. Forests that had been largely unmodified by humans since the conquest gave way to peasant farms, which gave way to large haciendas that used modern techniques to produce beef for export. US Department of Agriculture sanitation regulations as well as development-oriented credit practices encouraged fences, improved pasture grass, vaccination, sanitation, and other interventions that helped turn cattle into profit (Guess 1979; Myers 1981; Parsons 1965; Williams 1986). As agents of accumulation, cattle worked through racialized relations of labor and occupation whose patterns emerged during European colonization. These relations transformed forests across Central America—areas that in the past had only minimal involvement with the states that claimed them. Cattle facilitated, yet again, expansion into new frontiers.

The fabulous multiplication of wild colonial cattle, their appropriation as private property, and the emergence of the international industrialized beef trade enabled the fabulous multiplication of capital for British and US investors and for Latin American landowners. Along the way, landscapes shaped by diverse economies and ecologies were simplified into pastures and other feed-producing monocultures. Cattle were reduced to standardized, interchangeable commodities. Ties between consumers and producers were severed. Caught up in the machinations of industrial capitalism that controlled how cattle moved, ate, and reproduced, modern cattle seem to signal a definitive end to the wild, uncontrollable nature of cattle best embodied by ganado cimarrón. The confinement, control, and simplification of these creatures eliminated opportunities for wild herds to generate societies that sometimes subverted human projects of colonization and capitalization. While this process may be interpreted as an affirmation of human dominance over nature, however, the people who were invested in sustaining and expanding the meat industry were never fully in control of how cattle could establish relations with other species. Sometimes, these social relations create landscapes that overturn processes of capitalist expansion.

Pasture Expansion in Panama

When cattle came to Panama in the sixteenth century, they moved from the center of the isthmus to the west. It was not until the twentieth century that cattle and colonists began expanding into the forests of eastern Panama, a region that had been long abandoned by the shifting geography of colonialism. The state’s political project of integration in the 1960s and 1970s, under the rule of General Omar Torrijos, sought to extend state power into the nation’s margins and transform “unproductive” land into rationally managed units of rural production. Modernization took on a distinctive ecological form: the dream, in the words of one state planner, was to turn Panama into one giant pasture that extended from border to border (Heckadon Moreno 2009:148).

This enthusiasm for pastured landscapes is the result of colonial dependency on cattle. Cattle defined which areas were habitable for colonists beginning in 1521, when 50 cattle came to Panama from Jamaica (Castillero Calvo 2004:170). They went west, following the grass that grew abundantly along the country’s Pacific lowlands and that had previously been maintained by indigenous people with fire (Bennett 1968). The same mostly treeless savannas that made it easy for cattle to occupy space also made it easy for colonists to stage raids into Cocle territory in search of slaves to distribute among Spanish homes, haciendas, and estancias (Castillero Calvo 2004:151–155). In areas where the indigenous population decreased by the brutalities of conquest, cattle took over the work of preventing forest from growing back through their grazing and trampling (Illueca 1985). Herds of ganado cimarrón greeted westward-expanding colonists, who founded towns and cities based on the availability of pasture in the area (Heckadon Moreno 2009:76).

1. Hoof-and-mouth disease, or aftosa in Spanish, is also referred to as foot-and-mouth disease in Europe. All three terms refer to the same disease.
Within decades, cattle occupied a stretch of land in the center and southwest of Panama, moving and eating and digesting in ways that helped establish Spanish territorial control (Jaén Suárez 1985).

By the mid-sixteenth century, Panama was recognized throughout the Indies for its abundant pastures. Cattle grazed on what was considered communal land, where they had access to water in rivers and streams and food in native grasses, including "pega-pega" (Pharus latifolius) and foxtail (Arundinella deppeana), as well as legumes and browse plants like mesquite (Prosopis juliflora). The large estates that formed on these pasture lands supplied meat, tallow, and hides to the Veraguas mining camps in Panama and the Cauca region of Colombia, and even the distant conquest of Peru. Some whites and mestizos left mines and towns to raise cattle, so that by the nineteenth century the savannas were occupied by large landowners of the aristocracy as well as numerous smallholders (Henderson 1958:244–246). Rural society revolved around cattle.

The relationship among cattle, colonists, and grassland would change with the reconfiguration of the pasture as a key site of capitalist expansion during the nineteenth and twentieth centuries. Three introductions shaped this transformation: workers, capital, and fences. Grass, cattle, and fences helped mark lands as cultivated and therefore to be private property. Communal savannas were enclosed by wealthy cattle raisers and peasants (Heckadon Moreno 2009:110). Fences had once been used to protect home gardens from animals, but the barbed wire introduced the same year as Pará and Guinea grass was used to enclose the new kinds of grass and cattle (Henderson Fuson 1958:249).

The transformation of pastures brought about a change in land tenure. By the time of Panama's independence from Colombia in 1903, municipalities had already begun to grant licenses to enclose public land. The enclosures accelerated in the early twentieth century when the liberal state changed legislation to actively promote the privatization of communal lands. Cultivated communal lands could be claimed by an individual if that person could prove that the land was cultivated. Permanent home gardens and pastures planted with African grass were easy to claim as cultivated and therefore to be private property. Communal savannas were enclosed by wealthy cattle ranchers with barbed wire who were able to claim large expanses of land for their own herds and refuse access to small cattle-raisers and peasants (Heckadon Moreno 2009:95–130).

Grass, cattle, and fences helped mark lands as cultivated—as showing signs of human intervention—and therefore private property.

A distinctive landscape and identity emerged from these changes. The enclosure of savannas with barbed wire, their seeding with African grass, and their occupation by beefer cattle threatened the livelihood of peasants who raised cattle for cash and grains for subsistence. Land enclosures forced them to migrate to remaining forests and clear them in order to continue the practices they had followed for generations (Henderson Fuson 1958). In this production system, peasants bred cattle that were then purchased by ranchers (often with bank credit) who fattened and sold them to slaughterhouses (Heckadon Moreno 2009). This peasant way of life, by the mid-twentieth century, came to represent “national culture,” especially as their music, attire, and rituals—all deeply infused with a love for cattle—came to be institutionalized as folklore.

The iconic Panamanian rural landscape emerged alongside the iconic peasant. Among the different species of plants found in pastures, cattle found the African grasses more palatable and nutritious, and their preferential eating of these introductions led to their propagation until they became nationalized (Sluyter and Duvall 2015). Faragua thrived so exceptionally that the Panamanian geographer Omar Jaén Suárez (1981) called it a “conquering grass.” It was the most drought-resistant of the introduced grasses, and therefore prospered in areas where waterhungry grasses were unable to grow. Despite its lower nutritional content, faragua offered other important things to peasants and cattle. It is called “aggressive” because it spreads easily, successfully competes with weeds, and responds especially well to fire. It is also described as “robust,” able to withstand poor soil and overgrazing with little human care (Heckadon Moreno 2009:228; Henderson 1958:250). It was the perfect pasture for cattle and peasants pushed out of better lands by big ranchers. Its ability to expand in difficult terrains allowed peasants to continue raising cattle, which were sold to ranchers, who in turn sold them to city buyers and invested that wealth into acquiring more land, dispossessing more peasants, who cut down forests and planted faragua and raised more cattle.

The beauty of faragua pastures has been celebrated in Panamanian poetry and song. But it should also be clear that this landscape is also a wasteland. Without plant cover and trampled by hooves, soil washes away with the rain, especially in the spaces between clumps of faragua. The annual fires peasants use to discourage weeds and ticks further expose soils to erosion. By grazing, cattle transfer scarce minerals like phosphorous and calcium from grass to their bones, depleting nutrients from the soil (Heckadon Moreno 1985). If faragua enabled peasant and cattle survival, it was also an agent of environmental destruction.

When there was no more land in central Panama for peasants, beginning in the 1940s they began to migrate to the Canal watershed, the Caribbean coast, and eastern Panama. Eastern Panama was a land of rivers and forests inhabited by indigenous Emberá, Wounaan, and Guna, Dariénitas, or the black and mixed descendants of runaway African slaves, and black
seasonal workers from Colombia’s Pacific coast. Each in their own these ethnic groups practiced shifting agriculture for subsistence and sold surplus for cash and hunted, fished, and raised chickens and piggies and a few cows in some places, and were more connected by trade and kinship to Colombia than to Panama (Torres de Araúz 1975). To this land of wet tropical forest the colonists attempted to transplant a way of living that had developed in dry grassland.

Colonists trickled into the region in the 1950s but the big wave did not come until the 1970s when the Pan-American Highway was extended out of Panama City east into forests where modern roads had never been built. The Panamanian government hoped the road would support the economic and political integration of this space of black and indigenous autonomy. From the state’s point of view, these forests were problematic because they contained underutilized resources and people of ambiguous nationalities, some of whom could be subversives (Dirección General de Planificación y Administración 1972). Equally problematic, the landless savanna peasants could themselves become subversives, as happened in Nicaragua and other places where guerrilla movements emerged in response to expanding cattle ranching (Weinberg 1991:26). Instead of redistributing land, the state imagined in eastern Panama a bonanza of “free” land where colonists would settle in areas designated by science to be appropriate for pastures, with access to breeding centers and demonstration ranches that would teach people how to properly raise cattle for beef and milk destined for the national market economy (Organization of American States 1978).

It is only fitting that the American construction company hired to build the highway installed its base camp in one of the few pastures in the region. Winston Bryan was among the men hired to do construction work. Like many other workers, he claimed land adjacent to the route well in advance of the colonists who came in great numbers once the highway opened. But unlike other workers, and unlike colonists, Bryan was a black Anglophone from the Caribbean side of Panama. He farmed the land he claimed with his wife, who was from a local town. But they were forced to move. They had problems with cattle.

Bryan’s neighbors had a pasture next to his farm. Many colonists hoped to acquire or expand their herds. Cattle needed space—about 1 hectare per animal—and they needed water. Because the neighbors’ stream dried up every summer, Bryan had to give them access to his water. This went on for years. Then, as Bryan tells it, they waited until he was far away on a job operating a tractor and tried to take his land. They had a relative who worked at the Agrarian Reform, the agency that kept track of land claims, and with this person’s help they measured 9 hectares of his farm and titled it in their name. When Bryan returned and learned what had happened, he ran to the Agrarian Reform office, but they told him there was nothing they could do.

But Bryan had already registered his land, not at the local Agrarian Reform office but at the central office in central Panama. It took him 2 days to get there, but at the central office he obtained a letter certifying his claim. The engineers at the central office told him the date they would visit. And they really did visit, Bryan told me. They showed up at his house at 5:00 in the morning, and he ran to the river and bathed, and then they all went to the Agrarian Reform office. The local official did not know what to do. The secretary said she felt sick and went home. “From that day on up to this date,” Bryan said, “[the local official] never called me Bryan ever again. Ever since that day, he says Mister Bryan.”

Despite the victory, trouble with the neighbors continued. On another occasion Bryan left his wife two buckets of rice to plant while he was away, deep in the forest, cutting down trees. While the money he earned as a lumberjack was important, the rice he grew as a farmer was what would feed his family. But this livelihood was threatened by four-legged invaders. As soon as the rice was ready for harvest, 50 cows invaded from the neighboring pasture. His wife shot two of the cows, but she felt sorry for them and could not shoot any more. Bryan, on the other hand, affirms that had he been present he would have shot each of those 50 cows, and then his neighbors would have killed him, or he would have been forced to kill somebody in self-defense. “She told me: negro, we better sell and go to another place.”

People like Bryan and other eastern Panamanians did not fit into dominant constructions of the nation. Their swidden agriculture and resistance to notions of private property were at odds with the expansion of agro-industry. Colonists, on the other hand, brought about new relationships to land and new ecologies through their dependence on cattle. Clearing forest and planting—whether corn or pasture grass—allowed colonists to claim use rights. Those who wanted to title their land proceeded to have it measured, though use rights were frequently bought and sold to avoid paying the agronomist and the bureaucracy. Ranchers accumulated large tracts of land by being the first to claim them, and they often demonstrated their productivity by planting Indiana and Guinea grass (even if they had not purchased the cattle yet). They also pushed out and bought out smallholders like Winston Bryan. Pastures expanded, along with market relations and racial conflict. Cattle colonized by taking up space where (the right kind of) humans were too few, and by helping turn land into private property, in the process destroying enormous extensions of forest (see fig. 1).

This human project of capitalist expansion depended on cattle and the social-ecological relations they had established in the open savannas of central Panama. Even though cattle inadvertently aligned with the project of turning Panama into a giant pasture from border to border, in eastern Panama cattle overturned human designs by acquiring a new ecological relation. Hoof-and-mouth disease, the highly contagious virus that had shaped the global beef industry, was present in Colombia and the rest of South America. Panama, despite sharing a border with Colombia, was protected from hoof-and-mouth disease by the forest in eastern Panama—the same forest that in the 1970s was being colonized and converted into pastures.
If road construction continued and colonists and cattle were able to reach the border, the disease could easily travel through Central and North America, spreading through contact with infected equipment, vehicles, and clothing. Keeping the forest intact was critical to protecting the US livestock industry, and to keep the forest intact, highway construction had to be stopped.

This, at least, was the argument presented by the Sierra Club in its 1975 lawsuit against the US Department of Transportation, which was funding two-thirds of the highway that Winston Bryan was helping to build. While the Sierra Club’s ultimate goal was to protect the wildlife and indigenous Emberá, Wounaan, and Guna who depended on the forest that was being destroyed by cattle and colonists, the environmental organization obtained the support of the National Cattlemen’s Association and the Foreign Animal Disease Advisory Committee to pressure the US government against completing the highway. The lawsuit succeeded in suspending further road construction on the grounds that the project lacked an environmental impact statement and thus had not complied with the National Environmental Policy Act (Comptroller General of the United States 1978).

The environmental impact statement prepared by the Federal Highway Administration in 1976 claimed that hoof-and-mouth disease would not be a problem—as long as the local control programs were effective. Panama and Colombia had already prohibited the breeding, fattening, sale, or purchase of cattle in a 20-mile fringe along the international border in 1966. Bilateral agreements between both countries and the United States made in the 1970s further limited the expansion of cattle by establishing a quarantine zone along the border, where no cattle were allowed, and a control zone where existing cattle were allowed to remain but could not leave the zone (Organization of American States 1978).

The Sierra Club criticized the environmental impact assessment as superficial. The court, however, accepted the assessment and in 1977 allowed highway construction to continue—but not in Colombia until the US Department of Agriculture had certified that the hoof-and-mouth control program in the country complied with its standards, and this took decades. Even though construction could proceed at least on the Pan-


manian side, the US Congress never approved further funding. The Panamanian government abandoned the expensive project in the 1980s. Cattle, though confined and controlled by industrial technology, interrupted the project of capitalist expansion in eastern Panama through their relation with hoof-and-mouth disease.

Winston Bryan abandoned his original farm and purchased land on another location on the unfinished highway. He continued to plant and to work as a lumberjack and even owned some cattle at one point. Colonists continued to arrive, though many were deeply disappointed that their ranching dreams would not come true because of the quarantine. Many cleared forest and planted pasture grass anyway. Grass was an “improvement” to the land, after all, and justified claims to use rights. Yet the landscape and society that emerged from cattle quarantine generated land arrangements that complicate and undermine the expansion of state power and capitalist relations. Emberá and Wounaan, who previously lived in dispersed households at considerable distances from each other, began to settle into villages around the same time that colonists began to arrive and the Pan-American Highway was being constructed. Motivated by the threat of newcomers, by the desire to send their children to schools, and the influence of missionaries, and with the support of the Panamanian government, Emberá and Wounaan created a Comarca in 1983—a semiautonomous reserve with a hierarchical political structure, that accepted state power but also created communally controlled land (Herlihy 1986). More boundaries against cattle colonization emerged with the creation of national parks on both sides of the border by 1980, their primary purpose to buffer against hoof-and-mouth disease. Safeguarding cattle inadvertently called for safeguarding the forest, and this called for limiting the resource extractions that would destroy it.

The quarantine landscape likewise generated noncapitalist modes of exchange and reciprocity. Cattle under quarantine could be purchased or raised, fattened, and sold locally, but never at a scale that would sustain cycles of massive accumulation and dispossession; they were unable to reach the markets in Panama City and instead were confined to local networks, where the beef-eating population was significantly lower. In this context of isolation from the national market, the labor economy relied on kinship and reciprocity. Most colonists complement their subsistence activities with wage labor on ranches, plantations, in commercial establishments, or local government offices. But when they work a medias, landless colonists temporarily raise cattle on another’s land and, in exchange, promise half of the profits from the sale. When a family has to complete a task that requires more workers than the family can provide, kin and neighbors come together in a peonada in which they work collectively to fix a fence, for example, with the understanding that the help will be reciprocated at a future time.

The dream of a thoroughly national territory neatly organized into individually owned, rationally managed cattle-raising farms that would continue to expand state power and market relations is quite removed from the landscape that emerged with the hoof-and-mouth problem: an incommensurable jumble of quarantine and control zones, protected areas, indigenous collective lands, and colonization fronts. Cattle in this savanna-less tropical forest did not go wild or fabulously multiply like in other places and times. But their relationship with hoof-and-mouth disease, and their centrality to Panamanian ways of life, made it difficult for humans to control what could happen in a pasture and what shape the consequences could take.

Conclusion

As the case of cattle in Panama demonstrates, particular configurations of soil, climate, and vegetation—as well as particular differentiations between humans—shape how nature, property, and labor come to be organized in cattle landscapes. Attention to the specificities of more-than-human ecological relations as well as the specificities of human culture and society are essential to understanding how creatures of the Anthropocene create unsustainable environments in a given place and time. Whether grazing on faragua on a pasture in central Panama or eating corn in a midwestern feedlot, the environmental—and political and social—problems of livestock in the Anthropocene are the result of human actions and cattle actions shaping each other and shaping the places where these interactions occur. If the problems of the Anthropocene are not the result of premeditated human action but, rather, the result of complex webs of more-than-human interdependencies, then the solutions to these problems must necessarily account for how interventions carried out in the name of sustainability affect not only humans and cattle but also other species that constitute these ecologies—including how relations of interdependency may be severed or reconfigured.

By centering animals in processes of environmental destruction, the goal of this article is not to erase indigenous knowledges but, rather, to push forward a framework for thinking about the connections between environmental change and colonialism in its many forms. As this history of cattle in the Americas makes evident, the landscapes that emerged from cattle expansion benefited some humans at the expense of others. Cattle show how the destruction and dispossession of nonwhite peoples is, in part, the unintended consequence of animals eating, moving, taking up space, and doing other things that modify their environment. Cattle, when considered in relation to humans in all of their racial and ethnic diversity, decenters notions of homogenous humanity that undergird policy-driven accounts of the Anthropocene while also bringing the violent encounters between colonizers and natives into a frame that considers the role of nonwestern and nonhuman agencies in processes of environmental change.

Attention to history beyond the twentieth century is essential because it shows how cattle and their landscape-making activities align with colonial expansion in ways that shaped and continue to shape the modern world. At the regional level,
mo. This double movement of cattle in relation to human projects—in and out—signals processes of great environmental change but also transformative possibility. Of course, situations where cattle do not support expansionist projects can always potentially become situations into which capitalism extends. But the opposite can also be said: capitalist relations are always potentially noncapitalist. The terrible worlds humans have made along with cattle can also be unmade, with and without human intervention. Human efforts to unmake these worlds could look to these instances of more-than-human environmental change—these situations of transformative possibility—to better account for the landscape-shaping power of cattle and other creatures of the Anthropocene in order to build less terrible ways of multispecies and multiracial living together.

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An Unexpected Politics of Population
Salmon Counting, Science, and Advocacy in the Columbia River Basin
by Heather Anne Swanson

Through the case of salmon population science in the Columbia River Basin, this article explores how political mobilizations can sometimes use quantitative analysis of populations in unexpected ways. In the Columbia River, both fish counting and such controversial concepts as carrying capacity have served as tools not only for conservation advocacy but also, at times, for probing histories of settler colonialism and building alliances across difference. By examining the unusual case of salmon tallying and research in this region, this article argues that while population biology has been repeatedly used within problematic and even violent state projects, in certain contexts it can also become a practice of multispecies noticing and a catalyst for new coalitions. Based on this example, the article raises broad questions about what renewed attention to population biology might contribute to the growing subfield of more-than-human anthropology. It argues that anthropologists have not paid enough attention to the possibilities for numbers and population concepts to positively contribute to movements for more livable worlds. In light of this example, this article aims to foster additional anthropological attention to the situated and context-specific politics of scientific practices and tools.

When population biology has a dark history, can it also be a productive part of struggles for more-than-human livability?

Seeing Social History in Aggregations
A key challenge for more-than-human anthropology is how to better learn to see social histories in material form. Unable to verbally "interview" animals, plants, or fungi about their life stories, anthropologists have increasingly explored other ways of listening to their experiences of life on an unevenly changing planet. In the case of trees and mycorrhizal fungi, anthropologists Anna Tsing and Andrew Mathews have suggested that a key approach for querying more-than-humans is to pay attention to their bodily forms as biographical expressions (Mathews 2018; Tsing 2013). For many organisms, their shape, or morphology, is fundamentally historical, a response to the contingent social relations of their emergence and development. Using the example of a tree (in dialogue with Mathews), Tsing describes what one can learn about its past relations by looking at its present shape:

A tree with thick lower branches probably grew up without too many neighbors, even if you find it now surrounded by other trees. If it had grown up in the shade of others, those thick lower branches would not have developed. A tree with multiple trunks may have a fire or an ax in its biography. A gentle concave curve near its base is a sign of coppicing; that stem grew up from a stump. (Tsing 2013:32)

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1. For a related intellectual project, see Caple’s (2017) work on “critical landscape ecology.”
Anthropologists are increasingly turning to such bodily forms as a technique for exploring questions of patchy environmental change. When one pays attention to something as seemingly ordinary as the shape of a tree trunk, it pulls one into the multiple histories of shifting human-nonhuman engagements within which some beings thrive while others die. In his work on cultivated Italian chestnut trees, Mathews (2018) probes what the shapes of individual trees reveal about how environmental change happens in particular sites. From the bodies of trees, Mathews demonstrates how environmental change emerges at the intersection of struggles between pastoral peasants and the Italian state, trade routes that spread a fungal tree disease, and economic policies that led to decreased forest use and increases in fire. For Mathews, Tsing, and a growing number of more-than-human scholars, close observation of individual organismal bodies has become a core practice for learning how “to perceive larger-scale landscape patterns and to wonder about the causal forces that brought these patterns into existence” (Mathews 2018:402). It is part of the “arts of living on a damaged planet,” a practice for noticing the ongoing fragmentation of long-standing more-than-human relations (Tsing et al. 2017).

I build on and challenge this work by asking how we might extend its focus on form to aggregates. How can we probe the relational more-than-human histories that materially shape organismal groups as well as individual bodies? I explore this question through the case of Pacific salmon in the Columbia River Basin, a large watershed that stretches across parts of seven US states and two Canadian provinces. Over the past 200 years, the basin has been radically remade through dam building, mono-crop agriculture, industrial logging, urban development, and indigenous displacement. One way to see the profound more-than-human effects of these changes is through the basin’s salmon, who are acutely sensitive to watershed alterations. However, these histories of watershed damage are often difficult to see in individual fish bodies. Rather, they are most visible in the morphing shapes and sizes of aggregate salmon groups, units that fisheries biologists call “populations.” In this context, population is a term of kind rather than of number. It refers to a distinct group of salmon that spawn in a particular geographic area at a particular time. Within fisheries biology, salmon are renowned for their diversity of subspecies populations. Because salmon usually return to their natal stream to spawn, a given tributary’s fish reproduce with a relatively high rate of endogamy, allowing each group of salmon to form a multigenerational relationship with a particular stretch of stream and its surrounding area.

These populations, I propose, are biographical in ways akin to the trees described by Tsing (2013) and Mathews (2018). They are supraorganismal bodies whose forms are materially emergent within multiple intersecting histories. Yet to read history in salmon populations poses new methodological challenges. To notice embodied history in trees, one can repurpose tools from natural history, such as drawing and photography, which already closely resemble anthropology’s ethnographic methods. In contrast, the detailed forms of aggregations are difficult to see via field observation alone. It thus requires some uncomfortable alliances for anthropologists to see the details of these forms. While the shape of a salmon aggregate lies in part in its unique traits—in its coloration, migratory pathways, or run timing—it also lies in the number of its members, as well as in the dynamics among them and with other beings. These aspects of aggregates can sometimes be made more visible through the numerical counting and modeling practices of population biology.

While the field of population biology has been widely critiqued in the social sciences, this article explores how, in specific cases, its tools can be repurposed to enhance understandings of how particular landscape patterns have been made and how they might be made otherwise.

In the case of Columbia River salmon, the shapes of populations are brought into relief within a vast technoscientific apparatus of fish counting, genetic analysis, and modeling. Within this context, some of population biology’s tools and concepts have been used to critique the vast restructuring of the basins in which salmon spawn, rather than to further rationalize rivers and fish. Indeed, they have become a central part of political mobilizations against the ongoing industrialization of the river basin. As I lay out in more detail below, population biology has often been used in deeply problematic ways, and its ties to eugenics and forced displacements in the name of conservation are clear. Yet the Columbia River is a special case where something else has happened: since the 1990s, salmon population biology has become a catalyst and linchpin for broad political mobilizations that seek to constrain and counter industrialization and landscape damage. In this case, population science has become integral to the partial alliances among scientists and indigenous groups rather than an all-out flash point, and it has served as a key tool in legal claims. As this article explores, the unexpected politics of population biology in the Columbia River are also enabled by the very machinery that has contributed to the river’s capitalist reorientation, as the region’s exceptionally fine-grained knowledges of salmon populations are made possible by the dams that have facilitated the profound reformulation of the basin.

Population Biology in the Columbia River

While the study of Columbia River salmon populations has a long history, I begin with a recent moment in which quantitative population analysis has come to matter in a new way. It is July 2017, and I stand along the south bank of the lower Columbia River, the waterway that serves as a border between the states of Oregon and Washington.3 This river, whose tributaries stretch inland to Wyoming and the western border of Alberta, is known for its Pacific salmon. As I look out across the nearly 5-mile-wide estuary at the river’s mouth, there are undoubtedly

2. While this article draws primarily on textual sources, it is grounded in my long-term field research on salmon and fisheries biology in the Columbia River and Hokkaido, Japan (Swanson 2016, 2018).
salmon swimming upstream beneath the water’s reflective surface. There are more fish out there, beyond the rotting pilings and abandoned cannery buildings, than there were 20 years ago when 12 of the basin’s salmon populations were listed as endangered under the US Endangered Species Act. In 2015, there were 2.3 million fish recorded at the river’s first dam, roughly three times more than during the historic lows of the 1990s. But the futures for the descendants of the fish now gliding past me continue to trouble the region’s fish biologists, government managers, and tribal leaders. The returns for 2017 and 2018 were again dismal for several stocks, with upriver dam fish counts running roughly half of what they have been in the past several years.

Fisheries biologists knew they were dealing with a damaged river and remade salmon populations, but they were surprised and troubled by these recent numbers. Since the mid-1990s, salmon restoration has been among the most highly funded ecological projects in the United States. Between 1997 and 2001, federal agencies, including the Bonneville Power Administration, the US Army Corps of Engineers, the Department of the Interior, and the Environmental Protection Agency, spent over US$1.5 billion on salmon management (US Government Accountability Office 2002:3). In 2016, the Bonneville Power Administration alone reported spending US$621 million on fish and wildlife management, the vast majority of which went to salmon-related projects. These funds have supported improved upstream and downstream fish passage at dams, fences to keep cattle out of spawning streams, screens to divert young fish away from irrigation ditches, and tree-planting efforts. Most important, environmental managers have worked to reseed rivers with adult spawning fish, by significantly limiting fisheries and using hatchery programs.

Everyone—from fishermen to scientists to indigenous groups—thought the problem for upriver Columbia River salmon was primarily one of passage, with the most significant mortality arising from the dams and fishing nets that cut across migratory routes. River habitats were not pristine, but they appeared ample for supporting salmon spawning and rearing. Dams without fish ladders had reduced the amount of available spawning habitat by about a third, yet estimates of earlier fish populations indicated that prior to European settlement, the number of salmon in the river basin was somewhere between 10 and 16 million fish. Even with only two-thirds of the habitat left, it seemed possible to restore naturally spawning salmon populations to large numbers, if one could just get enough salmon through the gauntlet of dams and nets and back on the river’s spawning grounds.

Dealing with the obstacles to fish passage was daunting. But fisheries researchers, the US Army Corps of Engineers, and wildlife managers managed to come up with a semiviable patchwork of techniques: waterside-like dam bypass tubes, fish transport barges, and carefully timed water releases to move juvenile salmon downstream, along with select area fishing policies, gear changes, and alterations to fish ladders to allow the fish to swim back up. As passage rates improved, people began to imagine that naturally spawning salmon runs might be restored. For much of the twentieth century, the Columbia River Basin had relied heavily on salmon hatcheries to prop up its fish runs via artificial propagation. In the 1990s, managers began to use hatcheries in a new way—to help restore stream-spawning salmon rather than merely replace them. Managers allowed many former hatchery fish to spawn in streams, assuming that they would help rebuild self-reproducing runs. In the early 2000s, it seemed like these practices were partially working: a number of populations of endangered and depressed salmon began to rebound. Then, all too soon, the success began to sputter as their numbers plateaued and even declined again. What was going on?

Experts and laypeople alike expected that greater numbers of stream-spawning salmon would lead to larger numbers of them in the next generations, as salmon gradually recolonized the reaches above the dams that had been made more passable. Ample stretches of spawning streams seemingly lay open, waiting for the fish to return. But this did not happen. As more adult salmon deposited their eggs and milt in the fall, the numbers of juveniles headed downstream in the spring seemed to stagnate rather than increase. These salmon populations seemed to be exhibiting the effects of what ecologists call “negative density dependence” (Independent Scientific Advisory Board [ISAB] 2015). Typically, when salmon have abundant food and habitat, their populations grow quickly. As their population densities increase, their numbers grow even more slowly as their population growth is constrained by crowding and competition. But why were Columbia River salmon populations unable to expand, when their densities were still far below historic levels? Rivers now appeared to support fewer juvenile fish per kilometer.

This attention to the dynamics of population numbers turned fisheries biologists’ attention to river habits. Drawing on fish numbers and the conceptual languages of population biology, they became alarmed that the salmon carrying capacity of the basin’s streams appeared to have dramatically decreased. This insight was startling, even for people deeply familiar with the industrialization of the basin. In a summary of a 2015 report, officials openly acknowledged their distress: “Given that regional fish and wildlife agencies and tribes hope to see runs continue to build, the notion that the habitat might not be able

5. For detailed fish counts by dam and 10 year averages, see http://www.fpc.org/web/apps/adultsalmon/R_yearToDateComparison_table_results.php.
7. This estimate is debated with ranges including 5 to 8.9 million (Chapman 1986) and 5 to 9 million (Independent Scientific Advisory Board [ISAB] 2015), as well as the 10 to 16 million fish (NPCC 1986 in ISAB 2015:5) that I choose to cite here based on 2016 Columbia River Intertribal Fish Commission (CRITFC) arguments for the higher number.
to support many more fish because of its limited carrying capacity is disconcerting, even shocking.” How could the capacity of these streams have so severely contracted in only a few decades? It appeared that the damage to the basic ecological functions of the basin’s rivers was even more pronounced than previously thought.

These insights are part of mounting calls for more holistic forms of watershed restoration that contrast with established approaches that have overwhelmingly invested in improving dam passage. While calls for habitat restoration and attention to widespread watershed damage are not new, the practices and concepts of population biology, including carrying capacity, have been important in describing the profundity of change in ecological structures and generating increased momentum for developing more comprehensive practices of landscape repair.

Uses and Abuses of Population Biology

The use of population biology in the Columbia River region contrasts starkly with the way it has been deployed in other contexts, especially in relation to human groups. Population biology has a bad rap for good reasons. As countless social scientists and humanists have shown, the definition and management of human populations has served as a core technique of modern governance and state power, often with violent and troubling effects (Appadurai 1993; Rabinow and Rose 2006; Rose 1996). Via census making, counting, tracking, and mapping, human population biology has created norms, defined deviance, and made everyday life a site for expert and governmental intervention (Foucault 1977, 2001 [1978]). States have used population biology’s statistical genres to pathologize and criminalize ways of being, sometimes using population management as a justification for eugenics and genocide.

Many specific population concepts, like the notion of carrying capacity evoked by the Columbia River fisheries biologists, have equally troubling reputations. Carrying capacity, crudely put, is understood as the maximum number of individuals of a particular species that a geographical area can support. It has a thoroughly dirty history in relation to discussions of human population. Wrapped up with neo-Malthusianism, Garrett Hardin’s (1968) “tragedy of the commons,” and Paul Ehrlich’s (1978) “population bomb,” carrying capacity has been integral to horrifically flawed propositions for human population management that ignore histories of colonialism, imperialism, and capitalist modes of production. Asserting that the fundamental rule of planet Earth should be “Thou shalt not exceed the carrying capacity,” Hardin argued for a “perverse moral economy” in which North American and European countries should offer no international aid on the grounds that any support to poor countries merely encourages their residents to have more babies and strain the earth’s life support systems for the rest of “us” (Höhler 2014:110; see also Höhler 2006).

Third World famines, within Hardin’s logic, are “natural” events that should be allowed to run their course in order to assure that national populations remain within their alleged carrying capacities.

Social scientists have rightly criticized such propositions in the strongest terms possible, and as a result, our default orientation toward the concept of carrying capacity has been to reject it. In opposition to Hardin-esque analyses, we have built a politics that stresses inequalities of distribution rather than material limits or capacities. These politics have not been superseded; unjust distribution continues to be the core dynamic of our times. But as anthropologists increasingly turn to multispecies ecologies and landscapes as objects of study, questions of number, population, and capacity can no longer be entirely set aside. In certain configurations, attention to animal and plant populations can be a powerful tool in the study of the patch dynamics and landscape structures of which they are an integral part. The traits of particular patches shape not only who can use and inhabit them but also how many beings can do so. For example, fragmenting a forest via industrial logging may not immediately lead to a local extinction, but it may reduce the number of birds and mammals an area can support (Andren 1994). Inversely, changes in organismal numbers can affect ecological relationships within patches. For example, if the number of deer that use a given patch declines, there will almost certainly be changes in that area’s vegetation, as it becomes subject to less grazing.

In relation to animals and plants, the politics of population concepts, such as carrying capacity, have been diverse and multiple, as the concepts have been deployed by different people as part of contrasting initiatives. To be sure, carrying capacity and related population concepts have often been part and parcel of governance projects that aimed at managing landscapes for capitalist production. Emergent within questions of rangeland management, carrying capacity has been part of colonial projects that dispossessed African communities by fostering land privatization, under the logic that private ranches have higher carrying capacities and can maintain higher cattle densities and thus represent a more efficient mode of land use (Sayre 2008). Such arguments continue to shape land management in many parts of the world from southern Africa, where stock owners operating in communal areas are marginalized by government policies that set overly restrictive limitations on grazing in collectively held lands, to northern Norway, where related ecological concepts are used by the state to demand reductions in Sami reindeer herds in the name of conservation (Benjaminsen et al. 2006, 2015).

Yet uses of carrying capacity have never been politically consistent. While carrying capacity has served as a handmaiden of


10. For an excellent historical overview of the concept, see Sayre (2008). For more detailed analysis of the concept within rangeland science, see also Sayre (2017).
colonial capitalism in some places, this is not the case in all locales. For example, in the late nineteenth-century US West, it was sometimes used as a tool to critique industrial overstocking and predator elimination programs. One of the most iconic examples comes from the writings of conservationist Aldo Leopold in which he sought to use notions of carrying capacity and population dynamics to point out the pernicious logics of industrial rangeland management. In an oft-cited passage of his *A Sand County Almanac*, Leopold poetically redescribed the ecological crisis on Arizona’s Kaibab Plateau in the late 1920s and 1930s, when its number of mule deer exploded from 4,000 to 100,000 after the US government sponsored the mass killing of predators as part of broader landscape management practices designed to foster cattle production and sport hunting (Worster 1994:270–271; see also McCulloch 1986):

I now suspect that just as a deer herd lives in mortal fear of its wolves, so does a mountain live in mortal fear of its deer. And perhaps with better cause, for while a buck pulled down by wolves can be replaced in two or three years, a range pulled down by too many deer may fail of replacement in as many decades. So also with cows. The cowman who cleans his range of wolves does not realize that he is taking over the wolf’s job of trimming the herd to fit the range. He has not learned to think like a mountain. Hence we have dust-bowls, and rivers washing the future into the sea. (Leopold 1970 [1949]:140)

The Making of Salmon Numbers

Leopold’s work (1970 [1949]) points toward the multiple political possibilities of population concepts in general, and carrying capacity, in particular. Yet how are population concepts made to do particular kinds of work in given contexts? In contrast to the examples from Africa and Norway, population biology in the Columbia River is not a government imposition. Instead, it is an impressive achievement—the result of decades of popular activism by partially allied groups. How, in the specific case of Columbia River salmon, have concepts and techniques from population biology become central to efforts to craft more livable landscapes?

The answer is tied, to some degree, to the role of dams in the Columbia River Basin. While the industrialization of the Columbia River began in the late nineteenth century with large-scale logging and salmon cannery, it hit its zenith in the 1930s. In 1929, the US Army Corps of Engineers recommended the construction of a series of dams on the Columbia River, whose purposes would be wide-ranging, offering an economic power pack of irrigation water, flood control, locks for improved ship traffic, and electricity production. The goal of the dams was to reengineer not only the river’s flows but also patterns of land use across the entire basin, ushering in large-scale mono-crop grain cultivation and energy-intensive industries such as aluminum smelting. In the early 1930s, Franklin D. Roosevelt and other government officials agreed to back the initiative as a part of the New Deal’s employment initiatives, and by 1934, construction was underway on Grand Coulee and Bonneville dams, two facilities on the Columbia’s main stem. From the moment the dams were proposed, white commercial fishermen and Indian tribes were outraged by the damage dams were going to cause to salmon by impeding their passage. Grand Coulee Dam, located on the upper main stem Columbia, was built without fish ladders, blocking access to over 1,000 miles of prime salmon spawning habitat. While ladders were installed at Bonneville, its location in the lower part of the river also raised concerns because such a large percentage of salmon spawned above it and would thus be impacted by any extra challenges it would pose.

The US federal government would have simply sacrificed the basin’s salmon runs in the name of progress, development, and looming wartime necessity. Indeed, the government initially claimed that the dams would have little impact on the fish. Yet an awkward alliance of wealthy cannery owners, unionized white fishermen, outdoor enthusiasts, and American Indian groups challenged this outrageous claim, which sought to paper over the impending destruction of the Columbia’s salmon runs and their own ways of life. They flooded the opinion pages of regional newspapers with their arguments against what amounted to the government’s usurpation of the river and petitioned government officials and representatives to address their concerns.

In 1938, the year that Bonneville Dam went online, these efforts forced the US Congress to admit that the dams were likely to harm the salmon and to pass legislation, called the Mitchell Act, that aimed to mitigate their harms. The Act authorized funding for fish hatchery construction, the screening of irrigation channels to prevent fish from getting caught in them, and other measures to maintain salmon numbers in the midst of the growing degradation of the basin’s rivers. At the same time, salmon advocates, including the Oregon and Washington state fish commissions, pressured for documentation and mitigation of the dams’ effects: they called for fish counting as a mode of holding the government accountable. Their appeals ensured that from the completion of Bonneville Dam in 1938, the US Army Corps of Engineers recorded the number of adult salmon that passed through its fish ladders every year on the way upstream. As other major dams were completed on the main stem Columbia and various tributaries, they too were pressured to count fish, with demands for additional data over time, including downstream juvenile counts.

11. These predators included mountain lions, wolves, bobcats, and coyotes.

12. For more on Grand Coulee’s history, see Pitzer (1994).


14. Other forms of salmon research also increased around the same time.
redd (salmon spawning nest) counts, and other research on fish numbers.15

As a result of these dam-based fish counts, there is extraordinarily accurate data on upriver adult fish numbers with a vast political and technical apparatus for tallying fish, including elaborate protocols jointly overseen by NOAA Fisheries, state fish and wildlife agencies, the intertribal council, as well as the Corps of Engineers.16 Fish passage data is coordinated and made publicly available via the Fish Passage Center, created through a federal program. Advocates have had to iteratively insist on a right to good dam data, demanding more rigorous oversight of fish numbers in 2000, then suing the government in 2006, when a US Senate Appropriations Subcommittee tried to dismantle the fish passage center.17

The quality of the numbers that these efforts have produced stands in sharp contrast to many animal population measurements, which are often speculative at best. It is impossible, for example, to precisely count the numbers of ocean-dwelling fish, such as bluefin tuna. One can only make rough population estimates based on various sampling methods, all of which are riddled with uncertainties. Similar challenges arise for migratory mammals on land and at sea: depending on how and when one samples, researchers can easily end up with significantly different population estimates. Under such conditions, population numbers for many species remain questionable due to the impossibilities of direct counting (Link 2003).

Columbia River salmon numbers do not suffer from such problems. Since the construction of the dams, it has become possible to track upriver Columbia River salmon with rare precision. At Bonneville Dam, for example, trained fish counters sit in front of a window into the fish ladder from 4:00 a.m. to 8:00 p.m. from April 1 through November 30, directly counting the fish that pass through. At night and during off-seasons, the view into the fish passage window is video-recorded, and counters later review the tape.18 The data from these fish counts is not flawless: slightly different procedures are used at various dams, and video-recording was not used in early decades, requiring estimates of nighttime fish passage. Yet the counts remain exceptional, especially when combined with their spatial distribution. Because there are 14 dams that count fish at various points across the upper basin, the overall data from the dam system allows one to parse the numbers of fish at various points across the upper basin, the overall data their spatial distribution. Because there are 14 dams that count fish numbers.15

Political Possibilities of Salmon Population Science

This data became essential in the next round of efforts to keep salmon runs alive and facilitated more elaborate engagements with emerging forms of population research in conservation biology. By the 1990s, dam counts showed upriver salmon numbers at perilously low levels; indeed, they were so low that several groups of upriver salmon seemed candidates for listing under the Endangered Species Act (ESA). As soon as salmon advocates appealed for ESA status, it pulled salmon into new practices of counting and population biology.

In April 1990 the Shoshone-Bannock Tribe was the first group to petition the National Marine Fisheries Service to list the Snake River sockeye as an endangered species; only 2 months later, a coalition that included Oregon Trout, the Oregon Natural Resources Council, the Northwest Environmental Defense Center, American Rivers, and the American Fisheries Society filed additional requests for federal protections for Snake River spring, summer, and fall Chinook.19 Such calls for ESA listing were made viable by the dams that killed the fish and remade their watersheds; the petitioners had numbers to back up their claims of a salmon crisis: they could say with a certain degree of authority that the number of naturally reproducing Snake River spring/summer Chinook, who must pass eight major dams, had dropped to a mere 1,822 adults by 199419 from 100,000 in the 1950s (ISAB 2015:22).21

Yet these endangered species petitions precipitated a deeper engagement with population biology. Rather than following typical biological definitions of “species,” the Endangered Species Act defines the term to apply equally to what would typically be considered subspecies units. Slightly revised in 1978, the definition of “species,” which retains legal force today, includes “any subspecies of fish or wildlife or plants and any distinct population segment of any species of vertebrate fish or wildlife, which interbreeds when mature” (Waples 1991:12). If groups of salmon were going to be made protectable under the ESA, they needed to be identifiable and trackable as “distinct population segments.”

Columbia River salmon counts already divided fish into categories based on their species (Chinook, sockeye, coho, steelhead), run timing (spring, summer, fall, winter), and spawning location (upper/lower river, name of tributary basin). Such classifications were largely based in the long-standing vernacular observations of both American Indian and white residents, who noted and named visually distinct subspecies of salmon. While the ESA accepted these already recognized groups of

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18. See the following website for fish counting times and methods at dams in the Columbia River: http://www.fpc.org/currentdaily/HistFishTwo_Yday-ytd_Adults.htm.
21. Although pre-dam numbers require extrapolation from harvest statistics and other data and are thus less certain, estimates indicate that there were approximately 1.5 million of these fish in the early 1900s. See https://www.nwfsc.noaa.gov/publications/scipubs/techmemos/tm200/sum.htm.
salmon as distinct population segments and listed 12 salmon aggregations over the course of the 1990s, ESA regulations compelled additional attention to salmon groupings and their population dynamics. ESA protections are a powerful political tool: they can be used to mount lawsuits, mandate changes in dam operations, demand land use changes, and generate funding for scientific research.

Yet to make ESA protections work, one needs highly detailed population data. Because the ESA aims to prevent extinction and actively promote self-sustaining aggregations of organisms, population dynamics are critically important to its work, as scientists use them to track numbers and try to alter conditions to keep kinds alive. While, in human-centered debates, attention to population dynamics is often linked to fears of “too many” (i.e., overpopulation), in contemporary conservation biology, it is more often tied to concerns about loss, extinction, and “too few” (e.g., Boyce 1992; Soulé 1987). The ESA also frames population biology as a tool for learning how to repair ecological damage: by monitoring population numbers, one can explore whether or not particular interventions increase the vitality of specific organismal aggregations.

With the ESA listing of salmon groups in the 1990s, the amount of research on their population dynamics—on how they live and die—increased dramatically. While it is difficult to calculate the exact amount of money spent researching, sustaining, and restoring salmon runs in the Columbia River Basin, some estimates put the number for the Pacific Northwest region at around US$3 billion a year by the early 2000s (Hering 2005). In recent years, the Bonneville Power Administration (the agency that administers the dam’s power sales) has been obligated to spend about US$500 million annually on Columbia River salmon restoration and research.22 Some of these dollars trickle down not only to federal scientists but also to nonprofit scientific research groups, university labs, state commissions, and tribal agencies to undertake salmon-related activities.

In short, the same dams that rent the river apart also made it possible to count fish and model their populations: not only do they allow for the highly accurate counting of adults within their ladders, but they also provide economic and physical infrastructure for other forms of counting that have produced even more detailed knowledge about salmon populations. Via mandated ESA mitigation and research funding, partially garnered from dam profits, scientific researchers have been able to conduct countless studies of salmon numbers and movements that exceed those of their upstream migration through the dams. Using the physical form of the dam and its passage points, researchers have been able to implement relatively accurate technological systems for monitoring the number of juvenile fish who pass downstream through the dams en route to the sea. Furthermore, with the research funds made available through dam mitigation monies, they have been able to implement a variety of ambitious marking, tagging, tracking, and trapping practices across the river basin to learn not only about salmon numbers but also about their broader interactions with their worlds. Such numerical data has also been increasingly coupled with genetic research, enabled by the same funds, which seeks to explore chromosomal patterns to better understand how to protect the diversity within and across salmon groups. In short, this wealth of diverse data has led to the ability to track and model Columbia River salmon population dynamics with an uncommon degree of empirical detail.

It is important to note that such research has been the work not only of government scientists: university researchers, nonprofit groups, and American Indian tribes have also made successful claims to salmon mitigation and research funds. The mobilizations of American Indian tribes are especially noteworthy here, as they have asserted that their treaty rights to co-management include rights to participate in salmon population science. Both individual tribes and the collaborative Columbia River Intertribal Fish Commission (CRITFC) maintain active fisheries research divisions, including a CRITFC-run fish genetics laboratory.23 The science of salmon populations has thus emerged from the burgeoning amount of research at the interface of these overlapping but nonidentical agendas. It is a patchwork of passionate initiatives that demand government resources, rather than a unified state project.

Noticing Changed Relations

These vast troves of salmon population data and research continue to catalyze new forms of politics in the Columbia River Basin as insights from population biology create spaces for possible alliances. Let us return to the case of upriver salmon carrying capacity that I laid out in some detail above. Despite the concept’s record of pernicious use, this articulation of carrying capacity appears to be generating possibilities for more livable futures by both making visible the profound damage to the watershed and fostering more widespread engagement with the ongoing legacies of settler colonialism.

In the case of Columbia River salmon, carrying capacity calls attention to the extensive webs of relations within which salmon populations thrive and wither. Where earlier approaches to salmon restoration focused on improving dam passage, the detailed tracking of salmon population dynamics and the use of carrying capacity models show that such a single-fix approach is wildly insufficient for sustaining salmon and the ecologies with which they are intertwined. While population biology and concepts like carrying capacity have often been criticized for


their single-species focus, in the case of Columbia River salmon, attention to fish numbers is provoking deeper engagement with broad sets of ecological relations.

To be clear, one does not need carrying capacity to see that the Columbia River Basin has been profoundly reconfigured by settler colonialism and industrial capitalism. Analyzing the region through other academic approaches, historian Richard White astutely described the Columbia River basin as an “organic machine”—a place fundamentally altered by human labor, but where nonhuman processes continue to matter (1995:59). Yet the more recent work on upriver salmon carrying capacity shows how the mechanization of the river has had even more profound impacts than those White presented when he penned his history of the river nearly 25 years ago. It highlights how watersheds are losing the basic ecological relations necessary to carry even modest numbers of salmon.

In the emic language of Columbia River fisheries biology, it appears the upriver salmon are experiencing “negative density dependence at lower densities” or, put otherwise, that their populations reach a level above which they seem unable to increase at numbers much lower than they did in the past.24 In some cases, these new limits to fish numbers—to the carrying capacity of tributaries—are shockingly low. In the most extreme case, the Chinook salmon populations in the Columbia’s Salmon River tributary—which were heavily affected by dam passage issues—declined 90% between the 1960s and late 1990s, with no significant loss in the physical quantity of rearing habitat (Achord, Levin, and Zabel 2003). Now, with improved dam passage, fish numbers should be quickly rebounding, but they are not. Based on the recent population research, it appears that density-dependent stream mortality—or deaths due to insufficient stream resources—are kicking in almost immediately and are seriously constraining the populations of salmon that try to inhabit these areas. Some tributary streams now seem to have carrying capacities that are less than half of what they were a little over 50 years ago (ISAB 2015:24).25

These numbers—together with other insights from salmon population research—have shocked scientists into taking the effects of the basin’s profound systemic changes more seriously. While highly responsive to watershed changes, salmon populations are not fragile, per se. For the last 4–6 million years, they have morphed with the rapidly changing geology of the Columbia Basin. As glaciers and landslides have blocked off tributaries and epic floods have scoured spawning beds, salmon have become experts in quickly adapting to and inhabiting new and altered river stretches. With high levels of intraspecific diversity, behavioral flexibility, and speedy evolution at the population level, salmon have been resilient to massive changes in the rivers in which they dwell throughout the Pleistocene and Holocene (Schtickzelle and Quinn 2007).

River carrying capacity has likely always been a limiting factor for Pacific salmon. Indeed, the most plausible explanation for the evolution of these fishes’ migratory life cycle is that the ocean’s vast food webs allowed them to grow to large sizes and develop sizable populations that would not be possible with the more limited nutrient sources in rivers. But even as they pack on about 95% of their body mass in marine environments, salmon remain highly dependent on streams—not only as a spawning location but also as a juvenile feeding and rearing site (Pearcy 1992). Most of the salmon species in the Columbia River require significant growth and maturation before they are able to successfully make their way downstream and undergo the physiological transformation necessary for inhabiting saltwater environs. For this, they need to eat—as well as hide from those who want to eat them.

Yet as the research on carrying capacity highlights, many upriver reaches of the Columbia are offering dramatically less food and fewer prime hangout spots than they once did. These watershed changes are at once monumental and subtle—physical alterations to channel structure, hydrology, and sediment delivery, along with food web modifications. Logging, diking, cattle watering, and the decimation of beaver populations are among the forces that have reduced or modified riparian vegetation. The loss of shade has led to higher water temperatures, while the loss of stream bank complexity and in-stream wood has decreased hiding places and increased erosion. With fewer streamside plants, there is also less food in the water itself, as “about half the food energy that sustains fish in small streams enters in the form of terrestrial invertebrates that fall into streams from riparian vegetation” (ISAB 2015:59).

Agricultural irrigation—provided by the dams—further affected fish habitat. Water extraction has reduced overall stream flows, which has further raised in-stream temperatures. Furthermore, the water that makes its way back to rivers after agricultural use is contaminated with herbicides that are causing reductions in the aquatic plants and algae that underpin salmon food supplies (ISAB 2015:60),26 and there is emerging evidence that endocrine-disrupting chemicals may be causing additional problems for salmon and other species (Arkoosh et al. 2017; Scholz et al. 2000). In addition, the oil and grease loads of Columbia basin streams have increased 100% between 1977 and 2000, a joint effect of agricultural activity, urban runoff, and municipal wastewater discharge (ISAB 2015:62).

24. There is substantial evidence of compensatory mortality (see Achord, Levin, and Zabel 2003, as well as ISAB 2015).

25. It is not as if things are going all that well in the ocean, either. Salmon populations in Alaska and Japan have indicated possible ocean density effects (see Swanson 2018). While ocean survival rates may be decreasing for Columbia River salmon, all evidence seems to indicate that the loss of freshwater habitat quality is currently the most limiting factor for population size.

26. While this section exclusively references the ISAB report, that report offers an extensive review of relevant literatures and bases its assertions on numerous other studies.
Abandoning the Upper River

These changes— and the shape of current salmon populations—are largely the result of explicit political decisions, including the willingness of Euro-American salmon advocates to betray American Indian communities. Soon after the 1930s anti-dam movements that demanded fish counting and mitigation, Euro-American fishermen and cannery owners accepted a deal that protected their interests but sacrificed upriver salmon populations and the needs of the American Indian groups that depended on them. While dams and the agriculture they sponsored have disproportionately affected the river’s upper reaches, the funds to mitigate such effects have been largely directed to the lower river. The disproportionate decline of upriver stocks was part of a concerted effort to largely abandon the upper river and redistribute fish to the lower sections of the basin.  

As dams made it tougher for upriver salmon to survive, fisheries managers offered hatcheries as a solution. The goal of hatcheries was to make “salmon without rivers”—to maintain fish runs at the same time that the river was remade into a source of hydropower and irrigation water (Lichatowich 1999). Hatcheries collect gametes from adult fish, fertilize and hatch their eggs, and then raise the resulting young fish until they are ready to migrate to the ocean. At that point, they release them into a nearby stream, where they then swim to the ocean alongside stream-born fish. Today, hatchery fish make up 80% of total Columbia River salmon numbers, while only 20% of the region’s salmon begin their lives in its rivers. These hatcheries have been consistently located in the lower sections of the Columbia River. From 1946 to 1980, the Columbia River Fisheries Development Program (CRFDP) used Mitchell Act funds to construct or expand 26 hatcheries, all but two of them in the lower portions of the river (Allen 2003). Furthermore, among the more than 1 billion juvenile hatchery salmon released into the Columbia River between 1959 and 1970 under federal dam mitigation programs, 99% were produced either below Bonneville Dam or in the area just above it, and fewer than 1% were released in the upper river (Allen 2003). Other mitigation hatcheries established outside of the CRFDP also showed a consistent “spatial discontinuity between impact and mitigation,” with the hatcheries located far downstream from the dams whose effects they were supposed to mitigate (Allen 2003; see also Taylor 1999).

Hatcheries were systematically sited below Bonneville to maintain and even supplement the number of fish available for white commercial fishermen, while intentionally neglecting the tribes’ treaty rights to fish. Although there were once robust American Indian fisheries throughout the basin, by the mid-twentieth century, white commercial fishermen held exclusive control of the lower Columbia River, while Indian fishermen were limited to harvest grounds above Bonneville Dam. By ignoring Indian rights and lives, industrial fisheries and industrial power could ostensibly be made compatible. Since a 1974 court decision reaffirmed existing treaty agreements, Columbia River Indian groups have been able to claim 50% of the river’s harvestable salmon that pass through their designated upriver sites. But this long-standing neglect of upriver salmon populations in favor of lower river stock enhancement means that salmon populations have been remolded such that the bulk of fish now spawn at or below Bonneville Dam.

Population and the Reimagination of Upriver Salmon

American Indian leaders have fought against this reshaping of salmon populations since the start of dam construction and lower river mitigation. They gained substantial recognition of their loss of fish and the neglect of treaty rights in the 1970s, when they mounted several successful legal claims. Still, while this decade marked the beginning of fisheries comanagement, the fish passage rates through dams remained poor—especially for out-migrating juveniles—and there was not enough pressure on the US Army Corps of Engineers to substantially change dam operations and technologies. Under these conditions, upriver fish restoration was nearly impossible. In the 1990s, however, the situation began to change: lower river hatcheries were generating poor returns and Euro-American fisheries were plagued by season closures and low catches. Furthermore, a growing number of fisheries scientists and Euro-American members of the public increasingly came to view salmon not as a natural resource for commercial harvest but as an integral part of ecological and biodiversity conservation. Hatchery salmon were no longer seen as acceptable replacements for stream-spawning salmon, who were now viewed as a “keystone species” with an outsized role in sustaining regional ecological processes.

27. A 1946 federal government report states that the Mitchell Act funds should be oriented toward “developing the salmon runs in the lower tributaries to the highest level of productivity.” https://oregonencyclopedia.org/articles/mitchell_act_1938_/9.WZF9TYpLdc. See also Cone and Riddington 1996 and Taylor 1999.
29. This was not the first time hatcheries were used to dispossess American Indians. In 1877, e.g., US Fish Commissioner Livingston Stone evicted Clackamas Indians from an established fishing area in order to reduce competition with a hatchery (Taylor 1999).
30. For an extended historical discussion of these issues, including relevant court cases, see https://www.nwcu.org/reports/columbia-river-history/indianfishing.
31. The legal nuances of these cases are complex, but for a quick overview in relation to the founding of CRITFC in 1977, see https://www.critfc.org/about-us/critfc-founding/.
32. It is important to note that the tribes still do not have full hatchery comanagement: http://plan.critfc.org/2013/spirit-of-the-salmon-plan/institutional-recommendations/tribal-hatchery-management/.
Fisheries population research was clearly essential to revitalized Euro-American interest in upriver fish in both scientific and wider popular contexts. Dwindling dam fish counts were published in regional newspapers, along with mounting concerns about the possible extinction of some salmon groups. Within this context, tentative and partial alliances between Euro-American conservationists and American Indian communities once again emerged. As Euro-Americans became interested in salmon via concepts such as ecological function, keystone species, and genetic uniqueness, they began to have a renewed interest in the upper basin as an important site for salmon diversity and conservation. Within these new conservation imaginaries, the lower river, once seen as a haven for below-dam hatchery production, was recast as a place of partially domesticated and genetically inferior hatchery fish who lacked the complex population structures and ecological relations of the more “wild” upriver fish.

In the midst of these shifts, which included the ESA listing of some salmon groups, government agencies became more interested in supporting and collaborating with tribal fisheries initiatives that aimed to actively aid upriver fish populations and their watersheds. In the 1990s, for example, tribal organizations were able to make claims on funds from the Bonneville Power Administration (BPA) to establish upriver fish hatcheries and expand their upriver salmon conservation programs. Despite the role of hatcheries in Indian dispossession in the mid-twentieth century, the tribes have made use of them—along with other fisheries biology tools—within their own efforts to restore upper river fish.

Yet, while some tribal efforts have produced promising results, overall plans to restore upriver salmon runs, especially the large-scale government initiatives, have produced worrisome results, as described in the initial vignette about the loss of upriver carrying capacity. Despite the growing use of upriver hatcheries—federal, state, and tribal—in a conservation mode (i.e., to increase stream-spawning fish numbers and to seed salmon recovery), salmon populations are struggling to become self-sustaining.

In this context, concepts like carrying capacity and density dependence are helping to make vivid the profound systematic damage of the region’s watersheds. These forms of population biology are also forcing Euro-American conservationists to more directly engage the settler colonial histories bound up with the structure of Columbia River salmon populations. It appears likely that the sacrifice of upriver salmon populations within dam construction, mitigation practices, and hatchery siting may be a significant factor not only in the current low numbers of fish but also in the difficulties of fish population recovery. This is the issue that shows up as a decrease in stream carrying capacity, or what one group of fisheries biologists has called “the ghost of impacts past” (Achord, Levin, and Zabel 2003:335).

Drawing on a term from conservation science more generally, fisheries biologists describe salmon as “ecosystem engineers,” or species that have outsized effects on the creation, modification, and maintenance of habitats (Jones, Lawton, and Shachak 1994). When adult salmon return to a river to breed, they do not merely spawn the next generation of fish. Rather, they spawn entire ecologies. In the process of digging their stream-bottom nests, they radically alter stream substrates, aquatic macroinvertebrate populations, and algal production with substantial effects on stream metabolic processes (Moore 2006; Moore, Schindler, and Scheuerell 2004). But perhaps most important are the nutrients—marine-derived phosphorous and nitrogen—that they carry in their bodies and deposit in streams when they die after spawning. Salmon fertilize the nutrient-poor watersheds they inhabit in ways that may have profound feedback effects for the survival of their offspring. Numerous scientific studies have shown that nutrients from salmon carcasses affect vegetation patterns (Helfield and Naiman 2001), invertebrate densities (Hocking and Reimensch 2002), and even songbird populations (Christie and Reimchen 2008).

This growing body of research indicates that salmon carrying capacity is significantly impacted by recent salmon population size (Achord, Levin, and Zabel 2003), suggesting that the twentieth-century decisions to neglect upriver salmon populations may have so severely starved aquatic systems of nutrients and disrupted fundamental nutrient cycling patterns that the rivers have little to offer to the larger numbers of fish who are now trying to recolonize their reaches. Some fisheries managers wonder if they may now be caught in a double bind. Has the carrying capacity of many streams fallen so low that their salmon populations are too small to be viable without inputs of hatchery fish? Indeed, it currently appears that some upriver salmon populations may be dependent on the addition of hatchery fish, as the reproduction rates dip below replacement levels (ISAB 2013:116). Such data have served to further amplify concerns.

Precarious and Partial Alliances

Overall, such insights—gleaned from population research—have encouraged Euro-American scientists to pay more attention both to the earlier abandonment of the upper river and to the forms of pronounced systemic damage it may have caused. While there remain points of disagreement between the tribes and other salmon advocacy and scientific groups, this growing attention to carrying capacity is nonetheless a moment of partially overlapping concerns. Upper river carrying capacity research has been undertaken by scientists with a variety of institutional affiliations, and the Columbia River Intertribal Fish Commission is among the entities that co-commissioned a 2015 independent scientific review of salmon density dependence and river carrying capacity.33

While tribal leaders do not need fish population research to remind them of the ways that settler colonialism and industrial expansion have remade the Columbia Basin, they do seek its insights for how to tailor their practices of repair. Would it be best to increase the number of spawning salmon in the upper river through the addition of hatchery fish in order to expand circulating nutrients, referilterize rivers, and kick-start core ecological processes? Or might large numbers of hatchery salmon inadvertently reduce the genetic fitness of naturally spawning fish and further imperil their futures? The tribes, along with Euro-American fish advocates, seek better data. Working carefully with concepts like carrying capacity and density dependence rather than wholly rejecting them, tribal scientists contest some of the population arguments of nontribal managers by using scientific practices in different ways. What, they ask, about the evidence—including traditional knowledge, archaeological findings, and early catch data—that historic population numbers were even higher than currently accepted estimates, pointing toward even greater losses of fish? In a similar vein, they take up the details of population models, questioning whether salmon density dependence data might more closely resemble a Beverton-Holt curve than a Ricker curve, meaning that—contra current governmental policies—it might be important to invest in additional upriver hatcheries to referilterize rivers with more fish.

Population biology is likely not a language of salmon that tribal groups would choose were it not legible to and effective within state and legal frameworks. Neither is it likely to have become the preferred choice for white fishermen or even, for that matter, environmental activists. Yet at the same time, it cannot be simply dismissed as an ontological opposition of technoscientific governance. Salmon population numbers are a hard-won political accomplishment—a way of fighting to hold the state accountable for the harm it has wrought on the Columbia River Basin’s fish. It is a nontrivial project to which people with a variety of backgrounds and stakes have contributed, and where the numbers and models themselves have opened new spaces for collaboration.

At the same time, however, it is important to point to the limits of this kind of political mobilization, which is made clear through the case of Pacific lamprey (Entosphenus tridentatus, also called Lampetra tridentata). Lamprey are elongated jawless fish who visually resemble eels; like salmon, they migrate between rivers and the ocean and thus must also pass through the Columbia River’s dams. While they have suffered declines concurrent with those of salmon, lampreys—a highly significant being and food for tribal members, but not for white residents—have received comparatively little attention. While they have sometimes been included in fish counts, lamprey numbers are spotty. For example, at Bonneville Dam, lamprey were included in daytime fish counts in 1938–1969, 1993, part of 1997, and then, from 1998 onward (Moser and Close 2003). But even when they were tallied, the measures used to count them—designed for salmon—were inappropriate and inadequate for adult lamprey, which, unlike salmon, are nocturnal and disproportionately pass through dams at night (Moser et al. 2002).

Tribal groups have struggled to highlight the plight of lampreys, which are sometimes seen as repulsive and snake-like and were deemed “trash fish” by early fishery managers (Wicks-Arshack et al. 2018). Without a long-standing salmon-like mobilization to demand their tracking and monitoring, lamprey have little data. As a result, lamprey conservation has been more constrained than enabled by practices of counting and population science. In 2004, a petition to consider Pacific lampreys for ESA protections was rejected due to an absence of research and solid numbers. While tribes are beginning to garner more attention for lampreys, the support for their monitoring and research remains far less robust than for salmon. So, too, do their legal protections. In 2008, six tribal groups signed the Columbia

34. This is an issue of uncertainty and ongoing debate. Conservation-oriented hatcheries have clearly been a linchpin for endangered and threatened populations that might otherwise have disappeared. The most extreme example is a sockeye strain that spawns in Redfish Lake, in the far-inland reaches of the Columbia Basin. Between 1991 and 1998 only 16 adult sockeye returned to spawn, and all were taken into a special captive breeding program. By 2014, 460 naturally spawned and 1,200 hatchery-spawned sockeye returned to the lake—with an approximately 95% retention of the population’s remaining genetic variability. See https://www.nwfc.noaa.gov/news/features/idaho_sockeye/index.cfm. Yet large-scale hatcheries may impede the restoration of naturally spawning salmon. Although the data are debated, the 130–150 million juveniles released annually from more than 200 hatcheries may compete with stream-born young (ISAB 2015:62). Because they are fed prior to release, hatchery smolts are often larger than the stream-born fish and may put pressure on already limited food resources. A multiyear study of 30 coho salmon streams indicated that while hatchery releases increased the overall density of young fish, they decreased the abundance of stream-born juveniles. When these cohorts later returned to spawn as adult fish, the hatchery-origin salmon produced fewer offspring per fish than the stream-born ones, so the overall number of salmon in the streams did not increase in the next generation (Nickelson et al. 1986 in ISAB 2015). While there is no doubt that hatchery programs can significantly enlarge fishing harvests, the degree to which hatchery supplementation can foster stronger stream-reproducing salmon populations remains unclear. There are numerous risks to hatchery supplementation, including changes in genetic diversity and loss of unique traits, risk of disease transmission from hatchery settings, and fish numbers that exceed the carrying capacity of streams and sometimes even parts of the ocean (Nash et al. 2008:64). Because hatchery stocks are rarely identical to those they are used to supplement, they can be less well adapted to the specifics of a given patch, and their introduction can cause substantial declines in the adult-to-adult reproductive success of the populations they join, driving their numbers even lower if supplementation ceases (Araki et al. 2008).

Basin Accords, a 10-year agreement (now extended until 2022) on fisheries protection and conservation primarily in relation to salmon. Within that agreement, the tribes also negotiated for some conservation and research initiatives for lamprey, yet these “voluntary agreements” pale in legal force compared to an ESA listing (Wicks-Arshack et al. 2018).

Reconsidering Population within More-than-Human Anthropology

Population biology is no panacea. Yet neither is it the outright evil that social scientists and humanists have sometimes assumed it to be. While it has been used within many racist and violent projects, the political roles of population biology have been more varied than scholars have typically recognized. This multiplicity does not absolve population biology from its great sins; however, it points toward ways that the tools of the field might be productively engaged, especially within the growing field of more-than-human anthropology.

While numbers are a problematic proxy for justice and thriving, they can help highlight how particular landscape arrangements sustain certain ways of life over others. In this way, they offer powerful tools for probing what Donna Haraway, a science and technology studies scholar, has presented as one of the central political and ethical questions of more-than-human worlds, that of “who lives and who dies and how” (2016:2). It is no stretch, I argue, to see population numbers as material-semiotic expressions of the livability of landscapes for particular beings. At present, extinctions and ecological simplifications are mounting concerns not only for biologists but also for scholars in the humanities and social sciences (Kolbert 2014; van Dooren 2014). In our growing attention to ecological relations, might we want to consider the potential possibilities for population biology as one method, among many, for learning more about how extinctions unfold, as well how we might build arrangements to facilitate survival and regeneration?

Although it may seem counterintuitive, the quantitative measurements and ahistorical models of the population sciences can indeed play a role in building less mechanistic and more historical approaches to landscapes. As we have seen in the case of carrying capacity and Columbia River salmon, attention to population dynamics has pulled some Euro-American salmon advocates into deeper engagement with the political choices to sacrifice the upper basin by showing the profound ways that those processes have fundamentally remade the basin’s ecological forms. For some salmon advocates, changing numbers have served as a way of noticing alterations in processes and patterns in fuller breadth and depth.

This discussion returns us to the question of how more-than-human anthropologists might examine social history in the form of aggregations as well as individual bodies. In the case of entities like trees, mycorrhizal fungi, and lichens, which grow throughout their lives and whose shapes are less genetically linked, it makes good sense to take the organisinal body as the site for inquiries about embodied and material histories. Yet for many animals, it may be the collective body of the aggregate—what natural scientists call a population—that most clearly records their contingent encounters with an ever-changing world. While the restructuring of the Columbia River watershed also leaves marks on the genes, bones, and tissues of individual salmon, its effects are most clear in the torqued shapes of its aggregates—in the changed dynamics of dwindling upriver stocks and the vast growth of hatchery stocks below Bonneville Dam. When we extend more-than-human approaches to these plural bodies, population techniques become an integral part of our historical toolbox.

Furthermore, despite social scientists’ distrust of population methods, they may indeed hold potential as a site for collaboration and cross-field engagement. This is a moment when the practices and politics of population biology are themselves unstable and changing, as binaries of organism/environment increasingly implode.36 Today, the concept of “carrying capacity” is to ecology and population biology as “culture” is to anthropology: a term infinitely contested within the discipline and often anachronistically used beyond it.37 As biologists become increasingly alert to the ways that organisms actively reshape the worlds they inhabit, they are coming to view carrying capacity as something that is relationally and iteratively produced via the interactions of multiple species, geophysical processes, and human land use practices (e.g., Simberloff 1998). Who or what, they ask, is “carried”—species, biomass, or relations? Within these broad changes, biologists—like anthropologists—are increasingly committed to seeing ecological interactions in historical and relational terms rather than in mechanistic ones.

This article is not a call to throw caution to the wind: there remain many cases where population biology continues to have pernicious effects and deserves the most pointed critiques. It also remains a common technology of elite power and governance. Yet, as the Columbia River shows, it can also become an integral part of multilayered political projects, catalyzing partial alliances that have mobilized against the state-sanctioned destruction of salmon runs and struggled to hold the federal government accountable via fish counting. In the case of the basin’s salmon, population statistics and modeling have been more than a strategic tool for talking back to the state in a technoscientific language that it can hear: they are also a part of diverse efforts to restitch the frayed patchwork of the Columbia basin.

36. See Tsing et al. (2017) for several examples of broad changes in the biological sciences. The ISAB (2015) report shows such changes in relation to population biology and salmon population science, in particular.
37. As one wildlife biologist wrote, carrying capacity “is a term any barbershop biologist can use in confident ignorance,” since it “is a whole, broad band concept, not an exact idea” (Giles 1978:194–195; see also Dhondt 1988). Biologists have long recognized that landscapes are dynamic—often with major seasonal variations—and have debated how to define a carrying capacity that is constantly in flux (Clarke 1954 in Dhondt 1988:340). Some biologists have preferred to think of carrying capacity as conceptual rather than calculable, but others indeed define it in mathematical terms (i.e., Odum 1953).
River Basin and its fish populations. In light of this example, this article hopes to foster more anthropological attention to the highly situated and context-specific politics of scientific practices and tools.

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Being Affected by Sinking Deltas
Changing Landscapes, Resilience, and Complex Adaptive Systems in the Scientific Story of the Anthropocene

by Atsuro Morita and Wakana Suzuki

This paper considers recent studies of global environmental change and their impact on the deltas, social and ecological patches that epitomize an Anthropocene environmental dynamism. Looking into these delta studies, we explore an emerging imagination about human-planet relations. Specifically, we indicate that the relationship between the changing Earth and human activities depicted in these studies is comparable to the kind of affective relations to which the anthropology of science has recently brought attention. While affective relations as anthropologically described depend on the capacity of the body to be affected by other entities, global change research on deltas asks the public to imagine collective life, including infrastructure, land use, resource consumption, and companion species, as composite bodies affected by the changing planet. This imagination is made possible by analogies developed in the vicinity of the notion of resilience, a term that originated in mathematical ecology and complex adaptive systems in computer science. In exploring this interdisciplinary traffic of ideas and models, we elucidate an analogical imagination that crosses the border of machines and organisms.

The world needs a new narrative—a positive story about new opportunities for humanity to thrive on our beautiful planet... The dominant narrative until now has been about infinite material growth on a finite planet, assuming that Earth and nature have an endless capacity to take abuse without punching back. (J. Rockström and M. Klum, Big World, Small Planet: 11)

Introduction

In 2015, the American think tank the Breakthrough Institute published the Ecomodernist Manifesto in reaction to growing concerns over the Anthropocene. The manifesto is structured around the possibility of (re-)separating humanity from nature. Intensifying many human activities—particularly farming, energy extraction, forestry, and settlement—so that they use less land and interfere less with the natural world is the key to decoupling human development from environmental impacts. These socioeconomic and technological processes are central to economic modernization and environmental protection. Together they allow people to mitigate climate change, to spare nature, and to alleviate global poverty. (Asafu-Adjaye et al. 2015: 7)

This emphasis on decoupling offers a stark contrast with the environment of the Anthropocene as depicted by Earth system science and global environmental change research (Syvitski and Kettner 2011; Vörösmarty et al. 2013).1 If the Breakthrough Institute’s vision of ecomodernism is an expression of a (mostly Western) yearning for a stable and detached nature independent from human activities, what we find in the scientific literature is an image of environment and humanity as thoroughly entangled. Indeed, there is a growing consensus among environmental scientists that nature is inherently unstable. Some argue that due to massive human disturbances “stationarity”—“the idea that natural systems fluctuate within an unchanging envelope of variability”—is gone forever (Milly

1. Emerging out of international Global Environmental Change programs since the 1980s, Earth system science is an interdisciplinary field concerned with understanding “the entire Earth System on a global scale by describing how its component parts and their interactions have evolved, how they function, and how they may be expected to continue to evolve on all timescales” (Earth System Science Committee, NASA 1986:4). While Earth system science is mostly comprised by physical science approaches, it is broadly concerned with the long-term impact of human activities. Since 2015, global change research has been consolidated under a common platform called Future Earth. For a brief history of the global change research including anthropological engagements with it, see Brondizio (2016b).

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et al. 2008:573). The notion of the Anthropocene exactly epitomizes such an unstable nature. As is well known, the atmospheric chemist Paul Crutzen and the ecologist Eugene Stoermer (2000) proposed the term Anthropocene to describe human-induced planetary transformations. Testifying to the direct link between the Anthropocene and global change research, their first note appeared in the newsletter of the International Geosphere-Biosphere Program (IGBP), one of the central platforms for global change research.

Gradually becoming part of scientific consensus, this idea has led to the emergence of a new type of policy discourse that emphasizes the necessity of constant adaptation to an ever-changing environment. Key to this discourse is the notion of “resilience,” understood as the capacity of “social-ecological systems” to absorb disturbances and adapt (Chandler 2014; Folke 2006; Stockholm Resilience Centre 2015).

The contrasting views of the Ecomodernist Manifesto and global change research represent conflicting visions about “our” relationship with the planet. On one hand, the Ecomodernist Manifesto looks like a desperate cry on behalf of a modern world in which it will be possible to maintain economic development and stable environments by keeping nature and culture separated. On the other hand, by depicting ever more complicated entanglements between human activities and the planet, global change research calls for a radically different imagination about the human-Earth relationship. In contrast to the notion of a stable nature, what comes into view is an active, unpredictable, and affective Earth.

As contributors to this supplement illustrate, engagements with Anthropocene landscapes take diverse forms. Because of this diversity, why and how a particular imagination enters into policy discourse matters significantly. In this paper, we specify how the imagination of resilience generated by global change research came into being and highlight how certain models and technologies shaped this resilience imagination in a distinctive way.

Both the theory and models of resilience and social-ecological systems emerged through a complex movement of modeling techniques and ideas. This traffic has drawn analogies between supposedly separate domains of mathematics and species population, ecology and algorithms, and between machines and organisms. Along with data archives, remote sensing facilities, and observation networks, these analogical relations take part of infrastructures for Earth system science that rests on processing a vast amount of data (Edwards 2010). At the same time, this particular assemblage of heterogeneous ideas and models had made it possible to expand the resilience imagination further into new realms including societal transformation.

While exploring the analogical relations made by the traffic of models, we also experiment with the resilience imagination by putting it in conversation with yet another form of imagination about the Anthropocene. In a recent piece, Bruno Latour (2014) outlines a number of ramifications of global environmental change. Drawing on the philosopher Michel Serres’s (1995) *The Natural Contract*, Latour notes that in the past, Earth embodied “the objectivity of a world without humans,” thereby providing a solid ground on which law and science could be based (5). As Serres wrote: “Nature acted as a reference point for ancient law and for modern science because it had no subject: objectivity . . . emanated from a space without man, which did not depend on us and on which we depended de jure and de facto.”

Climate change, however, has fundamentally transformed this supposedly objective ground, and in its place we now find an Earth subject to human action. Accordingly, Latour notes, “at the time of the counter Copernican [anthropocene] revolution,” in the place formerly occupied by nature, we encounter “an agent which gains its name of ‘subject’ because he or she might be subjected to the vagaries, bad humor, emotions . . . of another agent, who also gains its quality of ‘subject’ because it is also subjected to his or her action” (Latour 2014:4).

In unpacking the philosophical and anthropological ramifications of this planetary transformation, Latour implicitly refers back to his previous discussion of affect (Latour 2004). In “How to Talk about the Body” he observed the following:

An inarticulate subject is someone who whatever the other says or acts always feels, acts and says the same thing . . . In contrast, an articulate subject is someone who learns to be affected by others—not by itself. There is nothing especially interesting, deep, profound, worthwhile in a subject “by itself.” . . . a subject only becomes interesting, deep, profound, worthwhile when it resonates with others, is effected, moved, put into motion by new entities whose differences are registered in new and unexpected ways. (210)

If the modern view of nature and culture renders humans as subjects who follow their course of action regardless of how the planet responds, the Anthropocene urges “us” to become articulate, capable of learning to be affected by the changing Earth. And, Latour argues, this requires a new vision of subject: “To be a subject is not to act autonomously in front of an objective background, but to share agency with other subjects that have also lost their autonomy” (Latour 2014:5–6).

As this suggests, the Anthropocene concerns more than scientific facts. Indeed, it entails a fundamentally new imagination of the relation between people and the planet. And in fact, some Earth system scientists are also well aware of this ramification. Emphasizing the need for a new narrative, the epigraph by Johan Rockström, an acclaimed Earth systems scientist known for the idea of “planetary boundaries,” and the photographer Mattias Klum, exemplifies this point. As we will see, the notion of resilience that highlights adaptation to changing environment is a central protagonist in their story.

2. Anthropocene discourse tends to evoke a planetary “us” required to collectively transform in order to maintain a habitable environment on the changing planet. Given the inequality of the world economy responsible for the changes in the first place, the question of who is included in this “us” is fundamental (Hecht 2018). We return to this issue in our conclusion.
Importantly, one can find further interesting parallels between Latour’s affective Earth and resilience thinking. Both foreground the mutual relationship between the planet and humans. Moreover, both also deploy an analogical imagination that sees a hybrid collective consisting of humans, technologies, institutions, and ecologies as a kind of organic body.

In line with Science and Technology Studies scholars who draw on the concept of affect (Brown and Stenner 2001; Despret 2004; Myers 2015), Latour’s (2004) earlier discussion of affect highlights the role of the body of the human knower and technical objects in cultivating an articulate subject. “To have a body,” he had written, “is to learn to be affected,” meaning “effecteduate,” moved, put into motion by other entities, humans or non-humans” (Latour 2004:205). Drawing on the case of the training of employees in the perfume industry to become sensitive to many kinds of smell, Latour pointed to the importance of tools for mediating and transforming bodily potentials. It is because the body is assisted by numerous forms of technical mediation, all of which are embedded in the larger networks of the industry, that it can learn to gradually become attentive to the rich set of differences that make up the world of perfumes.

Transposed to Anthropocene discussions, Latour’s (2014) argument for the affective relationship between people and the planet seems to imply that human collectives might learn to be affected by the changing planet by creative deployment of various mediators. If Latour’s affective Earth implies an analogy between the body and hybrid collectives of humans and non-humans, Earth system science draws a similar analogy by arguing for making human society, or what they call socio-ecological systems, adaptive to the instability of the planet. The notion of adaptation refers to an organism’s capacity to change its behavior in response to the changing environment. The reliance of both of these imaginaries on organic analogies raises the question of how it is possible to make human collectives and organisms equivalent.

Using Latour’s analysis as a reference point, we continue to examine what allows Earth system science to make this organic analogy. Doing so, we also raise questions of the conditions that might make it possible for societies, infrastructures, and human-made landscapes to become adaptive, like living organisms. If employees in the perfume industry become articulated with the aid of technical mediation embedded in the network of the industry, what kind of technical mediation and network would be required to construct social-ecological systems as adaptive bodies? And what kind of “we” might be composed as a consequence?

Our argument to answer these questions is based on a reading of the Earth system science literature, alongside global change research and complexity theory, and Morita’s ongoing fieldwork among hydrologists and hydrological modelers in Japan, Thailand, Denmark, and the Netherlands who work with global change research and climate change adaptation. In this exploration, we highlight the role of models that enabled Earth system science to compose a new kind of entity called social-ecological systems. Drawing on the philosopher Max Black (1962), Casper Bruun Jensen (n.d.) has drawn attention to the “analogical” nature of many models. In contrast to scale models, computer models are analogical extensions that reproduce (what the modeler sees as) “the structure or web of relationships in an original” (Black 1962:222) in different media such as computer codes. This is why “they are able to transport modelers beyond their initial understanding of phenomena and lead to new insight” (Jensen, n.d.:2).

Computer models transfer aspects of observed phenomena in the medium of computer code and enable scientists to manipulate them, connect them with other models, and examine them from different perspectives. As analogical extensions, they also connect different scientific fields such as hydrology, ecology, and computer science. Indeed, the notion of resilience can be seen as a product of such traffic across disciplines. Computer models enable modelers to draw an analogy between socio-ecological systems and living organisms akin to Latour’s articulate bodies. This has helped to generate a vision of socio-ecological systems as adaptive, capable of being affected by the changing Earth. Nevertheless, this analogical extension rests on a particular form of imagination centering on the notion of systems. In contrast, Latour’s Spinozist imagination, according to which bodies are continuously modified by each other, simultaneously affected and affecting (Brown and Stenner 2001), provides an interesting counterpart to the system imagination.

To explore how global change research depicts Earth’s sensitivities to human activities, we focus on the global crisis of the world’s deltas. Scientists depict deltas as particularly sensitive landscapes that have been significantly impacted by a wide range of human activities. In the words of the environmental anthropologist Eduardo Brondizio and his colleagues, “deltas are emblematic sentinels of global change and at the forefront of the challenges facing local, regional and global sustainability” (Brondizio et al. 2016a:192). In other words, deltas are landscape patches that epitomize what Latour calls the affective Earth sensitive to human actions.

To illustrate how scientists and residents view the sensitivity of delta landscapes, we now turn to Morita’s ethnographic studies of a specific delta, the Chao Phraya Delta in Thailand.

Models and Landscapes in the Delta

After sending my 2-year-old daughter off to nursery, I (A. Morita) rushed into the conference hall of the engineering school of a large research university located in the northern part of Bangkok. The occasion was an internal workshop of a Thai-Japan collaboration project on hydrology. It took place less than a year after the 2011 floods that devastated Bangkok.
and the Chao Phraya Delta. Before the flood, I had started a project on water infrastructures in the delta right, and at the time I was still struggling to figure out how to engage with the massive delta landscape. Thanks to Yosuke, a Japanese researcher in charge of coordinating the project’s activities in Thailand, I had been allowed to join the workshop.

The big screen in the conference room displayed a colorful map of the Chao Phraya Delta. Large parts of the delta were painted with blue to mark inundated areas. After briefly overviewing the flood situation, the presenter showed the entire river basin of the Chao Phraya River system stretching up to the northern border of the country. This presentation of the main characteristics of the river basin and the research group’s observation sites in it was one of my earliest encounters with diagrammatic representations of the river basin and the delta, which would continue to appear during my fieldwork.

For hydrology and water management, the river basin is the basic unit of analysis (Molle 2009; Morita 2017). To global change researchers from hydrology, geomorphology, oceanography, ecology, and environmental anthropology, the delta, which is formed in the lower part of the basin close to the estuary, is a landform of central interest (Brondízio et al. 2016a; Svytski 2012; Svytski and Kettner 2011; Tessler et al. 2015). As an unusually dynamic landform, the delta is shaped by complex interactions between sedimentation transported by rivers, compression of soils due to gravity, and erosion caused by the sea. Geomorphologists and hydrologists tend to focus on the delta’s amphibious nature stemming from what they see as the opposed forces of river and sea. The river constantly creates land by transporting sediments from upstream, while the sea keeps undermining this land-forming process by eroding the coast.

Aside from these geomorphological characteristics, deltas are extraordinarily important for humans. For one thing, they are usually very fertile and thus constitute a good portion of the best agricultural lands. For another, as places where rivers and the sea cross, they are often ideal locations for trade (Morita and Jensen 2017). For these reasons, many large cities and industrial centers around the world are built on deltas. Yet, due to their flatness, deltas are also prone to flooding and erosion due to sea level rise. Thus, they are particularly vulnerable to climate change.

During the workshop, I was soon overwhelmed by the complexity of the research project, which covered such diverse activities as radar observation of rainfall, examination of forecast data from global circulation models (GCMs), algorithms to collate heterogeneous data, developing simulation models of the river and land cover, measurement of evapotranspiration from sugarcane fields, and more. This perplexity was due to my inability to understand the complex infrastructure of hydrology. Not only hydrology but also the environmental sciences in general today draw on complex infrastructures comprising multiple methods of observation, complex data analyses, and widespread use of simulation models. Such complex infrastructures make it hard for outsiders to grasp their knowledge practices (Edwards 2010).

It soon became clear that I was not alone in experiencing a failure of understanding. The hydrologists shared a similar sentiment, although about a different topic. At the beginning of the workshop, the Japanese leader, Professor Umino, said that the floods in 2011 had been totally unexpected and required reconsideration of basic assumptions about the Chao Phraya River, a remark that brought back vivid memories of the unpredictable flood to many participants. During the coffee break, some shared their personal experiences and recollected TV news coverage that reported on the slow advancement of a huge mass of water from upstream. With a tinge of self-irony, others recalled the repeated failure of the government to predict the advancement of the flood. Yosuke jokingly told me that he might be disqualified as a hydrologist, since he was entirely unprepared to find his own apartment in Bangkok flooded as he came back from upstream fieldwork.

The 2011 floods had clearly left a strong impression of the uncertain nature of the Chao Phraya River among everybody in the workshop. Moreover, this sense of alterity was largely shared by the Thai public. In media discourse, it was often articulated in terms of climate transformation. However, Yosuke, the hydrologist, was skeptical of public discussions of the 2011 floods as a production of climate change. Statistical analyses had estimated the probability of heavy rainfall capable of causing this scale of flooding as a once-in-50-years occurrence (Komori et al. 2012), and indeed a flood of the same magnitude had hit Bangkok in 1942.

The popular imagination, however, tended to be ignorant of, or indifferent to, this long-term statistical view. Instead, it zoomed in on observable changes of the delta landscape. For example, villagers I talked to during fieldwork in Ayutthaya, a province in the middle of the delta that routinely experiences floods, saw the mutation of the delta as a one-directional change, readily visible in the form of dams, dikes, and roads, all of which influenced the behavior of the river in ways they could observe every day. Even more, they also expressed vague concerns about land subsidence, reportedly happening in many areas in the delta. However, in many cases the precise extent and location of subsidence remained unclear to those I spoke with.5

5. Land subsidence caused by decline of the water table has been a major matter of concern not only in Chao Phraya Delta but also in many urbanized deltas. The cause is usually extraction of groundwater. In Thailand, government departments are monitoring the water table levels and land subsidence. However, the exact extent and area of subsidence are hard to know even for scientists. After the 2011 floods, some Japanese experts I spoke to found that many survey markers that served as benchmarks to measure land subsidence had sunk with the ground around them.
Sinking Deltas

In a sense, contemporary scientific discourse of the Anthropocene connects the views of the scientists and villagers. And it does this in a manner that highlights the close connections between historically changing landscapes and global environmental processes. In 2012, for example, IGBP’s journal *Global Change* featured a cover story by the geologist James Syvitski titled “Anthropocene: An Epoch of Our Making.” This essay focused on ways in which “humans have changed the Earth in a number of fundamental ways . . . , which are far less known than global warming” (2012:13). In particular, Syvitski paid attention to the flux of soil:

Infrastructure—dams, cities, transportation networks and coastal-management measures—has led to lasting and profound impacts. . . . The large dams . . . trap more than 2.3 Gt of sediment every year in reservoirs. This starves deltas of sediment and, in combination with the mining of water, oil and gas, has led to a situation where large deltas are sinking at four times the rate of sea-level rise. . . . By any unbiased and quantitative measure, humans have affected the surface of the Earth at a magnitude that ice ages have had on our planet, but over a much shorter period of time. (Syvitski 2012:14)

By emphasizing sediment flux as an important dimension of the Anthropocene, Syvitski (2008; also Syvitski and Kettner 2011) and his colleagues tell a story significantly different from the one focusing on climate change. If the narrative of climate change brings together carbon dioxide emissions, oil infrastructure, capitalist economy, deforestation, ocean acidification, biodiversity loss, and sea level rise, the soil flux story features impressively different actors such as sedimentation, rivers, dams, levees, tide, groundwater, and massively sinking landscapes. Sinking deltas are central protagonists of this story (Brondízio et al. 2016a, 2016b; Syvitski and Kettner 2011; Syvitski et al. 2012; Tessler et al. 2015).

While climate change stories, particularly those focusing on mitigation, rely on the unity of the global atmospheric circulation; the scale of the delta story is somewhat more complicated. It is about landforms, which are by definition local entities. However, because the sediment transported by a river to a delta is gathered from the whole basin, the delta also functions as an indicator of landscape changes in the entire basin, which can extend hundreds or thousands of kilometers. Similar to Hong Kong, which Frédéric Keck (2019) describes as a sentinel for global health concern over avian flu, for Earth system science, deltas are sentinels for the changing global hydrological cycle and sediment flux (Brondízio 2016).7

6. As the atmosphere has no boundary, the global scale is the only reasonable one to study and simulate climate change. For details, see Edwards (2010).

7. At the same time, this scale can also be temporal since changes in deltas take a much longer time frame than the construction of infrastructures that trap sediments. As Naveeda Khan notes in her paper (2019), steady transformation of deltas is a window to geological time.

The complexity of scale in relation to deltas becomes yet more evident when compared with hydrology. Conventional hydrology uses the river basin as a unit of land water processes that allows for integrated analysis of rainfall, river discharge, evapotranspiration, human activities, sedimentation, and erosion (Morita 2017). Thus, the focus of hydrology is usually local, centering on a particular river basin. In contrast, the new delta studies systematically compare deltas from all over the world. Syvitski’s analysis, for example, is based on comparison of 33 large deltas across the globe.

The focus on the global scale reflects the new delta studies’ reliance on remote sensing and global modeling, for which the global is the only “natural” scale. But it also relates to a growing recognition that the global water cycle must be a central matter of concern. The hydrologists Charles Vörösmarty and his colleagues, for example, argue for a global perspective as follows:

What this new thinking sought to overcome was a traditional mindset steeped in local-scale perceptions, research agendas and management approaches to water . . . . To reach the next horizon—to understand inherent variability in the water cycle, its predictability, and human dimensions—has elicited a slow, though purposeful, reformulation of our thinking to broader scales. (Vörösmarty et al. 2013:540)

Similar to Syvitski and his colleagues’ recognition, global hydrology also shed light on an underside to modern infrastructures. Vörösmarty et al. write that “the countless human decisions and resulting actions that seek to optimize water security for humans at the local scale today accumulate as global syndromes of increasing environmental stress” (Vörösmarty et al. 2013:539–540). Paying attention to interaction across scales brings into view previously unseen shortcomings of modern engineering approaches to water. What emerges in the cross-scale vision depicted by Syvitski’s and Vörösmarty’s groups is that infrastructures, particularly dams, are agents of historical transformations of water cycles, sediment flux, and landforms. This vision alludes to a new form of natural history of planetary transformation in which infrastructures bring about complex changes in geophysical interactions across patches and scales.

Indeed, the negative effects of river basin engineering make the delta story even more pessimistic than the climate change story. Although it has already become unrealistic, the climate change story often features decarbonization of the economy as a possible technological fix. In contrast, no technological fix for sinking deltas is available once there is a lack of sedimentation. The only feasible solution to the problem is to remove or fundamentally alter basic infrastructures such as dikes and dams, a task that seems impossible for the foreseeable future.8

8. However, there are growing critiques of modern fixed infrastructures in architecture, urban planning, and landscape ecology. The notion of the river basin also plays a significant role in these developments (Morita 2017).
In a paper published in *Science*, the environmental scientist Zachary Tessler and his colleagues have made this predica-
ment clear. In their comparative study, featuring no less than 48 deltas, they scrutinize the potential vulnerability of deltas in
developed countries. While these deltas would typically be less vulnerable to future land subsidence due to the high level of
infrastructural investment, this solution “has been called into question because of their heavy reliance on external fi-
nancial and energy subsidies.” Considering “a future scenario in which infrastructure costs have increased,” they find that
deltas in both developed and emergent economies including “the Mississippi, Rhine, Han, Chao Phraya, and Yangtze del-
tas had the greatest increases in vulnerability” (Tessler et al. 2015:641). In these deltas “future increases in vulnerability will
have a disproportionately large risk impact relative to other deltas” (642).

The delta story epitomizes Earth system science’s render-
ing of an affective Earth sensible to human action. In this new
vision, deltas’ unpredictable reaction makes conventional en-
ingineering interventions unsustainable in the long run and de-
mands a new mode of human engagement. This new demand fundamentally concerns ways engineers and scientists imagine
the human-environment relationship not as that between ac-
tive subject and passive object but as complex entanglement
where each affects and is affected by the other.

Resilience Thinking and Social-Ecological Systems
For Earth system scientists and their allies, the key to con-
tceptualizing this entanglement is resilience, which they fea-
ture as a central notion for sustainability in the Anthro-
pocene. A popular brochure by the Stockholm Resilience
Centre, one of the key institutes in global change research,
notes that resilience thinking “moves beyond viewing people
as external drivers of ecosystem dynamics and rather looks at
how we are part of and interact with the biosphere—the
space of air, water and land that surround the planet and in
which all life is found.” It proposes resilience as a property of
social-ecological systems, “interacting systems of people and
nature,” which is proposed as a unit of management for
“sustainable and resilient supply of the essential ecosystem
services on which humanity depends.” Resilience is simply
defined as “the capacity of a [social-ecological] system to deal
with change and continue to develop” (Stockholm Resilience
Centre 2015:3).

One can see how Earth system and sustainability scientists
envision the coupled notions of resilience and social ecological
systems in an ongoing interdisciplinary project that compares
the Ganges-Brahmaputra-Meghna, Mekong, and Amazon Del-
tas. Led by the ecological anthropologist Eduardo Brondizio,
this project aims to build a conceptual framework of deltas as
social-ecological systems (Brondizio et al. 2016a, 2016b). While
his team’s main empirical study focuses on a dilemma between
urban development and fishery in the Amazon Delta where wa-
ter pollution induced by uncontrolled urbanization has caused
damages in downstream fishery, the project represents a domi-
nant trend in social-ecological systems research.

Brondizio’s group sees deltas as extraordinarily complex
systems consisting of both social and ecological components.
The notion of social-ecological system as “a bio-geophysical
unit and its associated social actors and institutions” is the key
to understanding this complexity. Social-ecological systems
are “complex and adaptive and delimited by spatial or func-
tional boundaries surrounding particular ecosystems and
their problem context” (Glaser et al. 2012:4, cited in Brondizio
et al. 2016a:188).

Brondizio and his colleagues’ work (2016a, 2016b) defines
deltas as social-ecological systems primarily in relation to situa-
tions that appear as “collective action problems of common pool
resources (CPRs) wherein the actors involved compete and ne-
gotiate for resources at different scales” (Brondizio et al. 2016b:
592). As we will see in the following sections, this particular way
of framing problems reflects the historical trajectory of resilience
thinking in which the market model and problems of natural
resource management played significant roles.

There is a clear contrast between the approaches of social-
ecological systems and the conventional mode of engineering
that Vörösmarty and his colleagues (2013) criticized. The
latter usually focuses on a few closely related problems such as
water provision and flood protection that materialize at a
particular spatial scale. However, social-ecological systems anal-
ysis focuses on interactions between separate domains such as
fishery and urban development and across scales such as the
delta and the entire basin ones. Resilience is a property of such
a complex and heterogeneous system to absorb impacts from
environmental changes and transform itself to adapt to them.
It is in this rather abstract notion of resilience that one en-
counters an analogical imagination mediated by models.

Modeling the Dynamic Property
Adaptability to changing environment is usually seen as the
central characteristic of organisms in contrast to machines that
only repeat predefined behavior. However, because most classic
models in science and engineering are mechanistic, it has often
been difficult to grasp such organic capacities (Holland 1992).
Therefore, the development of resilience thinking has depended
on newly developed modeling technologies that go beyond the
limitation of the mechanical model.

Resilience was originally coined in ecology in the 1970s by
C. S. Holling (1973). In the original ecological context, resilience
was defined as an ecosystem’s capacity to absorb disturbance
while still maintaining its basic function and structure (Holling
1973). This original notion developed against the then pre-
dominant view of a balance of nature, another aspect of the modernist idea of stable nature. Ecology at the time assumed that ecosystems have a single equilibrium to which they naturally return if external disturbances are removed. In the sense that the ecosystem oscillates around a fixed equilibrium, the conventional model of ecology was mechanistic. Based on mathematical modeling, however, Holling argued against this conventional wisdom. In his 1973 paper, he claimed that an ecosystem has multiple equilibria and that external disturbance can push the system from one to another, for example, from forest to bush. Originally, then, resilience designated the limits within which a given system would return to its present equilibrium. However, if the disturbance exceeded this threshold, the system might shift to another state, and this transformation could be more or less permanent. The importance of this was that ecological state changes were often negative from a human perspective.

Holling’s model-based argument was faced with skeptical responses from mainstream ecologists in the early days “because it seemed easier to demonstrate shifts between alternate states in models than in the real world” (Folke 2006:256). This indicates the difficulty of imagining organic systems that can transform themselves rather than oscillating around an equilibrium. Resilience thinking has thus developed around modeling efforts to grasp this rather elusive quality. In this, complex adaptive systems introduced from computer science have played a crucial role. Resilience scholars found significant commonalities between Holling’s original idea and complex adaptive systems. As the environmental scientist Karl Folke notes, similar to Holling’s model, “theories of complex systems portray systems not as deterministic, predictable and mechanistic, but as process-dependent organic ones with feedbacks among multiple scales that allow these systems to self-organize” (Folke 2006:257, emphasis added).

The shift to complex adaptive systems happened in tandem with the expansion of the scope of resilience research. Holling applied his idea to the field of natural resource management where traditional approaches had led to sudden and unexpected resource collapse. Gradually, Holling and his colleagues came to see social institutions, culture, technology, and local knowledge as integral to the target system, which thus came to be called social-ecological systems (Berkes, Colding, and Folke 2002).

In this new context, complex adaptive systems brought about a significant shift in resilience thinking. By highlighting social-ecological systems’ “capacity for renewal, re-organization and development” (Folke 2006:253), complex adaptive systems allowed the notion of resilience to extend to include adaptation, social learning, and transformation as key features. From this viewpoint, “the buffer capacity or robustness captures only one aspect of resilience” (Folke 2006:259).

Currently, complex adaptive systems thinking has become central to the sustainability discourse in the Anthropocene. The website Welcome to the Anthropocene, for example, features “Fostering Complex Adaptive Systems Thinking” as one of the seven pillars of resilience thinking. The Stockholm Resilience Centre notes that “management based on ‘complex adaptive systems thinking’ that appreciates these interactions [between social actors and ecosystems] and the often-complex dynamics they create can enhance the resilience of social-ecological systems” (2015:10).

Originally heavily dependent on mathematical models in ecology, resilience thinking is now equally indebted to complex adaptive systems, which were first developed in the quite different context of simulating the behavior of life forms by the use of algorithms.

Complex Adaptive Systems

As discussed earlier, both Latour and resilience thinkers commonly highlight the significance of mutual accommodation between the planet and human collectives. Moreover, both see these collectives as a hybrid of human and nonhuman elements. The notion of social-ecological systems exemplifies this hybridity. One can also see some sort of organic analogy at work in both of Latour and Earth system scientists’ arguments. Latour highlights the affective capacities of the body. Meanwhile, resilience thinking highlights adaptation, understood as a particular characteristic of organism. Ideas and models of complex adaptive systems precisely made the organic analogy with resilience thinking possible.

As mentioned, computer models work by recreating the structural relations of a phenomenon in a different medium. Casper Bruun Jensen (n.d.) notes that because scientists are able to conceive of many different sets of relations from different viewpoints and at different scales, it is often possible to construct widely varying models of any given phenomenon.

In resilience thinking, modeling, and particularly the use of complex adaptive systems, exemplifies a sort of reverse move based on the same analogic principle. That is, just as it is possible to model the “same” phenomenon in multiple ways, it is also possible for scientists to model a set of structural relationships common to many different phenomena while using the same model. And indeed, models often have dual purposes. While scientists study the phenomena that hold their interest by means of models, they simultaneously study the technical aspects of models that pertain to the particular media used for the modeling.

Studies of complex adaptive systems offer a good illustration of this situation. On the one hand, these models aim to capture certain aspects common to organisms, ecosystems, and economies by means of computer algorithms. Yet, since the emphasis is on systemic commonalities rather than individual phenomena, and because simulating such commonalities requires particular computer programs, complex adaptive systems research entails a strong emphasis on the study of computer models themselves. Almost reversing the case described by Jensen, one type of model is related to numerous very heterogeneous phenomena, from developing embryos to resilient social-ecological systems. This versatility is the key to complex adaptive systems’
ability to draw analogies between organisms and social-ecological systems.

Complex adaptive systems modeling was initiated by the computer scientist John Holland. Inspired by theories of neural networks developed in the 1950s, he had been developing computer programs to mimic brain functions pertaining to learning and adapting to new environments. In brief, this theory sees brain functions as the outcome of interactions of numerous neurons. On this basis, Holland started to develop a kind of ecosystem of algorithms that would be capable of learning (Waldrop 1992).

In an introductory paper on complex adaptive systems, Holland argued that even though computer simulation is capable of dealing with most physical systems such as “the flow of air over an airplane wing,” “economies, ecologies, immune systems, developing embryos, and the brain all exhibit complexities that block broadly based attempts at comprehension” (Holland 1992:17). Despite the apparent diversity of these systems, however, Holland suggested that they share certain essential characteristics. “Each of systems involves a similar ‘evolving structure.’ That is, these systems change and reorganize their component parts to adapt themselves to the problems posed by their surroundings” (Holland 1992:17–18).

In these systems “the parts evolve in Darwinian fashion, attempting to improve the ability of their kind to survive in their interactions with the surrounding parts.” The aggregate behavior of the system emerges from interactions between these evolving parts. Essentially, Holland designed his computer models as an ecology of algorithms. In this ecology, algorithms collectively solve problems, compete for rewards, or breed offspring by mixing genetic traces. Just like a species population in the neo-Darwinian model of evolution, these algorithms evolve through natural selection posed by the external environment. The emergent complex behavior of the entire system is an outcome of such evolutionary interactions.

While complex adaptive systems are new entities in the world invented by Holland, they nevertheless rest on an already familiar imagination about systems, neo-Darwinian competition, and natural selection. Holland even designed the central component of complex adaptive systems that governs neo-Darwinian competition among parts as a certain form of market mechanism. These familiar elements fit well with the framework of natural resource management, where problems are indeed often framed as versions of the market problem of efficient resource allocation. Brondizio and his colleagues’ (2016b:592) specification of delta social-ecological systems in relation to “collective action problems of common pool resources” illustrates this affinity. There is thus no surprise that social-ecological systems analysis has become entwined with the new institutional political economy promoted by Elinor Ostrom (Brondizio et al. 2016a; Folke 2006).

As we have shown, the transformation of resilience from describing the ability of ecosystems to absorb external shocks to characterizing the capacity of social-ecological systems to learn and transform was mediated by models of complex adaptive systems that connected the adaptive behavior of organisms to computer algorithms and the market model. This mediation entails a sort of equivocation that is central to the acceptance of resilience in diverse policy fields (Chandler 2014). On one hand, the affinity to the market model built into the complex adaptive systems model has contributed to making resilience thinking acceptable to policy makers and stakeholders with whom Earth system scientists hope to collaborate. On the other hand, social learning and self-transformation look much closer to the broadly pragmatist tradition in social science, to which Latour also belongs (Chandler 2014). The diverse analogies between different entities and models, particularly between market mechanism, neo-Darwinian selection, and the complex behavior of organisms allows for a certain flexibility in the interpretation of resilience. This flexibility has enabled resilience to capture the imaginations of widely different political actors from sustainability scientists and institutional economists and policy makers to critical social scientists (Chandler 2014) and social movements (Hopkins 2008).

But this flexibility also stems from the model-based nature of resilience thinking. As is clear from its history, resilience aims to capture the dynamic property of complex systems that is difficult to define in static or empirical terms. This is exactly what hindered the acceptance of Holling’s earlier model by ecologists. Even today, it is still difficult to clearly see the correspondence between the complex adaptive systems model used in resilience thinking and the empirical phenomena they tackle. For example, it is difficult to imagine how complex adaptive systems components, which are tested by competition and fitness, correspond to empirical phenomena such as land use regulations, fishery practice, local governments, and social groups that social-ecological systems researchers wish to tackle. Such ambiguity might be a reason that complex system thinking remains as a heuristic for resilience thinking (Folke 2006). However, such gaps between the model and the empirical world do not seem to matter much in the policy context. What Earth system and sustainability scientists seek is to give a certain form to the imagination about the mutual relationship between humans and the planet so that it can translate into policy discourse. Thanks to its affinity with new institutional political economy, resilience thinking has served this purpose well.

Conclusion

Offering a novel image of the instability of the planetary environment, global change research calls for a total revision of the modern vision of a nature separate from people. Raising questions not only about the notion of a detached nature but also about human autonomy, this image of unstable environment, which is closely affiliated with the notion of the Anthropocene, has stirred debates that go far beyond the environmental sciences.

Today, some Earth system scientists depict deltas as particularly important locations for thinking about such instability. Densely populated deltas are highly significant for human
collectives. At the same time, they are landscape patches particularly sensitive to changes in global water circulation and long-distance sediment transport due to infrastructure building. While the Anthropocene debates tend to speak of global processes, the complex topology of the delta crisis that cuts across scales testifies to the patchiness and unruly cross-scalar dynamism of the Anthropocene environment.

In this context, resilience thinking has emerged as a new mode of conceptualizing and managing the complex entanglement of humans and the planet. This paper has traced the travel of ideas and models across diverse fields that enabled resilience thinking to grapple with the dynamic quality of this entanglement. Analogies among organisms, algorithms, and social-ecological systems enabled by computer models have played central roles here. Moreover, we have also excavated some of the assumptions buried in the technicalities of complex adaptive systems. In particular, a neo-Darwinian model of natural selection and close adherence to the market model played an important role in making resilience thinking accessible to the policy circle.

Those assumptions are important when we return to the question of the "we," the changing human collective that often appears as the protagonist of the Anthropocene future. For resilience thinkers, a new kind of "we" composed by the hybrid bodies of social-ecological systems is indeed required to enable people to continue to thrive on a changing planet. This "we" was composed through multiple mediations by models, in which system thinking, neo-Darwinian evolution, and market mechanism play the central role.

Anthropologists are generally skeptical of the idea of such a unified "we." As the contributions to this supplement show, anthropology strives to extend and transform the main story line of the Anthropocene by highlighting the multiplicity of people and their projects (Haraway 2016; Omura et al. 2018; Tsing 2015). In contrast, this paper has tried to trace a different path by situating the story of global change and resilience within the web of analogic relations that made it possible to construct such a "we" in the first place. This exploration foregrounded the internal heterogeneity of the models that generate this "we."

Although it is deeply embedded in the conventional ideas of politics and economy, one characteristic of resilience thinking is the patchiness of its own conceptual architecture, which consists of ideas and observations taken from various fields and contains gaps between the conceptual and the empirical. Analogical relations drawn by models fill these gaps by weaving together heterogeneous ideas taken from diverse disciplines. This conceptual patchiness renders resilience significantly ambiguous. As mentioned, the close affinity of complex systems theory with neo-institutional economics made it possible to ally itself with the dominant policy discourse. But at the same time, the expansion and transformation of resilience from ecological robustness to transformative capacity and learning has enabled other forms of imagination. Indeed, Latour’s argument about the affective Earth itself developed in partial conversation with Earth system science. Yet, even as he takes Earth system science’s depiction of human-environment entanglement seriously, his perspective ends up looking quite different, not least because of its Spinozist imagination (Brown and Stenner 2001).

In this sense, Earth system science has opened up a new material-semiotic arena for thinking about possible futures of the human-planet relationship in which each party affects and is affected. It is not yet quite clear what is the affordance of this new conceptual horizon of the Anthropocene. More importantly, it is not at all clear whether human collectives can really learn to be affected in different and sustainable ways. Yet, this uncertainty is also what lies behind the Earth system scientists’ loud call for new stories, capable of rousing the imagination for engaging with an unstable planet.

In this paper we have elucidated the backstage of this call, filled with models and analogical relations. Now it is time to open new conversation between this dominant system imagination and other forms of imagination about the affective Earth (Jensen and Morita, n.d.). This paper aims to contribute to setting the terms of engagement for this crucial conversation.

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On Models and Examples
Engineers and Bricoleurs in the Anthropocene
by Eduardo Viveiros de Castro

This paper advances a heuristic distinction between “model” (in the Geertzian sense of “model-for”) and “example” as contrasting modes of articulating thought and action in the Anthropocene. I argue that the distinction is helpful in understanding the ontological presuppositions of geo-engineering as a technopolitical fix. Finally, I draw the outlines of a notion of “ontological anarchism” as the proper meta-mode of existence of the Anthropocene.

For studying out a question in all its bearings, there are no folk in this world like savages, peasants, and provincials; and this is how, when they proceed from thought to action, you find every contingency provided for from beginning to end. (Balzac, The Collection of Antiquities)

The Misanthropocene

Much has already been written about the Anthropocene—and we have barely started—yet one wonders how little of consequence has been said about “what is to be done” (and undone), not to mention the little that is being done. This special issue is a conversation between “natural” and “social” scientists; I reckon it counts as a scientific meeting carrying on with the “new disciplinary alliances in the Anthropocene” (Jensen 2017). Still, I cannot refrain from observing that while the Earth System Sciences (Lenton 2016) can give us a very good sense of what is happening on our planet and what should (much) or could (not much) be done to cope with the advancing catastrophe, neither natural nor social scientific traditions can really tell us how to go about it. The movement from knowledge to action is fraught with unknowns, and in the present case it seems to require the mobilization of capabilities other than epistêmê or, for that matter, technê. I mean something of the order of cunning (mêtis): prudent audacity, flexible doggedness, a good amount of political (and some physical) courage, a certain joyful pessimism, and well-honed rhetorical skills, in particular storytelling skills.

To that as it may, whether scientific committees decide to officialize the name Anthropocene or not, however the concept is defined in geological terms and its referential inception is precisely situated, whatever the Powers That Be declare and promise and feign, however forcefully ecopolitical activists manifest and protest, or how much scarier each successive IPCC report gets, one thing only, perhaps, seems beyond a reasonable doubt, anthropologically speaking: We have entered a new “axial,” historico-metaphysical age, a new “climate of history” that is generating what is increasingly looking like a cosmological paradigm shift—a new worldview, in which the very meaning of the words “world” and “view” and the identity of the “viewer” are in dispute. This is an age in which new ghosts, new monsters, new fears, new hopes haunt the imagination of what used to be called “the future” but is actually “the present,” above all for peoples of all living species and other Terran entities who endure in a large part of the world now. The sci-fi thinker William Gibson famously observed: “The future is already here—it’s just not evenly distributed” (The Economist, December 4, 2003). I presume he was referring to “our” hypertechnological future that is already present “here” and that would hopefully be evenly distributed sometime in the future’s future. But of course there is another very different future-laden present, a correlated but

1. This passage serves as the epigraph of Lévi-Strauss’s La pensée sauvage (1962). It was already omitted in the 1966 English edition of that book. Balzac’s original in Le cabinet des antiques reads: “Il n’y a rien au monde que les Sauvages, les paysans et les gens de province pour étudier à fond leurs affaires dans tous les sens; aussi, quand ils arrivent de la Pensée au Fait, trouvez-vous les choses complètes.”

2. On Deleuze’s “joyful pessimism,” as opposed to Negri’s “disenchanted optimism,” see Zourabichvili (2002). For a theoretical and political vindication of storytelling, see Haraway (2016), Tsing (2015), and Tsing et al. (2017), as well as the papers of this symposium for excellent examples of such skills. The growing presence of references, motives, and authors belonging to sci-fic committees decide to officialize the name Anthropocene or not, however the concept is defined in geological terms and its referential inception is precisely situated, whatever the Powers That Be declare and promise and feign, however forcefully ecopolitical activists manifest and protest, or how much scarier each successive IPCC report gets, one thing only, perhaps, seems beyond a reasonable doubt, anthropologically speaking: We have entered a new “axial,” historico-metaphysical age, a new “climate of history” that is generating what is increasingly looking like a cosmological paradigm shift—a new worldview, in which the very meaning of the words “world” and “view” and the identity of the “viewer” are in dispute. This is an age in which new ghosts, new monsters, new fears, new hopes haunt the imagination of what used to be called “the future” but is actually “the present,” above all for peoples of all living species and other Terran entities who endure in a large part of the world now. The sci-fi thinker William Gibson famously observed: “The future is already here—it’s just not evenly distributed” (The Economist, December 4, 2003). I presume he was referring to “our” hypertechnological future that is already present “here” and that would hopefully be evenly distributed sometime in the future’s future. But of course there is another very different future-laden present, a correlated but

3. See the already classic paper by Chakrabarty (2009); on the idea of a “cultural” (cosmopolitical) paradigm shift connected to the Anthropocene concept, see Latour and Lenton (2019).

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antipodal future to Gibson’s which is already here also, and that is not evenly distributed just as well: the “patchy Anthropocene” that gives this special issue its title.

From another point of view, however, it is almost as if the *physiologoi*, the nature philosophers of the remote pre-Socratic past already had all the necessary elements—namely, four—to diagnose what is going on: the Air, Fire, Earth, and Water that our sublunary sphere is made of are now catastrophically out of whack. By the same token, the steadily growing scarcity of the Earth, its geologically unceasing becoming-other.6 To conclude, some of them unrecognized by the Modern ontological fiction thus named is refracted and diffracted in many directions (it is not isotropic or isochronic in any scale), which makes it even more subjected to the vagaries of an all-powerful and rapidly changing Earth. When one considers the empirical and transcendental uncertainty that pervades virtually all the assessments of the “Great Derangement” (Ghosh 2016), it would not be too far-fetched to argue that the Anthropocene has confronted “technologically modern humans” with a supernatural or, more properly, alternatural dimension, a “combined and uneven geo-spiritual formation” (Szerszynski 2017b) also known as Gaia,” which is our task to theoretically explore and find a viable way within it.4

4. On the “supernatural” or “alternatural” dimension of the Earth as Gaia, see Latour (2017a, 2017b) and Stengers (2016 [2005]). The neologism “alternatural” points to the necessity of unpacking and dissolving the old notion of “Nature” that functioned as the universal background of immutable necessity as against the uniquely human attribute of freedom. The Gaelic Earth is not the Lovelockian-Margulisian Gaia; it is not the same “Nature” that makes it turn (Latour and Lenton 2019).

5. Since the symposium on which this special issue is based took place in Sintra, Portugal, it may be appropriate to recall the Great Lisbon Earthquake of 1755, an “act of God” that marked a high point of early modern theologico-philosophical speculation (Tavares 2005). As is well known, it inspired Voltaire to write his novella *Candide* (2005 [1759]), a scathing satire of Leibniz’s treatise *Theodicy* (2005 [1709]), in which the great German philosopher argued for the essential justice of God’s will, in accordance with his theory of the best possible world (see Danowski [2011] for an interpretation of Leibniz’s optimism in the context of the Anthropocene). Hazardous times and catastrophic events tend to trigger off speculative musings about the problem of evil, in the twenty-first century just as well as they did in the eighteenth. In our Anthropocenic times, the challenge, of course, would be to write an *Anthropodicy*. So far, what could be counted as attempts in that direction are of two types: (1) the “partial acquittal” arguments, which hold that it is not the human species as such that is to blame for the ongoing catastrophe but its modern, Western-originated ethos—the Capitalocene theories; (2) arguments that see it as the unavoidable birth pangs of a prosperous, safe future for humanity as a whole, a hard-won achievement of the species’ genius—the “good Anthropocene” theories (see Danowski and Viveiros de Castro 2017 [2014]; Hamilton 2016).

“The Anthropocene,” the geophilosophical concept describing a new sublunary space-time configuration, has emerged from the new “plane of immanence” (Deleuze and Guattari 1996 [1991]) that is tracing itself across the chaos of intensive and extensive changes happening unevenly all around the globe. All life forms on Earth are now projected onto this plane—an actual plane rather than a globe, really, since “Gaia is not a globe at all but a thin biofilm, a surface, a pellicle, no more than a few kilometres thick that has not made inroads very far up in the atmosphere nor very far down in the deep earth below no matter how long you consider the history of life forms” (Latour and Lenton 2019:19). A plane of immanence, according to the authors of What Is Philosophy?, has two faces, a “plane of Nature” and a “plane of Thought.” I prefer to imagine these two planes as forming a Möbius strip, a single, non-orientable surface that closes on itself with a twist. All the more so as Thought, be it conceived as different degrees of “sentence” or modes of “sapience,” is at long last being acknowledged as an attribute of many, perhaps all more-than-human bioforms and, in its human techno-economic mode, has ingressed into “physical” nature with disastrous consequences—a very material instance of “correlationism” (Meillassoux 2009 [2006]). This new plane of agential, historical nature (of nature prehending itself) is peoples by gods and spirits as well as by graphs and equations; by sacred rivers and extremophile life-forms as well as by satellites and computers; by earthbeings (de la Cadena 2015) and thinking forests (Kohn 2013) as well as by Critical Zone Observatories and radioactive waste disposal sites; by Wiccans, popes, and shaman as well as by Earth System scientists, anthropologists, eco-political activists occupying “Zones to Defend” and indigenous peoples fighting against logging companies and gas pipelines. Gaia must make room for the sundry different ways of living (in) the Anthropocene, since the Earth’s space-time-energy overall configuration named is refracted and diffracted in many directions (it is not isotropic or isochronic in any scale), which is one of the senses in which it is “patchy.” It is patchy, first, because it evinces and implicates a variety of modes of existence, some of them unrecognized by the Modern ontological vulgate but absolutely central to thousands of extramodern peoples, and second, because, as Arènes, Latour, and Gaillardet (2018) observe in their recent paper on “Gaia-graphy”—an anamorphic configuration of the planet as seen “from the inside” rather than from the usual view from outer space—the Earth itself “is much more concrete, dynamic, complex, heterogeneous and reactive than what can be captured through the cartographic imaginary of points defined on a map by longitude and latitude.” To which we might add the macrotemporal heterogeneity of the Earth, its geologically unceasing becoming-other.6 To con-
nect these two senses of Anthropocenic/Gaian patchiness is the challenge placed before anthropology more than to any other discipline.

In short, Anthropocene-thinking requires the practice of a radical form of ontological pluralism, both on the side of anthropology—the attention to the many ways of living and thinking the Anthropocene by different peoples in different places, differently affected by capitalism’s processes of material extraction and spiritual sorcery—and on the side of the ecological, biological, and geophysical sciences—unearthing the “different Earths”; mapping out of different zones of ecological simplification; recording the sometimes surprising unintentional effects of bio-, socio-, and geo-engineering actions on the part of states and corporations; developing the new insights about the multifarious symbiotic interdependence of all life-forms.7

May I venture, however, that we go beyond the notion of “ontological pluralism” and propose the expression “ontological anarchism” to characterize the proper meta-mode of existence of the Anthropocene or, rather, of Gaia as it surged on our thought horizon thanks to the event of the Anthropocene—of Gaia as the always unstable coexistence of different modes of existence? “Ontological anarchism” would then be the politico-philosophical translation of the sympoetic, symbiogenetic structure and function of life in its absolute material immanence (Haraway 2016); it would also include the postvitalist acknowledgment of the agency of “non-organic life” (Deleuze), from stones to hurricanes, from protons to fictional characters. If “anything goes” was the motto of Feyerabend’s epistemological anarchism—the motto was not a principle of method but a historical conclusion, let us not forget—we may say that “everything goes” is the motto of ontological anarchism. Everything goes, however, according to the requisites of the specific mode of existence to which each and every “thing”—a river, a spirit, a law, a feeling—pertains. It so happens that there are certain modes of existence shared by rivers and spirits, certain others where rivers meet legislation, others yet where rivers meet feelings, etc. In the Anthropocene, no mode of existence can be ruled out as illegitimate, because the “Modern Constitution” (Latour 1993 [1991]) must be radically reformulated. Above all, its constituents are changing: entirely new ones and long-forgotten ones are making themselves heard. Scientific practice and secular politics remain vitally necessary but are no longer sufficient to cope with what lies ahead.

The perplexity before the complex entanglement of the myriad reciprocal forces and influences connecting physics to metaphysics, science to fiction, geontology to biopolitics, not to mention all life-forms to one another as well as to so-called inorganic materials and processes—such “complexity” poses a major challenge to our current anthropological imagination, which now seems to waver between two different “misanthropologies.” On the one hand, there is a growing realization that the ontological state of exception (in Schmitt-Agamben’s sense) granted to anthrôpos, the Human, in our intellectual tradition was the ultimate justification, or cosmological precondition, of the Anthropocene; the affect derived from this realization cannot but be a profound sense of shame. This shame of being human, to recall the grim phrase of Primo Levi, is at one and the same time a shame before ourselves (and I mean the self-proclaimed paragon of anthrôpos, to wit “Western Man”) and before all the “critters” that share the Earth with us, including, of course, the less-than-Human humans who are bearing the brunt of the world’s ecopolitical derangement. This shame can only lead to a misanthropo-logy: an anthropology wary both of its own name and of presuming to speak in the name of its eponym.

On the other hand, our discipline has almost always been a mis-anthropology, insofar as it thought, first, that it could think the anthrôpos as a metaphysical substance, a self-subsistent imperium in imperio, while it is a being, like all beings, made and unmade of, through and with other beings, and, second, as it tended to systematically misrender the counter-anthropology of other(wise) human peoples into terms such as cultural “belief,” techno-economic “backwardness,” “primitive” psychology, and so forth, thus missing the crucial point that those extramodern peoples have always had more-than-human anthropologies that are at exactly the same epistemic level as our own academic discipline—anthropologies that therefore conceptualize the Anthropocene in other-than-Western terms.

As its title makes obvious, this article is an homage of sorts to Claude Lévi-Strauss, an author who prophetically suggested in the final pages of Tristes tropiques, published in 1955, that we

rather a number of different Earths that have succeeded each other in time, each with very different chemical, physical and biological states (cited in Hamilton 2014:6) (Clark and Yussof 2017:5).
8. On the coevality of the concepts of Gaia and the Anthropocene, see Latour and Lenton (2019). The concept of “mode of existence” comes from Latour (2013 [2012]). It has its roots in the work of Etienne Souriau (2009 [1943]), although Latour developed the notion in a somewhat different, personal direction. Isabelle Stengers was an important mediator between Souriau’s and Latour’s concepts of modes of existence (see the introduction to Les différents modes d’existence jointly signed by Stengers and Latour). Souriau’s concept, but also Latour’s, proposes an “existential pluralism,” the idea that “all forms of existence are equal in their autonomous capacity to produce” (Noske 2015:37), a modal and perspectival ontology of different forms of occupations of space-time or, rather, of different space-times created by different modes of existence (Lapoujade 2017:17, passim)—which is also a way of defining the Gaia of Lovelock–Margulis as opposed to the Earth of celestial mechanics.
9. Anthrôpos is conceived not only as a special animal—all species are special—but as an exceptional one: that animal who, by knowing that it is an animal, ceases to be “just” an animal. Western anthropology has always had a semiclandestine affair with angelology.
10. Cullen (2015); Margulis (1999); Haraway (2016); see Helmreich (2015: chap. 6) for a discussion of the “human microbiome” theme.
should change the name of our discipline to “entropology,” basing his proposal in arguments that anticipate much of our present Anthropocenic state of mind. He argued that humanity, from its very inception, is a machine “brought perhaps to a greater point of perfection than any other, whose activity hastens the disintegration of an initial order and precipitates a powerfully organized Matter towards a condition of inertia which grows ever greater and will one day prove definitive.” And he proceeded with his anti-Anthropodicy, this time focusing on civilized humanity:

“Taken as a whole, therefore, civilization can be described as a prodigiously complicated mechanism: tempting as it would be to regard it as our universe’s best hope of survival, its true function is to produce what physicists call entropy: inertia, that is to say. . . . “Entropology,” not anthropology, should be the word for the discipline that devotes itself to the study of this process of disintegration in its most highly evolved forms. (Lévi-Strauss 1961 [1955]:397)

As Marco Antonio Valentim (2018) observed, in an insightful philosophical reading of Lévi-Strauss’s entropology, there would be for the author of *Tristes tropiques* a fundamental incompatibility between the across-the-board anthropization of the Earth and biodiversity. Anthropocene equals Entropocene. “Entropology” would then be another name for the first of my two “misanthropologies.” I say the first because, although Lévi-Strauss indict[s] the whole species, it is quite clear that his dismissal or oversight of the negentropic potential of life did not abate his admiration for the other anthropologies consequent to other forms of human life—for those extramodern peoples who never wallowed in the belief of the exceptionalism of the human species, seeing themselves instead as entangled in a cosmic web, and therefore being extremely wary of the consequences of their actions.

If the readers would prefer a more contemporary remark on the connection of Western civilization (colonial technocapitalism plus “human” exceptionalism) to the Anthropocene, let us quote Pignarre and Stengers’s *Capitalist Sorcery*:

“We we are in the habit of deploring the crimes of colonisation, and admissions of guilt have become routine. Everybody now knows it was not a matter of civilisation but of dreadful exploitation. But we are lacking a sense of fright when we rest easy with this knowledge, and do not wonder about this “civilising” enterprise, which we know colonisation was not. Or at the fact that it is not so easy to stop taking ourselves for the brains of humanity, and that with all the best intentions in the world, we may well continue to do so. And that is the case, notably, each time we make there out to be a difference between “the others”, who, in one way or another, are defined by their beliefs and illusions, and us, who see things correctly thanks to our sober senses. (Pignarre and Stengers 2011 [2005]:63)

The authors conclude this reflection with the question: “How do we make room for others?” (Pignarre and Stengers 2011 [2005]:63, my emphasis). That, indeed, is the question. It goes beyond the usual scope of anthropology, which is the study of “other” humans, or rather, of all humans as others, if we include under these others, as we must, the legion of more-than-human peoples that are retreating under the ever-growing pressure of “ourselves.”

I take the question “How do we make room for others?” as being the same as the “What is to be done about the Anthropocene?” that I evoked at the beginning of this article. And I suggest that one of the possible answers to it lies in taking these others absolutely seriously, as examples of the “arts of living in a damaged planet” (Tsing et al. 2017). This answer treats the question(s) as supremely political, not technical.11 Now, what is an example?

Models and Examples

Rather than repeating here what Déborah Danowski and I have written in our recent book *The Ends of the World* (Danowski and Viveiros de Castro 2017 [2014]) about what we called “Terran technologies” as ways of resisting the Anthropocene, I will sketch a few notes on the subtle but profound difference between the notions of model and example. Making a distinction between these forms of world-making (-thinking, -living) has geopolitical and anthropological diacritical relevance because it allows us to gauge alternative ways to confront the Anthropocene, particularly when the notion of a “good Anthropocene” is touted as an antidote to the “apocalyptic” and “catastrophist” views that many scientists and climate activists hold and that more and more peoples experience as lived reality. The coming of a good Anthropocene is touted by eco-capitalist thinkers like those at the Breakthrough Institute or their Singularitarian fellow travelers in the Silicon Valley and is more or less directly implied by their left-wing “accelerationist” European counterparts.12 It relies on the implementation of large-scale geo-engineering projects as key to the continuous expansion, given “the new normal” (i.e., ever-worsening) climatic conditions, of the hegemonic socio- and bioengineering activity intrinsic to the modernist practices of “generalized domestication” (Hage 2017).

Geo-engineering is a privileged case of model-thinking as a tool of political domination over all life. Please note that I include under this term not only Anthropocenic projects of planetary geo-engineering but also the old and new “violent simplifications” of landscapes and human/nonhuman lifeways. The contrast between “model” and “example” may be useful to make us attentive to current and hopefully future modes of resistance and sub-sistence—of afterlives—in the face of the

11. Assuming it is useful to distinguish these two modes of existence (on Technics and Politics as two sui generis modes of existence, see Latour [2013 (2012)]).

12. See the above-mentioned book by Danowski and Viveiros de Castro (2017 [2014]) for the Breakthrough Institute, the Singularitarians, and the accelerationist current.
“super-sentent” technomodernist mentality and its brutal homogenizations of the immanent hypercomplexity of Earthly life.

There is a famous distinction put forward in *La pensée sauvage* (Lévi-Strauss 1962) between two ideal types of worldmaking: that of the bricoleur and that of the “engineer.” Although the metaphorical vocabulary comes from technology (the jack-of-all-trades or craftsman-tinkerer versus the scientifically trained designer-builder), Lévi-Strauss was mainly interested in the contrast between mythical imagination and modern science. But the general import of the distinction consists in the difference between a mode of creativity that relies on already available heterogeneous materials (like the encyclopedic knowledge stored in the myth-maker’s culture and language) not originally designed with the bricoleur’s contingent project in view, and one that starts with a project, devises a conceptual blueprint, and orders cut-to-measure equipment and elaborate specific materials to accomplish the engineer’s project. In short, the bricoleur is inspired by former examples of the kind of work she or he is engaged in; the engineer follows a model of his/her own design.

Let us not simplify the contrast, much less vilify the “engineer.” Nothing could be farther from Lévi-Strauss’s mind than a disparaging view of the natural and/or mathematical sciences as such, to which he has repeatedly referred with admiration (he was far less sanguine about modern technological civilization); and if there ever was an anthropologist fond of modelmaking, it was the father of structuralism. The distinction cannot but be relative, lying along a continuum rather than being a strict dichotomy. For the only engineer in a pure, absolute sense would be God, in whom concept-model and material implementation coincide immediately; human engineers must make do with ideas and materials at hand and therefore are bricoleurs, particularly when they leave the world (the worldview) of models and try to make things work in the phenomenal world. Reciprocally, every grassroots bricoleur calculates, anticipates results, and modifies the state of the world according to a certain intention, that is, a model; she or he is, after all, a “scientist of the concrete.”

This said, there is in bricolage an essential element of what Roy Wagner (1981) defined as the effort to “unpredict the world” he discerned in Melanesian indigenous anthropologies—to act in a way that subverts conventional understandings of the world, to invent after the fact, as it were. I believe here is an important idea for our times. We are now facing terrible predictions about the world. What should we do in order to “unpredict” them? And what can we learn from Melanesians and other extra-modern peoples about how to go about it?

Let us then distinguish very clearly between a notion of model as a normative versus model as a heuristic or scientific construct—between a “model for” and “model of,” to adapt the well-known Geertzian distinction. Scientific models, in the sense developed in Hadfield and Haraway’s article (2019) for this special issue, for example, are invaluable instruments to understand the world; they are ever more indispensable to grasp the complex imbrication of critters and processes, qualities and quantities, that the Anthropocene is at the same time revealing and destroying (see the introduction by Anna Tsing, Andrew Mathews, and Nils Bubandt [2019]). Hadfield’s report of his work with slugs—literally with, not just “about” them—shows beautifully how much of bricolage enters into actual scientific activity, with his exclosures, his contraptions to keep the slugs alive in laboratory conditions, and the efforts to reintroduce snail species in an ecosystem, not to mention the geopolitical negotiations with the very model of engineering mentality, namely, the armed forces. To cite another example of model-building that changes our way of seeing the Anthropocene world (from structures to events) and therefore of acting on it, I refer the readers to the above-mentioned “Gaia-graphy” paper by Arènes, Latour, and Gaillardet (2018).

Henceforth my reference to “models” means exclusively normative, “models-for” models, even if these often presume to derive their coincidence with Truth from scientific “models-of” and appeal to Science (in the singular, with a capital $S$) as a “guide to society.” Such is the case, for example, of all geo-engineering projects or the notorious models of economic development imposed by the International Monetary Fund and other tools of global capitalist “governance”—supposing economics counts as a bona fide science and development as a self-evident concept, something I seriously doubt. In its normative sense, a model is above all a political instrument, involving an asymmetric power relation which maximizes the distance between the modeling authority and the subjects (human and nonhuman peoples, landscapes, the atmosphere) that are to be modeled.

The “engineering” outlook of the technocratic type (macroeconomic, geopolitical, infrastructural, etc.) implies a reliance on models, that is, Platonic ideas that are typically imposed on less-than-modern peoples who are enjoined to copy them or on other-than-human critters and ecosystems that are expected to behave as predicted. Of course the target peoples never succeed, something that is usually attributed to their being primitive, superstitious, lazy, ignorant, or politically corrupt. But those peoples, when they are not killed by the model, may end up producing simulacra: inventive, creative distortions that subvert the ideal model imposed on them, thus...

13. This contrast between model and example is an example of a heuristic model. “Model” is a polysemic word if ever there was one, going from mathematics to politics and beyond. In a sense, all thinking is thinking with models. Also, (heuristic) models not only simplify reality but allow for analogical extensions and therefore for semiotic-practical discoveries and inventions. But the contrast stands insofar as there is a “moment of the model,” which is the moment of thinking/planning, and a “moment of the example,” which is the moment of making/doing. No action is entirely contained by thought. And—this is my point—one thing is to think with models (models-of), another quite different one is to compel others to think and act according to one’s own models (models-for).

14. “A daunting task lies ahead for scientists and engineers to guide society towards environmentally sustainable management during the era of the Anthropocene. This will require appropriate human behaviour at all scales, and may well involve internationally accepted, large-scale geo-engineering projects, for instance to ‘optimize’ climate” (Crutzen 2002:23).
opening up spaces of autonomy or “ungovernability” (Hage 2015) from within this heteronomic “governance.” As to the other-than-human objects, they always have a tendency to react in surprising ways, beings adept at unpredicting the ideal world of models.

Models are, by definition, simplifications of reality, but they can be used to understand it (models as heuristics) or be imposed upon it (models as norms) in order to browbeat reality, so to speak, into obeying them. In this latter sense they have always lain behind (or above) the Modernist project to flatten the many worlds of Gaian beings into a single global nomos. Examples, on the other hand, are ideas (techniques, institutions, etc.) that work as enticements to do something “differently alike” the inspiring example, which is itself always a version or transformation of yet another example, just as myths are but versions of one another with no original model or template. Examples are borrowed horizontally—they diffuse—while models are imposed vertically—they emanate. Models give orders and enforce order; examples give cues, inspiring inventions and subversions. The model of the model is Being, while the example lies within the remit of Doing. If the first is congenitally idealist and rationalist, the second is pragmatist and empiricist.

As is well known, evolution (and its evoevo expansion) proceeds by empirical bricolage, not ideal design. Life-forms are the ongoing, provisional result of the transformation of available materials, that is, prior life-forms and epigenetic contingencies: they are at the same time limited by what is given to them and use these limits to find unsuspected affordances, new opportunities to contrive solutions to “unpredicted” problems. The atomic and physiological makeup of organisms is true to the bricoleur’s spirit: “It’s good enough,” “It will do,” “It’s not perfect, but gotta live with that” (think of the biomechanical negotiation that gave humans their spinal column). The DNA should be conceived less as a model-template that is copied than as an example that entices modifications—being itself a bricole of human and nonhuman “intrusions” (the so-called endogenous retroviruses). An organism is a biobricolage that mutually adapts and adopts other organisms to form symbionts that co-adapt (i.e., ontologically empathize) with a meta-symbiogenic milieu. The same applies at the species level and beyond: every individual “species” is a society of species and every ecosystem a society of societies, thus giving reason to Gabriel Tarde when he objected to the romantic (and Durkheimian) model of society as an organism by arguing that it is the other way around, that every organism is a society—actually, that every entity is a society of other entities-societies, all the way down to the infinitesimal.16 Tarde’s vitalist and panpsychist cosmic sociology is a good example of a symbiogenic metaphysics of interpretive multiplicity. “What is society? It could be defined, from our point of view, as each individual’s reciprocal possession, in many highly varied forms, of every other” (Tarde 2012 [1895]:51).17

Human and nonhuman world-makings have always been geobricolages, insofar as they have always taken from the Earth the materials (of all shades of materiality) necessary for ensuring their livability. Balzac was not entirely right in stating that “savages, peasants and provincials” are really able to “provide for all contingencies” when they pass from thought to action; unintentional consequences are embedded in every action in this hypercomplex world.18 But the fact remains that many of these unintentional consequences of the past geobricolage activity of “savages etc.” were not damaging to Terran ecoscapes. One of the best examples of a positive combination of direct and semidirect large-scale ecobricolage is the present composition of the Amazonian rain forest biome, which is largely of so-called anthropogenic origin, as has been recently described by a wealth of archaeological and ethnobotanical research (for a recent assessment, see Levis et al. [2017]). The horticulture/agroforestry of indigenous peoples in Amazonia produced an abundance of edible and otherwise useful (by humans and other animal and fungal species) plants without destroying the great ecological

16. The ideas of Tarde, an ultra-Leibnizian thinker who was the greatest metaphysical adversary of Durkheim (a pious Kantian soul), were rescued from the Land of Lost Theories by Deleuze (1995 [1968]:25–26, 76, 307, 313–314, 2006 [1988]:125; Deleuze and Guattari 1987 [1980]:218–219). Recently they have been taken up again by B. Latour and M. Lazzarato, among many others (see Candea 2012). Kwa (2002:26) observed “the fundamental difference between the romantic conception of society as an organism and the baroque conception of an organism as a society.” This is an apt description of the difference between the sociologies of Durkheim and Tarde. Against the sui generis character of the social facts proposed by the former, the “universal sociological point of view” of the latter states that “every thing is a society, every phenomenon is a social fact” (Tarde 2012 [1895]:34, 28).

17. Tarde’s “law of imitation” actually includes two other fundamental elements, invention → [imitation] → opposition, a circular process in which every invention originates from an opposition to a previous imitation. The three together follow the principle of the example rather than of the model, for what he calls “opposition” can be rendered less dialectically as “modification” or “adaptation.” The bricoleur, in a sense, “opposes” his own usage of the available materials to the original purpose or meaning of the latter. An example is always a particular case that, as it diffuses, must be “tempered with,” in other words be modified to suit another particular case, while the model is by definition general—it is the particulars that must be remade to fit the Procrustean bed of generality.

18. We all may sometimes know “perfectly well” what we are doing; but we can never know perfectly well—far from it—all that we do does. This predicament could not but be shared by “savages, peasants, and provincials,” with the important difference, however, that their actions are essentially local and therefore on the same scale as their affaires (questions), thus making for a far narrower gap between the intentional and the unintentional effects of their behavior. This is unfortunately not the case for the urban citizen-consumers and their modern nation-states, much less for the global corporations that format the former and use the latter as their police force.
cycles of the forest, creating patches of livability that did not lead to the degradation of the nonhuman biosphere—quite the contrary (Balée 1994, 1998).

Indigenous peoples thus created “anthropogenic forests” that reciprocally created them as “phytogenic peoples”—peoples and forests both constituting and exceeding one another. Those huge patches of livability are now threatened by the ferocious ultrasimplification imposed on the region by the predatory expansion of a model of economic development based on political assassination, “unintentional” ethnocide, legal and illegal logging, extensive cattle ranching, large-scale mining and river damming, heavily subsidized monocultural agribusiness dependent on poisonous chemicals, and forced urbanization—or rather, slumization—of forest peoples (fisherfolk, peasants, First Peoples): model-thinking and geo-engineering in its starkest and darkest face.

Let me put on the table another example from Brazil, this time of an inventive reclaiming/reoccupying of a landscape that has been the site of an extremely violent simplification. The semiarid region of the interior of northeastern Brazil, which covers about 12% of the country’s territory of 8.5 million km², has a very distinctive physiognomy—a hot and dry climate, a very uneven amount of precipitation, both locally and seasonally, but overall in the low range (average of 700 mm/year, less than 400 mm in many areas), concentrated in 3 months of the year. Events of severe drought occur periodically. The semiarid was the homeland of several indigenous peoples, who were decimated between 1630 and 1720 in the War of the Barbarians waged by southern bandeirantes (fortune hunters, slave raiders, and ethnic cleansers hailing mostly from the state of São Paulo) with the support of the colonial authorities. The peasantry that came to inherit the region has a strong cultural and genetic Amerindian heritage. It served essentially as the labor force for large estates dedicated to extensive cattle raising and, later, to a plantation economy (cotton) run from the northeastern state’s capitals located in the luxuriant Atlantic coast. At the same time, this peasantry practiced a “subsistence agriculture” within the plantation/ranching domains or in the drier and more inaccessible areas. Contrary to the national stereotype of a drought-cursed region inhabited by wretched less-than-human folk, however, northeastern peasants managed to live with, to coexist, and cope with the challenging ecological conditions, having always managed to attune themselves to the specific biological and seasonal rhythms. Except when chased away by the big landowners (and the state and federal governments) who controlled the regional politics, which was/is essentially a hydropolitics, they developed a distinctive civilization, technically resilient and culturally original; its contribution to national culture (particularly in music, literature, and cuisine) is far more important than, say, that of the rich southern states of the country.

After 3 centuries of deforestation, cattle overgrazing, and cotton monoculture, the semiarid Northeast became something very close to a desert, with soils severely degraded into sterile sand and turned highly saline. In the mid-twentieth century, federal and state governments and big industrial interests began to support the typical geo-engineering idea that the application of the classic recipe: heavy doses of pesticides and chemical fertilizers. Many peasants, however—those poor tenants of the cotton and ranching estates whose families were
not forced to emigrate to Amazonia during the great drought of the late 1870s or to the southeastern capitals from the second half of the twentieth century up to the present—after having rejected the so-called technical assistance packets and rural development projects, rediscovered or invented low-tech, ecologically savvy methods of cultivation, including ingenious systems of water management (storage, irrigation) that are true prowess of geobricolage. Those loose-knit communities of free smallholders are connected in a network across sometimes long distances in the semiarid landscape, exchanging techniques, seeds, information on biofertilizers, organic defenses, soil and spring recuperation, and agroforestry, as well as re-designing their territorialities through popular cartography and intellectual-political alliances with scientific institutions and researchers.25 The unintentional effect of centuries of simplification of the caatinga biome was to reinstate, but in a different historical context, a budding assemblage of methods of cohabitation of humans and more-than-humans in a land laid waste by extractive colonialism. All this—to conclude—is being made in the face of the coming of climatic change, which is already being clearly perceived, conceived, and coped with by these communities of “cultivators-experimenters,” as these small-holders call themselves.26 Extended dry periods are more and more frequent; when rains come, they are increasingly torrential and destructive; temperatures are rising. Staying with the trouble.

So let us not essentialize model-thinking as “Western thinking,” much less as science tout court. Model-thinking—always in the normative sense of “model”—is empire thinking, be it occidental or oriental. Geo-engineering as the first practical actualization of model-thinking is intrinsic to the state form, particularly the imperial and colonialist state, from Wittfogel’s hydraulic despotism to the large-scale extractive operations and particularly the imperial and colonialist state, from Wittfogel’s hydraulic despotism to the large-scale extractive operations and gigantic dam- and road-building projects all over the modern world.27 Imperial geo-engineering models necessarily involve the destruction of the geobricolage assemblages in place, starting with the displacement or extermination of human and non-human populations. As Amitav Ghosh argued, capitalism “by itself” is not enough to account for the Anthropocene; one has to add empire: a certain technopolitical economy plus the geopolitics of world dominance. In his words:

I differ with those who identify capitalism as the principal fault line on the landscape of climate change. It seems to me that this landscape is riven by two interconnected but equally important rifts, each of which follows a trajectory of its own: these are capitalism and empire (the latter being understood as an aspiration to dominance on the part of the most important structures of the world’s most powerful states). In short, even if capitalism were to be magically transformed tomorrow, the imperatives of political and military dominance would remain a significant obstacle to progress on mitigatory action. (Ghosh 2016:146)

The problem here is that we may have (and have had for millennia) empire without capitalism, but it remains to be seen if we can have capitalism without empire. That would be magical indeed. Because “empire,” in its economic-capitulistic guise, means essentially “the so-called primitive [original] accumulation,” a perennal, necessary feature of capitalism, as Rosa Luxemburg memorably argued. In a sense, the Anthropocene—this is my understanding of Jason Moore’s argument regarding the “Capitalocene”—is the result of the ever-diminishing possibilities of primitive accumulation in the present condition of the planet, with the exhaustion of the four “cheap natures” (labor-power, food, energy, and raw materials; Moore 2014; Patel and Moore 2017). If such is the case, perhaps the weak link, the cracks, the fault lines, the interstices of livability in our Anthropocapitalocene lie precisely where capitalism and its bio-socio-geo-engineering project of general domestication “connects” with what remains at its social, biological, and physical exterior. Not with what is exterior from capitalism (for there is no absolute outside to it), but to the exterior of capitalism, the exteriormity (and “externality”) it must counterproduce as its own material condition of reproduction. In short, the “savages, peasants and provincials” of Balzac, rather than being a survival (in Edward Tylor’s sense) of past ages, may represent the best examples (not models) of strategies of future “survival” for life in a damaged planet, insofar as they—once their contingent is augmented by the millions of people, human or/and otherwise, that are rising (up) from and being born within the widening cracks of an unsustainable model(l) of living—cannot be dis-

25. See Rondinelly Medeiros (2014), from whence the former paragraphs were adapted, when not simply copied. See also the publication Semeando saberes, inspirando soluções (Programa Semear 2017) for an overview of different agricultural geobricolage initiatives in the caatinga.


27. See the well-known works of James Scott in this connection (e.g., Scott 1999). Model-thinking is intrinsic to what Deleuze and Guattari, taking their cue from Michel Serres, called “royal or State science,” theorematic science, as opposed to “minor” or problematic science. For many reasons, political as well as epistemic, climate science and related knowledge practices—not to mention anthropology—would be on the side of Deleuze and Guattari’s “minor science,” particularly from the moment they “hit upon” the concept of the Anthropocene. “Minor science” is not “deconstructive,” critical-only science but a practice- and problem-oriented science, a science of multifarious materials rather than of pure abstract Matter, of metamorphosis rather than of fixed essences, of marginal or minoritarian rather than central or majority phenomena: “According to a recent book by Michel Serres, both the atomic physics of Democritus and Lucretius and the geometry of Archimedes are marked by it. The characteristics of this kind of eccentric science would seem to be the following: 1. First of all, it uses a hydraulic

model, rather than being a theory of solids treating fluids as a special case; ancient atomism is inseparable from flows, and flux is reality itself, or consistency. 2. The model in question is one of becoming and heterogeneity, as opposed to the stable, the eternal, the identical, the constant. It is a ‘paradox’ to make becoming itself a model, and no longer a secondary characteristic, a copy; in the Timaeus, Plato raises this possibility, but only in order to exclude it and conjure it away in the name of royal science” (Deleuze and Guattari 1988:361).
pensed with by capitalism and “must” then, paradoxically as it may seem, continue to exist.

The Extramoderns in the Anthropocene

All Terran peoples, excepting the small but powerful tribe of climate negationists in the West, are aware of what is happening: the climate, the waters, the temperatures, the rhythms, and the cycles of their “environment” are taking a turn for the worse. They also notice the extinction, migration, or teratological mutations of sundry living species. Different peoples have different explanations for all this, but they do not “believe” in the Anthropocene. They experience it.24 Other peoples than we informed “global citizens” have different theories than ours, but they agree unanimously on a single point—your people are doing something very bad to the places we live in. You are messing with something you should not be messing with. You may be, say, digging the Earth in search of oil or metal and thus destroying its foundations; you may be sending poisonous fumes into the sky, and this will cause it to fall on us; you are cutting down the forests, and the land will become hot, barren, and lifeless. And all this is perfectly true at that level. It is not about belief at all.

The question then becomes: What do the other peoples of Gaia—those we should “make room for” but do not exactly know how, as Pignarre and Stengers (2011 [2005]) argued—what do these people I call extramoderns have to do with all this? In a sense, they have nothing to do with this—it was not their fault. They belong to that vast portion of humanity and other Terran denizens whose form of life was criminally disfigured by the technical, economic, political, and spiritual European invasion that began some 5 or 6 centuries ago. In another sense, they have everything to do with this, since they stand for a world that is disappearing, and many of them are disappearing with it. But many of these extramodern peoples have managed to survive in a world tragically transformed by an incomprehensible (at the beginning) foreign people. As we have argued elsewhere (Danowski and Vieiros de Castro 2017 [2014]), Amerindian peoples, for instance (but also African, Oceanian, Siberian), have had—are having—the experience of keeping on living after the end of their world. They are an example of the species capacity to live in difficult times. Their experience may prove useful to ourselves in the not so distant future. The present of extramodern peoples may be a prefiguration of everyone’s future.

It is glaringly obvious that the practical and theoretical ways of extramodern peoples of relating to Gaia and its other-than-human realms is far less suicidal—less entropic—than our own, the one we apparently cannot live without because it is no longer possible, historically, empirically, to live without it, never mind the stuff our dreams be made of. Are then these other ways still around just for us to recall that “once upon a time” there was life outside of capitalism and all the good and bad that comes with it? Is this all anthropology can do?

My own fieldwork, which already lies a long way behind me as regards time and place, was focused on very different subjects. Or so I thought, until I realized that Amazonian, more generally, native American cosmologies (my research focus), did have something to contribute to the debates around the Anthropocene. This realization became glaring evidence to me after I read the first sketches of what later became the book The Falling Sky, by a Yanomami shaman, Davi Kopenawa, and a French anthropologist, Bruce Albert (Kopenawa and Albert 2010). The Falling Sky is an astonishing piece of work, a powerful counter-anthropological disquisition on the culture of the Whites and a prophetic discourse on the Anthropocene—on what is soon going to happen to uríhi a (the forest), a term Kopenawa uses to translate the Portuguese mundo (world).29 As in the language of Le Guin’s Athsteans, the Yanomami word for “world” is “forest.” And as Richard Powers wrote in his recent Anthropocenic book The Overstory, “everything in the forest is forest.” Everything in the world is world (Le Guin 2010 [1972]; Powers 2018).

I can only suggest you read The Falling Sky to try and translate it into the language of Western scientific and philosophical discourse.30 Amerindians’ (the extramodern humanity I am less unfamiliar with) ways of thought, independently of the quantity and quality of “objective truths” they give access to, allow at the very minimum a commerce with reality that is less arrogant, less imperial, less destructive than the one facilitated, not to say enforced, by our cosmological vulgate. It is high time for us to seriously begin the task of translating indigenous ideas into a conceptual vocabulary that makes full sense to us—a vocabulary that does not infantilize or banalize the words (the concepts) of those foreign languages. Such vocabulary cannot replicate the original metaphysical languages of extramodern peoples. We are all “Whites” (in Kopenawa’s ethnopolitical sense); it will not do to insist on twisting our tongues to talk about spirit-masters of animals, trees with trunks covered with singing mouths, the heavenly dome falling on us: the “pluriiverse” (Blaser and de la Cadena 2018) requires an attention to—a respect of—difference. We must resort to the “controlled equivocation” method of anthropology and find the productive difference between our concepts and theirs, one capable of generating new concepts, situated in the gap between languages, the only location, it seems

28. The only people who “believe” in the Anthropocene are those who “do not believe” in it, i.e., the denialists.

29. “Whites,” in Yanomami Portuguese, as in many other Brazilian indigenous languages, has no immediate chromatic or racial meaning. It designates all non-Amerindian persons, or more generally all persons of non-Amerindian culture. The word is a “translation” of dozens, perhaps hundreds of vernacular words whose primary meaning is enemy (e.g. Kayapo kuben, Yanomami napê, Araweté awin). These words were originally used with determinatives specifying different indigenous enemy peoples (“red enemies,” “club-carrying enemies,” etc.). When Europeans arrived, they became the prototypical, unqualified Enemy. The fact that these many-colored non-indigenous enemies are called “Whites” is, of course, not without moral and historical significance.

30. For a groundbreaking philosophical “translation” of Kopenawa’s words, see, once more, Valentim (2018).
to me, where we can properly address the Anthropocene world. It is not a question of changing our beliefs or, for that matter, theirs. As Naveeda Khan (2019) said at some point during the symposium discussions, “the question is not about whether you believe or do not believe; the question is of efficacy.” Efficacy, in this sense, is not a question of technical prowess or mathematical precision but a measure of existential truth. And one of the existential truths we must consider is the truth of multiple modes of existence filling a “pluriverse” of many worlds (ethnographically diverse and multispecific) that intercept one another on an entity, Gaia, which is constituted by the entangled and discordant agency of innumerable life-forms.

“To make room for others,” as Pignarre and Stengers (2011 [2005]) proposed, certainly does not mean to take them as models for our future, moving them up from being our victims to our redeemers. The proper object of anthropology is to elucidate the conditions of ontological self-determination of other peoples, which means first of all to recognize the others’ own sociopolitical consistency, which, as such, is not transferable to our world as if it were the long-lost recipe of Earthly bliss. But it also means to accept the equivalent status of the ontological nations of other humans (and other others) and our own. The patchy Anthropocene is the ground where ontologies meet, precisely because it is ontologically patchy.

It is not a case, then, of opposing in very classic fashion “many human (and non-human) worlds but one single planet,” a variant of the multiculturallism-cum-mononaturalism Western modern vulgate. Of course “there is no planet B,” while there are N worlds on it—supposing “world” is really a countable name; for when it come to worlds, perhaps we should be talking of how much rather than of how many. But the planet Earth is not the same entity as Gaia, this discovery of the Anthropocene. Gaia “is not only a new being; it is a new kind of being” (Maniglier 2014). Gaia is unique, but it does not possess the wholeness and integrity that the usual images of the Earth as a mechanism or an organism presuppose: “Gaia is very much a patchwork and not a unified domain, sphere, region or entity . . . Gaia appears as a reticular, lacunar, dappled, distributed sort of entity for which there is no precedent, nor comparison possible . . . There is one Gaia but Gaia is not one” (Latour and Lenton 2019:670–675; emphasis removed).

Commenting on the discovery of Gaia by Lovelock and Margulis, Latour and Lenton note that “the novelty introduced in the notion of Earth by the joint efforts of Lovelock and Margulis consists in granting historicity and agency to all life forms, that is, in attributing to the life forms themselves the task of creating the conditions for lasting in time and expanding in space. It is in that sense that they can be said to obey their own laws” (Latour and Lenton 2019:664).

Gaia theory, then, seems much closer to what anthropologists used to call an “animistic” and “pluriversal” worldview than to a naturalistic or mechanistic one like the Earth of the Galileic “infinite universe” (Koyré 1968)—and of geo-engineering.

“Animism” suddenly appears as the most sensible version of materialism: a mode of attention to reality that sees “everything” as possessing a variably actualizable virtuality of agency. The translation between Kopenawa and Albert’s (2010) uruí a and Western Gaian science (for science it is) becomes possible without resource to too much hermeneutical analogy. As Maniglier (calling Gaia “the Earth”) remarked:

“Western Gaian science (for science it is) becomes possible with- out resource to too much hermeneutical analogy. As Maniglier (calling Gaia “the Earth”) remarked:

The Earth is not a transcendent identity; it is the dynamic of the diverging versions of itself. The Earth therefore only exists because it makes sense to say that the entity uncovered by the IPCC reports and the “great earth-forest” presented by Amazonian shaman Dami Kopenawa are indeed continuous with one another, which means that we have to understand how one becomes the other, without anyone being a metaphor or just a representation of the other one. (Maniglier 2014)

It so happens that many extramodern peoples also grant life (and therefore “historicity and agency”) to forms of existence we do not recognize as living. It falls to the anthropologist to elucidate what indigenous concepts we are translating by “life” before saying these peoples “are wrong” in this particular respect. They populate their worlds with agents differently constituted than the ones that inhabit ours—ours and theirs are structural transformations of one another—and these different agents largely intersect at the level of the effects they produce on the phenomenal world. And most importantly, we have to ask what difference those differences make when it comes to live (in) the Anthropocene, considering the intersection, when not the sensible convergence, of their respective effects.

A Postscript on Ontological Anarchism

What I had the temerity to name “ontological anarchism” must not be taken as synonymous with “ontological entropy.” It is, in a sense, a counterintuitive because counter-ontological notion, insofar as the concept of “ontology” in our tradition seems to repel any pluralization. There must be only one true ontology, because ontological discourse is the monological voice of Being, which is the Beautiful, the Good, and the True.

I would like to conclude these remarks on ontological anarchism with an ethnographic example, an apparently minor detail of Amerindian ontologies that may help to clarify what I mean by all this pompous ontology-talk. This detail evinces an aesthetic-metaphysical characteristic of Amerindian thought I

call “someness,” in other words, the revealingly minor role played by the universal quantifier in indigenous logics. I believe it is a common situation in fieldwork in, say, Amazonia, to be engaged in the following dialogue with an indigenous interlocutor. After he or she has stated that, for instance, “All forest creatures are people, they have souls,” the ethnographer starts:

—Oh, you mean all the creatures?
—Yes, all of them.
—Do jaguars have souls, are they people?
—Yes, they are.
—What about alligators?
—Same.
—Tapirs?
—Oh, yes.
—Ants?
—Yes.
—Guans?
—No, guans are just birds. They have no souls.

These curious exceptions are more or less random, varying according to interlocutors in the same culture or in different cultural traditions. A nice mythic instance of the same quality is found among the Aikewara, a Tupian people from eastern Amazonia. The ethnographer of the Aikewara starts the narration of their origin myth with the words: “When the earth and the sky were close to each other, there was nothing in the world except people—and tortoises” (Calheiros 2014:41). These anecdotes bring immediately to mind a passage in Hallowell’s famous paper “Ojibwa Ontology, Behavior and World View” (Hallowell 1960). Ojibwa language has animate/inanimate noun classes. Their ethnographer remarks that “What we view as material, inanimate objects—such as shells and stones—are placed in an ‘animate’ category along with ‘persons’ which have no physical existence in our world view.” Then he continues:

Since stones are grammatically animate, I once asked an old man: Are all the stones we see about us here alive? He reflected a long while and then replied, “No! But some are.” This qualified answer made a lasting impression on me. . . . The hypothesis which suggests itself to me is that the allocation of stones to an animate grammatical category . . . does not involve a consciously formulated theory about the nature of stones. It leaves a door open that our orientation on dogmatic grounds keeps shut tight. Whereas we should never expect a stone to manifest animate properties of any kind under any circumstances, the Ojibwa recognize, a priori, potentialities for animation in certain classes of objects under certain circum-

stances. . . . The Ojibwa do not perceive stones, in general, as animate, any more than we do. The crucial test is experience. Is there any personal testimony available? In answer to this question we can say that it is asserted by informants that stones have been seen to move, that some stones manifest other animate properties, and, as we shall see, Flint is represented as a living personage in their mythology. (Hallowell 1960:24; my emphasis)

So, independently of Hallowell’s linguistic-cognitive interests and with due note to his shrewd remark about our own dogmatic ontological tenets, what makes this passage interesting, in my opinion, is, first, the appearance of the “someness” phenomenon: all stones are grammatically animate; living things are grammatically animate; not all stones are alive—but some are. Second, the connection of this “some are/some are not” replies to the radical pragmatism identified by Hallowell. There is no hard-and-fast rule (perhaps not even the rule that there is always an exception to the rule) establishing what is this or that for all eternity in every case: living or nonliving, human or nonhuman, and so forth. The crucial test is experience, concludes Hallowell. And experience teaches us that we cannot generalize—because there is no dogma imposed by a transcendental code, a taxonomic nomos defining once and for all what is the being of each and every being. In short, those exceptions betray a sort of “impossibility” of presupposing a Whole, the inclusion in a closed set of all tokens of a conceptual “type.” There is no totality; universal quantification (“for all,” “given any”) seems to be maliciously violated or rejected. I take it as a sign of ontological anarchism—no All, no One, no Whole. No “all X are . . .” syllogisms. This does not mean that the Many should take the place of the One, but simply that we must have an eye for the not-one, not-all, the some. Ontological anarchism is a reminder to always leave some door open, at least one door open—the one that punctures the One. And someness inspires me to give it as an example of a style of thought that could change our own knowledge practices, an example useful perhaps to negotiate the irresolvable, because metaphysically flawed, tension between the one and the many that haunts the times and spaces of the Anthropocene. Someness is a form of unpredicting the world.

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33. The Araweté, also eastern Amazonian Tupian, also used to say that “tortoises are very ancient, they are here before everything/everyone else.”

34. Recall Alexander Luria’s notorious experiences with Uzbek peasants, whom he judged “incapable” of syllogistic deduction. “If he said to them: ‘In the Far North, where there is snow, all bears are white. Novaya Zemlya is in the far north and there is always snow there. What color are the bears?’ Luria often received a protest along the following lines: You’ve seen them, you know. I haven’t seen them, so how could I say?” (Harris 2007:209).
Déborah Danowski was a joint author of many of the arguments above.

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Plants, Politics, and the Imagination over the Past 500 Years in the Indo-Malay Region

by Michael R. Dove

This is an analysis of the way that the colonial-era model of plantation production in Southeast Asia disciplined plants and people and, of most importance, the way that production relations between plants and people were conceived. This discipline was challenged during historic moments of crisis that stimulated the imagination of alternative modes of production. The analysis will focus on the histories of three plants in particular: black pepper (Piper nigrum), Para rubber (Hevea brasiliensis), and a sword grass (Imperata cylindrica). Notable events in their histories include the proscription of pepper cultivation in the sixteenth century Hikayat Banjar in southeastern Borneo; the tribal dream of rice-eating rubber in the 1930s in western Borneo; and the contemporaneous international effort to restrict smallholder rubber cultivation; and the lengthy history of productive native management of Imperata and disbelief in such management by plantation managers and government officials. Each case represents conflict between alternative and competing systems of crop management, which consists in part in transcendent exercises to imagine, or deny, alternative systems of production. These leaps of the imagination are nourished by a focus on the human-nonhuman divide, especially during historic moments of crisis.

There are many persons in cultured communities who see nothing harmful about destruction of forest in shifting cultivation. (Bartlett 1956:709)

Industrial rubber . . . is made possible by the savagery of European conquest, the competitive passions of colonial botany, the resistance strategies of peasants . . . and much more that would not be evident from a teleology of industrial progress. (Tsing 2005:6)

The posthumanist turn and multispecies ethnography have brought attention to bear on the nonhuman, which in practice has mostly meant fauna. As Lewis-Jones (2016) writes, “Plants have all too often been relegated to the margins—their diversity and vitality obscured within generic terms such as “habitat,” “landscape,” or “agriculture” (1). The implication is that plants are too far from us to trouble our beliefs in the same way that animals can. A cat staring at Derrida (2008 [2006]) is disconcerting in a way that a geranium is not. Hall (2011:7) traces this stance to the views of Plato and Aristotle, who rendered plants as “radically different” from animals, placing them at the bottom of the hierarchy of life, where they existed for the use of human beings. In contrast, Aristotle’s pupil, Theophrastus, saw plants as “volitional, minded, intentional creatures that clearly demonstrate their own autonomy and purpose in life” (Hall 2011:7–8). Although the views of Theophrastus were largely lost for 2 millennia, some scholars now herald a “plant turn” toward the “vegetative point of view” as part of the larger ontological turn (Lewis-Jones 2016:1; Sheridan 2016:39). A systematic effort to describe what this might look like is Ellen’s (2016) survey of the field of ethnobotany and its “disjunctions of approach that could arguably be said to be ontological.”

Kohn (2013) is a seminal scholar in this field; he states his interest not in how natives think about forests—the focus of work by several generations of environmental anthropologists—but rather in how forests themselves think: “If we limit our thinking to thinking through how other people think we will always end up circumscribing ontology by epistemology” (94). For example, in one compelling passage Kohn discusses the impact on a monkey of the noise of a falling palm tree—but his analysis is not really about the tree. Also notable here is Tsing’s (2015) pioneering work on the Matsutake mushroom, which she uses as a lens to examine environmental history, global commodity production, and science.

Ortiz (1995 [1947]) did relevant pioneering work in his comparative analysis of Cuban sugar and tobacco, which raised the question of discipline (Foucault 1995): “delicacy” for tobacco versus “brute force” for sugar (xxi). The present analysis is about the history of regimes for disciplining plants and also people in the Indo-Malay region, especially during the colonial era. The archetypal disciplinary regime, upon which colonial...
rule in this region rested, was the plantation—owned by for-

eigners, set up according to foreign models of production, and
raising exotic commodities, but worked by natives. Much has
been written about the disciplining on plantations of land, 
water, plants, people—but not the imagination. Stoler (1985)
has written about the contest over how violence on the plan-
tation was imagined and represented, but no one has written
about the more fundamental and consequential contest over
how the agroecology of the plantation itself was imagined. The
political logic of the plantation, its very raison d’être, rested on
presenting its agroecology as the only rational one, the only
possible one. Essential to this logic was ruling out any alter-
native agroecology.

Work on plantations and other “concessions” has shown that
there is an epistemic imperialism to all such development
schemes (Bonneuil 2000; Hardin 2001). These schemes con-
struct bounded spaces in which exotic plants and knowledges
can flourish and in which native plants and knowledges cannot.
A tabula rasa is thereby constructed that privileges the crops
and technologies of powerful outsiders or settlers and de-privileges
the crop- and place-specific knowledge of local smallholders. The
tabula rasa permits the exercise of the imagination, to imagine
something that is not there and that does not resemble anything
that is there. This is the central conceptual project of settler co-
lonialism (Buurw, Brock, and Dove 2018), iminimal to which is
the existence of alternatives.

The disciplinary hegemony of the colonial plantations of Indo-
Malaya was great but not untroubled: some lands, plants, and
peoples escaped. In particular, the imaginations of the native
smallholders could never be entirely regulated: alternatives to
plantation-based production were constantly being imagined and
enacted. Discipline especially broke down during historical periods
of social, political, and economic perturbation, like the Great De-
pression. Disturbance of socioecological systems—which is not
peculiar to the modern era—creates space for pioneering, weedy,
“feral” plants (Tsing, Mathews, and Bubandt 2019). It creates space,
in short, for alternative socioecological landscapes, with different
possibilities for gain and loss, for different actors. Disturbance
thereby also creates space for feral ideas, for the imagination of
alternatives to hegemony. The historical product of such cir-
sumstances is agroecological patchiness, reflecting the codevel-
opment of the single vision of the plantation and alternatives to
it, state simplification and smallholder complexity, discipline and
escape from discipline.

In this study I will examine several historical moments that
illuminate this codevelopment, focusing on three of the most
controversial plants in the agricultural history of Southeast
Asia: Piper nigrum or black pepper, Hevea brasiliensis or Para
rubber, and the sword grass Imperata cylindrica. Associated
with each of these three plants has been a hegemonic discourse
from the state plantation sector regarding the way that they
should be managed and a dismissal of alternative practices by
native smallholders. These three plants are distinctive for the
markedly disparate views taken of them by state elites versus
smallholders, which reflect the capacity of smallholders to con-
test efforts to discipline their agricultural imagination. Small-
holders’ capacity to imagine alternative realities to those of elite
state actors is stimulated by their straddling the boundary between
inward-looking subsistence production and outward-looking com-
modity production.

The first section of the analysis covers the cultural, historical,
and political ecology of each of the three plants in question—
pepper, rubber, and sword grass—systematically comparing plan-
tation versus smallholder views and focusing on key historical
moments in the contest between their respective models of pro-
duction. In the next section, the ability to imagine or deny alter-
native production systems is examined, along with the particular
historic circumstances that made these exercises of the imagi-
nation possible or not. In the concluding section of the paper,
the political implications of being able to imagine alternatives
are examined, as are the circumstances that make such acts of
the imagination possible. The study will conclude with an appli-
cation of these points to the contemporary case of oil palm de-
velopment in Southeast Asia.

Important Historical Moments for Piper nigrum,
Hevea brasiliensis, and Imperata cylindrica

Key moments in the history of each of the three plants—Piper nigrum, Hevea brasiliensis, and Imperata cylindrica—clarify
the importance of the contest over alternate systems of production.

Pepper

Black pepper (Piper nigrum L.) has been important in global
trade for almost 2 millennia. Native to the Western Ghats of In-
dia, it was likely brought by Hindu colonists to the East Indies,
where for centuries it was grown first for the Chinese market
and then for the European one, which made it the dominant
commodity in global trade from the fifteenth through the seven-
teenth centuries. Sumatra and Borneo were the centers of the
pepper trade in the East Indies, and in the latter case the cen-
ter of production was the coastal Malayic kingdom of Banjar,
which existed in Southeast Borneo until the end of the nine-
teenth century.

The Banjar kingdom’s pepper drew many traders to it, fore-
most among whom were the Dutch and English. The Dutch
established a post in Banjarmasin in 1606, and in spite of Ban-
ji rese resistance and competition from the English, secured a
monopoly on the pepper trade by 1635. However, this did not
put an end to the conflict over pepper between the Dutch, the
English, and the Banjarese, which continued for the next two
and a half centuries. Armed resistance by the Banjarese against
the Dutch did not finally end until 1906.

A remarkable foretelling of this painful history can be found in
the “Story of Lambu Mangkurat and the Dynasty of the
Kings of Banjar and Kota Waringin,” more commonly known
as the Hikayat Banjar. It was written, and rewritten, between
the mid-sixteenth and mid-seventeenth centuries by three or
four separate court chroniclers, sitting in different Banjar courts at different times (Ras 1968). There is a remarkable passage in the *Hikayat Banjar* in which its founder and ruler, King Ampu Jatmaka, issues an injunction against the large-scale cultivation of *suihang* or black pepper for global markets, here translated from the Malay original:

> And let not our country plant pepper as an export-crop, for the sake of making money, like Palembang and Jambi [two kingdoms in Sumatra]. Whenever a country cultivates pepper all food-stuffs will become expensive and anything planted will not grow well, because the vapours of pepper are hot. That will cause malice all over the country and even the government will fall into disorder. The rural people will become pretentious towards the townsfolk if pepper is grown for commercial purposes, for the sake of money. (Ras 1968:265–267)

This injunction is repeated in almost identical terms by three of the kings who succeeded Ampu Jatmaka. This was not a unique case: there were similar efforts to proscribe pepper production scattered across the region—in Aceh, Banten, Ternate, and the southern Philippines.1

The scribes who wrote the Banjar court chronicles were prescient and made their rulers look prescient as well. With the basis. Regarding ings in the deathbed speech show a sound political-economic turies of pepper-related con—tions, the native smallholders of Borneo experienced a mo—ment of angst rather like that of King Ampu Djatmaka several

The smallholder dream. Incredibly, within one generation of first adopting rubber, native smallholders wrested the domin—ant market share away from the colonial plantations (fig. 1). At the same time as this was happening, during the depression years of the 1930s, when global market turmoil put pressure on the heavily capitalized and thus more fragile colonial plantations, the native smallholders of Borneo experienced a mo—ment of angst rather like that of King Ampu Djatmaka several

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1. Reid (1993:299–300) reports that early in the seventeenth century, the Sultan of Aceh ordered the destruction of pepper vines in the vicinity of the capital, because their cultivation was leading to the neglect of food crops and to annual food shortages. Reid also reports that Banten in West Java “cut down its pepper vines around 1620 in the hope that this would encourage the Dutch and English to leave the sultanate in peace,” and the Sultan of Magindanao in the Philippines told the Dutch in 1699 that he had forbidden the continued planting of pepper so that he could avoid conflict with foreign powers.

2. *Hevea brasiliensis* is commonly called Para rubber after the state of Para in northern Brazil, which was one of the historic centers of rubber production.
centuries earlier. This moment came in a dream, the gist of which was as follows: “Rice that people were drying in the sun kept disappearing. Then one day the people found this rice in a hollow rubber tree that they felled to use for firewood.”

The tribal Dayak of Borneo traditionally have regarded dreams as omens sent to them as communications from the spirits. Dreams can affect the decision whether or not to undertake a journey, what type of work to do on a given day, and where to locate a rice swidden. An inauspicious dream can provoke a community-wide discussion, proscription of all work that day in the swiddens, and staging of a prophylactic ceremony that even-tering to protect the community’s inhabitants from harm (fig. 2).

Dreams that are deemed to be particularly meaningful are not only told to other members of one’s own household or community, but they may be disseminated to other communities as well—as was the case with the dream of the rice-eating rubber.

The dream-image of the exotic rubber plant threatening the native and ritualized rice would have been a highly charged one because of traditional beliefs linking the welfare of the sacred rice plant to the welfare of the people who plant it, care for it, and eat it. As a result, public telling of the dream spread widely throughout the interior of central and western Borneo, which was impressive at a time when almost all communication was by word of mouth. Hearing news of the dream caused great consternation among the Dayak, so much so that in a minority of cases they actually felled their rubber trees upon hearing of it.

The dream calls attention to the vulnerability of the rice base at a time of increasing involvement in commodity production and to the need for vigilance in protecting this subsistence base against the ill consequences of such involvement. The literal meaning of the dream of the rice-eating rubber is that rubber can eat rice; the metaphorical meaning is that over-involvement in rubber production could threaten the long-term commitment to rice cultivation. The dream was not simply about rejecting an alien, New World cultigen: the Dayak had adopted rubber with alacrity, just as they had earlier adopted maize (Zea mays) and sweet potatoes (Ipomea batatas). The dream was about the complexities of market entanglement.

The plantation nightmare. At the very time that the Dayak were hearing news of the rice-eating rubber, the colonial powers in the region were experiencing their own rubber-related angst, focused on smallholder producers. As one colonial observer disingenuously stated the problem:

Rubber raised in an extremely acute form one of the most serious problems connected with colonisation, namely competition between Europeans and peasant producers, one armed with his capital, proud of his organisation and technique, and helped by his knowledge of the market; the other having the advantage of a low standard of living and securing unexpected profits from casual and slovenly cultivation. (Robequain 1955 [1946]:355)

The colonial plantation sector viewed smallholder rubber not only as casual and slovenly but also as a source of disease. The colonial disparagement of smallholder production led to draconian regulatory responses, most notably the International Rubber Regulation Agreement (IRRA). Enacted by the Netherlands, Great Britain, France, India, and Siam in 1934 and lasting for a decade, the IRRA was in theory designed to stabilize the world rubber market by limiting production through taxation, imposition of sales quotas, prohibition of planting, and the compulsory felling of rubber trees.

In practice the IRRA was a desperate effort to protect the colonial plantations’ initially dominant role in the rubber industry from the unexpectedly competitive smallholder sector, through imposing the burden of price stabilization largely on the smallholders—all to little avail. Smallholders could establish rubber for less than 10% of the plantation’s costs by integrating the rubber into their swidden cycles and using few if any capital inputs. In addition, because the smallholders could exploit their own household labor and because they did not have to depend on rubber for their daily subsistence, they were willing to tap

3. As Ross (2017) writes: “There was, as contemporaries remarked, something of a mania for tidiness and order on the foreign-owned plantations, which partly derived from the quest for operational efficiency but which also undoubtedly reflected a deep-seated cultural desire to achieve mastery over a wild and undisciplined tropical nature” (205).
rubber for prices that were as little as one-fifth of those that the plantations required to be profitable. In short order the smallholders “ate” most of the plantations’ market share, a position that they have held to this day: in 2016 smallholders accounted for 85% of the area under rubber cultivation in Indonesia and 82% of total rubber production (Badan Pusat Statistik 2016). Thus, the colonial disparagement of smallholders was an accurate perception of smallholdings that attack plantations, a perception of “plantation-eating smallholdings.”

Imperata

The third plant in this analysis is the sword grass Imperata cylindrica (L.) Beauv., of which MacDonald (2004) writes, “Cogongrass [a term of Philippine origin for Imperata] is found throughout the world, virtually on every continent . . . and is reportedly established on over 500 million hectares worldwide. . . . Estimates of infestation in Indonesia range from 8.5 million hectares . . . to over 64 million hectares” (370, 371). Imperata could be considered a commensal or “companion species” for human beings (Haraway 2003), much like those described in Kirksey’s (2015) “emergent ecologies,” but the “wreckage” with which Imperata is associated is not a product of the twenty-first century.

The smallholder view. Imperata is native to Southeast Asia and was an ancient part of the region’s cultural ecology. It is mentioned in the medieval court literature of Java (Pigeaud 1960–1963, vol. 4:160), but it was known to native societies well before that: Wolff (1994:516) suggests that the common Indo-Malay name for Imperata in the region (alang or alang-alang) has roots in the proto-Austronesian language. The antiquity and cultural importance of Imperata is suggested by the role that it plays in traditional ritual throughout the region. Hadiwidjojo (1956) quotes a traditional Javanese saying, “God lies in the tip of a stalk of Imperata” (6), referring to the fact that stalks of Imperata were traditionally used to sprinkle holy water during Hindu ceremonies. To this day, Imperata is used in most domestic rituals in Central Java, for example in marital ceremonies, when it is placed under the mat on which the bride and groom kneel (Carpenter 1987). The traditional symbolic importance of Imperata in Southeast Asia is attested to by its role in myth, for example, among the Toraja of Sulawesi (Bartlett 1957:10–11).

Native groups in the region value Imperata as cattle fodder when young, as a source of thatch when mature, and as an agricultural fallow cover. As a ground cover, attitudes toward Imperata vary according to how closely it resembles the desired fallow period vegetative cover. The greater the dissimilarity, the greater the degree to which grassland opposes versus supports the underlying vegetative dynamics of the agricultural cycle, the greater the amount of labor that must be devoted to managing it, and the more negatively it is viewed.

In practice, views of Imperata may vary even within a single group’s territory, which might include not only fields but also pastures, forests, and so on. As Conklin (1959) notes in his study of the Hanunóo of Mindoro in the Philippines: “Imperata cylindrica and Saccharum spontaneum are viewed as agricultural pests in one context (viz., a newly planted field) and all efforts are directed toward eliminating them, but they are viewed as economic necessities in other contexts (e.g., grazing lands), and all efforts are directed toward conserving them” (60). Among the contemporary Banjarese of Southeast Borneo, descendents of the earlier-mentioned sultanate, the presence of Imperata is interpreted as a sign of arable soils in the parts of the village territory closest to the village and most intensively cultivated (Dove 1986). The Banjarese see the growth of tall stands of Imperata, as opposed to the growth of prostrate grasses, as a sign that—in their system of grassland cultivation by hoe and plow—the fallow period has been sufficiently long to allow the land to be tilled again (fig. 3). In the more distant and less intensively cultivated parts of the village territory, however, they regard Imperata as a pest.

The plantation view. Many historic native states in the region, for example, in Java and Borneo, actively managed Imperata grasslands for hunting, grazing, and thatch. With the advent of large-scale, heavily capitalized, plantation-based production of export commodities like rubber and sugar, a different view of Imperata developed. These plantations were developed along
a European versus native model, in which the natural dynamics of *Imperata* represented an impediment to land management as opposed to an asset. *Imperata* came to be seen as one of the most notorious pests on plantations. Beyond the plantations, it came to be seen as, at best, an unproductive wasteland and, at worst, as an environmental hazard, due to the belief that it supports intense fires and promotes erosion (Bradley, Wilcove, and Oppenheimer 2010:1857; Holm et al. 1977:68; Lippincott 2000; MacDonald 2004:371). This plantation-based worldview made *Imperata* into a never-ending object of government efforts at suppression and reclamation, often through attempts at reforestation; and a generation of research before World War II and another following it has been devoted to these ends, typically with little to show for it.

The view of *Imperata* from the plantation sector has been shared by most plant and crop scientists. For example, Bryson and Carter (1993) state that “Cogongrass is an aggressive, pernicious, rhizomatous perennial in the *Poaceae* (Gramineae)” (1005). Holm et al. (1977) famously ranked *Imperata* as “the 7th worst weed in the world,” writing that “The plant must be regarded as a major menace in the high rainfall areas of the tropics. . . . It is . . . the worst perennial grass weed of southern and eastern Asia” (62). Their sweeping denunciation of *Imperata* is cited and repeated in much of the subsequently published literature on the plant. For example, MacDonald (2004) writes “Cogongrass is one of the most troublesome and problematic weedy species throughout the tropic and subtropic regions of the world” (376).

Southeast Asian smallholders typically refer to *Imperata* with nonpejorative terms, like *lalang* or *alang-alang* in the Indo-Malayan region or *cogon* in the Philippines, regardless of whether they see it as a boon or bane in their particular agroecological system. In contrast, references in the scientific literature— influenced by the long history of research focused on controlling *Imperata* on plantations—are much more subjective. As noted above, Holm et al. (1977:62) call it a “menace” and a “weed.” The subtitle of Bryson and Carter’s (1993) article on *Imperata* is “Weed Alert.” MacDonald (2004) repeatedly calls it a “troublesome and problematic weedy species,” and he notes that the US Department of Agriculture has placed it on the Federal Noxious Weed list (367, 373). These scholars underline the pejorative character of the “weed” label by commonly referring to *Imperata* growth as “infestations” (Bradley, Wilcove, and Oppenheimer 2010:1857; Bryson and Carter 1993:1005; MacDonald 2004:371). More generally, throughout colonial as well as postcolonial times in Southeast Asia, central governments have disparaged *Imperata* grasslands as “wastelands” or something similar. Even the anthropologist Clifford Geertz (1963:25), an otherwise astute observer, described the *Imperata* grasslands of Indonesia as a “green desert.”

**Imagining an Alternative**

Some of the actors involved in these historical events were able to transcend tradition, orthodoxy, and even empirical facts to imagine alternative systems of production, and some were not.

**Pepper**

Consider the rulers of Banjar. The pepper trade mentioned in the Hikayat Banjar was part of an ancient trading tradition, the importance of which is reflected in the fact that the presence of foreign traders is cited throughout the Hikayat as a sign of a healthy kingdom. A typical line is, “The country was bustling and prosperous, and foreign traders also came in great numbers” (Ras 1968:335, 231, 373). Even King Ampu Jatmaka, who repudiated the pepper trade on his deathbed, is also reported to have said, “In my heart I still take pride in considering myself as nothing but a prominent merchant” (Ras 1968:229, 231, 267–268).

The Banjar kingdom’s trade initially focused on forest products, the oldest trade goods of the archipelago. But at the beginning of the seventeenth century there was an efflorescence in the Banjar trade in pepper, and it became their most valuable export commodity, which literally put the kingdom on the map for the European powers. “Banjarmaseen” first appears on European maps at the end of the sixteenth century, and it was one of the first place names within Borneo to do so, reflecting its importance to European traders. The German cartographer Herman Moll’s 1708 map simply lists the Banjar region as “Pepper country” (fig. 4).

Given this history, for successive rulers of Banjar on their putative deathbeds to urge their subjects to abandon their foremost trade good represented an extraordinary leap of imagination; this represented an effort to imagine a very different reality for the kingdom, in effect an alternative reality. The rulers noted the downfall of the pepper kingdoms of Sumatra and made explicit their desire to avoid that fate. That desire can be contrasted with the centuries-long effort by the Dutch to forcibly impose a monopoly on the Banjar pepper trade, which represented one such effort to deny any alternatives to the Banjarese. How were the Banjarese able to articulate an alternate vision? Political insight, sharpened by the chaos and conflict of the colonial encounter surely played a part, as did the liminal context of the royal deathbed, which lent authority to such a transcendent vision as abandoning the pepper trade (cf. Turner 1967).

**Rubber**

In a similar fashion, the dream of the rice-eating rubber represented an extraordinary effort to read the image of rice in a
cavity in a rubber tree as a vision of a future in which rubber threatened subsistence rice agriculture. This threat has been borne out by the modern histories of smallholders around the world, including in Borneo itself, but at the time of the dream there was little evidence to back this up. The tribal rubber cultivators did not have cautionary examples—as the Banjar ruler had with the failed pepper kingdoms in Sumatra—to point to and learn from. They did have their prior history of gathering native forest rubbers as a reference point, and the market manias and attendant degradation of some native rubber resources that characterized this sector late in the nineteenth century may still have been remembered. But this is all there was, so the ability of the tribal smallholders to imagine a threat to rice subsistence in the 1930s, and to do so with sufficient conviction to imagine an alternative, in which they did not overcommit to rubber and abandon rice, represents an impressive exercise of the human imagination.

How were the tribespeople able to accomplish this? As was the case during the seventeenth-century colonial assaults on the Banjar kingdom, the 1930s were an unsettled time even in the interior of Borneo. Although the instability in the global rubber markets may have favored smallholders like the Dayak, they still experienced directly the full force of the regulatory response (the IRRA) from the rubber powers. Indeed, decades later many Dayak still called this the jaman kupon (coupon era), after the coupons that the Dutch issued to regulate the number of rubber trees that the Dayak could have. In the context of this political-economic tumult, the dream, like the seventeenth-century deathbed in Banjar, provided a liminal context in which prevailing wisdom could be questioned and alternatives could be envisioned.

As smallholder rubber cultivation exploded and threatened their market share, the plantation sector developed a detailed, albeit fanciful, critique of it. This critique focused on the myriad ways that the smallholdings differed from the plantations, which colonial planters and officials thought would lead to disease, degradation, and inefficiency. First, smallholder rubber gardens presented a very different appearance from the orderly plantations: not only did they deviate from the regular geometric layout of plantations, but they were characterized by planting densities over...
twice as high as those on plantations, the absence of clean weeding, and spontaneous coverage of the rubber groves by secondary growth during periods of nontapping (fig. 5). As a result, colonial planters believed that the smallholdings were subject to “rampant root disease,” which was proving to be a serious problem on European plantations at the time, and they thought that the source of this disease was the smallholdings. This specter of diseased smallholdings was used to help justify the IRRA.5 Second, the smallholdings were giving yields that equaled or surpassed those on plantations. Colonial observers attributed these suspiciously high yields to purported “efficient producers.” The guarantee of a “reasonable return to the average efficient producer” was the purported and oft-repeated official purpose of the IRRA, and the denigration of the smallholders on these grounds was, again, part of the justification for the measures undertaken to restrict smallholder production.

When surveys of the smallholdings were eventually carried out, the evidence gathered did not support the official view: almost no evidence of root disease was found, and the rate of bark usage was found to be well in line with the rate of bark production. And when the Rubber Manufacturers Association—representing the principal international buyers of rubber (including the US) and thus inclined to be skeptical of the motives behind the scheme to “stabilize” rubber prices—demanded a definition of an “efficient producer” from the IRRA, the latter merely replied that “Efficient producers are those who produce efficiently.” In fact, the IRRA protected the least efficient producers, the heavily capitalized plantations with their high overheads; and it penalized the true efficient producers, the smallholders.

The plantation sector’s negative depiction of smallholder rubber cultivation represented as great an exercise of the imagination as the Dayak dream or the Banjarese deathbed speech, indeed greater, given its lesser connection to reality. What accounts for such an act? For the plantation sector, the 1930s were not just an unsettling time but a time in which the established world order seemed to be turned upside down. On the global scale, the logic of the capitalist world system was challenged. On the local scale, in the East Indies and Malaya, plantation companies were crippled or bankrupted. The wondrously profitable and powerful plantation sector was challenged by an incomprehensible smallholder system of cultivation, the productivity of which the plantation managers literally could not comprehend. As Ross (2017:211) writes, “The idea that certain smallholder techniques, however disorderly they may have appeared, were not only cheaper to operate but also agronomically preferable was deeply unsettling.” So for plantation managers too, this era of challenge to the accepted order of things, this era of failure of orthodoxy, was also liminal in character. As in Turner’s (1967) conception of liminality among the Ndembu, this was for the plantations a time of disorientation and transition, and its central symbol—like the multidimensional milk tree of the Ndembu (Diplorrhyncus condylocarpon)—was the rubber tree, a source of wealth on the plantation and a source of disaster on the smallholdings.

Imperata

*Imperata* also has been the object of great exercises of the imagination, especially regarding its stability versus instability and the role of people therein.

**Stability and human agency.** An assumption of instability is at the heart of many systems of traditional grassland management. For example, after the Banjarese of southeastern Borneo crop *Imperata* lands in dry rice for a number of years, it will succeed to prostrate grasses, and so they fallow it, which allows *Imperata* to return. But if they fallow it too long, the

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5. The reputation of Indo-Malay rubber groves for disease even impacted efforts to export their seedlings to other parts of Southeast Asia (Aso 2009:243).
Imperata will succeed to brushy growth. The principal management tool that the Banjarese employ to prevent succession to brush is an annual burn. Their management objective, therefore, is to maintain an arrested state of Imperata grassland succession, based on the premise that the Imperata will disappear without human intervention. As Sherman (1980) wrote in his study of the Batak grasslands of Sumatra, “It can be said that, in some sense, grassland is protected [by the Batak] from progressing through bush to forest fallow” (140).

Precisely the opposite view of Imperata (and other) grasslands has long been held in the plantation, government, and even research communities, namely that Imperata grasslands are a tenacious, stable community that will not disappear without human intervention. This view is held notwithstanding the reversal in the academic understanding of grassland ecology over the past half-century as a result of the shift in the natural and social sciences from an equilibrium-based to a non-equilibrium-based paradigm. Whereas most scholars once saw grasslands as exemplars of ecological stability, most now see them as just the opposite, as models of instability and disturbance (Laris et al. 2015; Worster 1990:10). In this sense, the science has caught up with native views of Imperata as vulnerable and unstable. This shift in the science has had little effect on development policy toward Imperata in places like Indonesia, however, where attention is still focused on how to get rid of these grasslands, with little if any thought given to how they came to be there in the first place. Native land managers assume that if Imperata is present, it reflects human intention: the Imperata is there because someone wants it there. In contrast, within governmental bodies and even in international development agencies, human intention in creating or preserving Imperata grasslands is rarely if ever acknowledged.7

Origins and values. Native beliefs in the role of human intention in Imperata grassland ecology are reflected in folk mythology in Indonesia regarding the origins of these grasslands. Most Indonesian communities living in or near substantial Imperata grasslands possess oral histories of their origins (Dove 1986). For example, the tribal Ogan of South Sumatra trace the origins of Imperata in their territory to the arrival of the Portuguese, which ushered in the colonial era. Central Javanese peasants on Merapi Volcano trace the origins of Imperata there to the Islamic apostles of historic Java. The political authority cited in each case is the first to have a large-scale, transformative impact on the environment. Thus, Java’s historic Islamic courts, with their focus on inland farming and forest clearing are cited, as are the European colonists on Sumatra, the first actors to trigger a massive impact on that island’s natural vegetation. Imperata, a colonizing grass, is the perfect indexical plant for colonizing landscape transformation.8

Native land managers in Indonesia view Imperata as good in some contexts and bad in others. In contrast, the view in plantation, government, and development circles is essentialized: Imperata is simply bad. This negative view of Imperata is, like the colonial-era views of smallholder rubber, impervious to empirical evidence, which lends a schizophrenic quality even to some academic studies of the grass. For example, Holm et al. (1977) denounce Imperata as “a major menace” and “the worst perennial grass weed of southern and eastern Asia” (62), while noting in the same article native use of the grass for fodder and thatch, as well as its usefulness in controlling erosion. MacDonald (2004) similarly excoriates Imperata while also recognizing its use as fodder, noting that this was the reason for its introduction to the southern United States.

There is an imaginative dimension to views of Imperata among peasants, on the one hand, and on the other, plantation managers, government officials, and even some academic observers; but the former are more rooted in political-ecological reality, whereas the latter are influenced by the anomalous fit of Imperata with western agricultural models. Thus, Imperata is usually not planted, but it is managed; and it is a pest in some places but a valuable resource in others. There is no analogue to it in the more deterministic western agricultural models that prevail in the plantations. Of most importance, plantation and government actors regard Imperata as simply good or bad, not good or bad for one actor versus another, for example, for smallholders versus plantation managers. This denial of alternative views of Imperata is critically important to the appropriation of Imperata grasslands by state elites.

Summary and Conclusions

Summary

I began this analysis with a review of the relative inattention to plants in posthumanist, multispecies ethnography. Citing the work of Ortiz among others, I proposed to analyze plant-based disciplinary regimes in the Indo-Malay region during the colonial era, especially those enacted on plantations. Nothing was more essential to the logic of colonial plantations than denying the possibility—the very imagination of the possibility—of alternative modes of production. Historic moments of disturbance created opportunities for such exercises of the imagination, and I proposed to track these in the histories of three of the region’s most contentious plants: black pepper (Piper 6. One of the greatest threats to such grasslands is simply the passage of time which, in the absence of continued human intervention, can result in a process of vegetative succession that replaces the pioneering, quick-growing, and sun-loving Imperata with slower-growing, more shade-tolerant woody vegetation.

7. Most external observers today note the role of fire in maintaining Imperata grasslands, but few if any acknowledge that this is an outcome that is intended by local grassland managers.

8. Analogous folk histories are widespread in the region: e.g., Imperata has been called “European grass” in North Borneo in the belief that Europeans introduced it there to feed their cattle (Roth 1896, vol. 1:405).
systems of production; and I examined what conditions involved with these plants transcended tradition, orthodoxy, and even empirical reality to imagine, or not imagine, alternative histories of each of these three plants, which was essentially conflict over the validity of alternative systems of crop management. In the next section of the paper, I reexamined each of these historic events as moments in which the actors involved with these plants transcended tradition, orthodoxy, and even empirical reality to imagine, or not imagine, alternative systems of production; and I examined what conditions—an existential political threat articulated within the context of human-plant relations—are conducive to such leaps of the imagination.

Conclusions

Settlement and the imagination. All three of these plants’ histories represent examples of settler colonialism, in which native societies and systems of crop production are displaced by foreign societies and systems of production. This displacement is all about difference: incoming settler systems of production are never the same as the ones they displace. Integral to the logic of settler colonialism is demonstrating that it is non-native, that it is different from the native, and indeed, that it represents the only rationale mode of production. The possibility of alternative systems of production (namely, other than the settler system) threatens the logic of settler colonialism, so the settler focus is on disputing the goodness of native systems of production. A key to the working of settler colonialism, in short, is a thorough-going displacement of native concepts of production with the concepts of the settler society. Settler colonialism of the sort described in this study operates through a reworking of not just the physical landscape but also the conceptual landscape.

Resistance to the conceptual basis of settlement colonialism is intentionally intellectually challenging. It requires a huge exercise of the imagination. Certain historical circumstances seem to be more conducive to this exercise than others, in particular those that disturb the norms of daily existence. Both the early colonial encounter and the global tumult of the depression years seemed to be fertile ground for fantastic trains of thought regarding both the possibility and impossibility of alternate ways of life. Such times make the contingency of hegemonic systems both more visible and more susceptible to manipulation. When such circumstances enabled smallholders to imagine alternative modes of production, this undermined disciplinary structures and changed power relations.

Some discourses seem to be more conducive to flights of the imagination than others. Those discussed here include humoral thought (the hot vapors of pepper), alimentary principles (the rice-eating rubber), and imagery of disease (the smallholder rubber) and infestation (Imperata). It does not seem an accident that they involve people and plants, which is to say people and nonpeople. As von Uexküll (2010 [1934]) argued, the difference between species in their perceived worlds or umwelten is the quintessential case of ontological difference. It makes sense, therefore, that contemplation of the human-plant divide facilitates contemplation of conceptual divides in systems of agricultural production. As Feinberg, Nason, and Sridharan (2013) write, “One of the greatest strengths of multispecies ethnography is the ‘speculative wonder’ captured in its ontological revisions, a wonder ripe with potential to generate alternative ethical possibilities for living in the world” (2).

The case of oil palm. The approach taken here can be applied to the contemporary case of oil palm. There has been a vast expansion over the past generation of oil palm (Elaeis guineensis Jacq.) cultivation in the Indo-Malay region (Byerlee, Falcon, and Naylor 2017; Carlson et al. 2012). As with pepper and rubber, one of the most important characteristics of the plant at the center of this industry is its non-native origin: oil palm is an exotic from West Africa, first introduced to the East Indies in the second half of the nineteenth century.

Oil palm has been developed by the para-statal plantation sector in Indonesia and Malaysia strictly as a plantation crop. Governments have supported smallholder cultivation of oil palm only when attached to plantations: a succession of government projects over the past half-century, called nucleus estates, credit cooperatives, and partnerships, have organized smallholdings around an inner estate core, upon which they are dependent for credit and processing of their oil (Potter 2016:321–324). Independent smallholdings have been routinely appropriated by oil palm estates, resulting in widespread disruption of and conflict with rural communities (Cramb and McCarthy 2016; McCarthy, Gillespie, and Zen 2012; Potter 2016).

This exclusive emphasis on the estate model of development ignores the history of smallholder cropping in its African homeland (van Allen 1972); it ignores the robust history of smallholder commodity production in the region (Dove 2011); it ignores the fact that 80% of contemporary oil palm production comes from smallholders in Thailand, the region’s third largest producer; and it ignores the spontaneous adoption of oil palm by smallholders, independent of government schemes, across Malaysian and Indonesian Borneo, by 2013 reaching 42% of total acreage under oil palm (Byerlee 2014; Cramb and Sujang 2013; Potter 2016). The emphasis on estate versus smallholder development of oil palm development directly benefits the plantation establishment in several ways: it reduces market competition from smallholders; insofar as this underpins land-grabbing by the plantation companies, it frees up land for plantation ex-

pansion; and it creates a cheap labor pool for the plantations (Li 2017).

Byerlee (2014:591) attributes the dominance of the estate model to factors similar to those that favored it during the colonial era: high commodity prices, a convergence of state and investor interests, and a high modern belief in the virtues of agribusiness. Some observers regard the oil palm development as a quintessential example of "land grabbing" or "accumulation by dispossession," which suggests a process of forceful assault on the traditional rights of local peoples (Gellert 2015; White et al. 2012). Before the physical landscape can be grabbed, however, the conceptual landscape must first be secured; before local people can be dispossessed, work must be done so that it does not appear like dispossession is at issue (Bissonnette 2013). The primary conceptual work of land grabbing and dispossession involves ruling out any possible alternative model, which explains the ease of smallholders from modern oil palm development, just as has been done with other smallholder agricultural systems over the past half-millennium.

Smallholders contest this marginalization not only by planting oil palm themselves but by grasping head-on with the conceptual threat it represents. An example is the "rumor panics" that periodically sweep across Borneo's new oil palm landscapes, warning of strangers who are kidnapping Dayak to traffic in their organs, which has led in some instances to the murders of outsiders (Semedi 2014). Fear that market representatives from the wider world are stealing their organs can be read as a fear of an incommensurate and fatal exchange, which in many respects resembles the historic deathbed speech against pepper or the rice-eating rubber dream. This is fear of the biopolitical discipline of the plantation model of production and an inchoate cry for an alternative.10

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10. Cf. the analysis by Montefrio, Ortizga, and Josol (2014) of imaginaries concerning oil palm that migrant laborers bring back to Palawan in the Philippines from plantations in Sabah, East Malaysia.


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Filthy Flourishing
Para-Sites, Animal Infrastructure, and the Waste Frontier in Kampala

by Jacob Doherty

Thousands of marabou storks occupy Kampala, nesting in the city’s green spaces and eating up to 2 kilos of organic matter daily, mostly rotted garbage found in the city’s open dumps. Weedy birds, they flourish amid Kampala’s garbage crisis. Storks are both waste infrastructure and waste themselves, rendered disposable by the same state-centric views of infrastructure that make informal waste pickers precarious, and cast out from the imaginary of a clean, green, urban future. Theorizing animal and informal infrastructures together as “para-sites,” this paper follows marabou storks through Kampala’s ever-shifting waste frontier: the postconsumer equivalent to the extractive frontier that subtends the capitalist fantasy of endless growth. Kampala’s topography, hydrology, and class structure ensure that trash flows downhill, accumulating in slums where it leads to flooding and outbreaks of cholera, typhoid, and other waterborne illnesses as well as to endemic malaria. Waste with wings, marabou storks remake the urban waste landscape, undermining efforts to stabilize the city’s ultimate sinks in landfills, slums, and wetlands as they flourish in filth and defecate in the heart of greenness.

In his series Midway, photographer Chris Jordan shows dead and dying albatrosses with bellies full of disposable plastics from the Pacific garbage patch.1 An elegy for nature, these images illustrate the slow interspecies violence of the Anthropocene. I was reminded of Jordan’s images walking across the campus of Makerere University one afternoon in 2013. In the shade of one of the many trees that make Makerere an oasis of cool and green in the bustling city, I smelled and then saw a carcass on the ground, and 20 meters later, at the foot of another tree, another. The carcasses were marabou storks (kaloli in Luganda), enormous birds reaching up to one and one-half meters tall and weighing 9 kilos that roost in the campus’s trees, soar through the city skies, and roam its dump sites.

Marabou storks have a nightmarish, insect-like charisma (Lorimer 2015:35–55). While their size and upright stature invite anthropomorphism, this possibility is undermined by their sheer alterity—ungainly proportions, a robotic gait, the protruding fleshy air sac dangling beneath their foot-long beaks. Bizarrely other, yet somewhat familiar, these are uncanny creatures with monstrous faces who, in the course of Kampala life, lack “face”—the Levinasian ability to elicit an ethical response. Moreover, they themselves are largely unmoved by immediate human presence, content to walk and wander along roadsides and busy sidewalks or amid the comings and goings of dump trucks at the municipal landfill. Like Jordan’s albatrosses, marabou storks are trash eaters. Unlike the Midway birds, they are flourishing, feasting on the city’s filth. Marabou storks are weedy creatures (Tsing 2005:174–176), unplanned inhabitants making the most of marginal anthropogenic patches. However, the carcasses on campus are evidence of the ambivalence of the socioecological niche that these creatures occupy. They died not because of pollution but as pollution (fig. 1).

This paper examines the material and ideological infrastructures that enact marabou storks as pollution, situating these carcasses within the changing contours of animal and human belonging in contemporary Kampala. Learning from storks, and following them through the city’s wastelands, I track the patchy ecologies and economies that sustain the municipal waste stream, theorizing these patches as “para-sites”: spaces of heterogeneity that exceed the best-laid plans of municipal waste managers and give rise to new waste frontiers. In doing so, I illustrate the sheer amount of work that goes into the construction and maintenance of sociotechnical systems. In addition to being accumulations of capital, dead labor in the Marxist sense, infrastructures are also vitally constituted by living human and more-than-human labor (Fredericks 2014; Reno 2015). The aim here is to understand urban infrastructures as multispecies workplaces, constituted through the dynamics of simplification and proliferation characteristic of the patchy Anthropocene (Tsing, Mathews, and Bubandt 2019). I argue that storks are both waste infrastructure and waste themselves, rendered disposable by the same state-centric views of infrastructure that make informal waste pickers precarious,


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cast out from the imaginary of a clean, green, urban future. While never fully completing its projects, the modernizing municipal imaginary enacts a multispecies form of infrastructural violence: a series of violent simplifications that undercut the ability to recognize and respond to the multiple forms of infrastructure that constitute the city.²

Para-Sites

Contemporary Kampala is undergoing a dramatic process of techno-political transformation, as the Kampala Capital City Authority (KCCA) embarks on an ambitious program to transform urban governance, improve infrastructure, regulate the informal economy, and bring order to a city they approach as chaotic and unruly. Waste is at the center of this contested transformation, a process of urban ordering widely resented and resisted by many participants in the informal economy, residents of the city’s slums, workers in the transportation industry, and populist politicians. The KCCA’s first priority after its formation in 2011 was tackling Kampala’s waste crisis, founding its authority on promises of a clean and green future and relying on sustainability discourse to manage the contradictions between economic development, urban growth, and environmental degradation. Rationalizing waste management—through a combination of standard-issue international like public-private partnerships, along with municipal investments in new equipment, and experiments in neighborhood “self-loading” techniques—emerged as a way to try to stamp the KCCA’s authority on urban space that was becoming increasingly politically ungovernable (Doherty 2019). The KCCA’s aim was to take full control of the waste stream to increase collection rates from 40% and, in so doing, demonstrate the efficacy of a new regime of technocratic authority.

Kampala’s new official waste stream is predicated on the idea of “away,” on the fantasy of disposability. Municipal policy seeks to move waste from source to sink via sealed streams, handled by authorized municipal workers or licensed private companies. This waste stream is no easy achievement; it takes work. This work is widely distributed in space, time, and species, extending from the everyday intimate practices of domestic waste disposal to capital-intensive mechanized weekly collections. The spills from this stream—such as the filthy feasts that sustain marabou stork colonies or municipal loaders’ illicit access to recyclable materials sorted and separated inside trash trucks and sold en route to the landfill—are not simply unofficial

Figure 1. Marabou storks dead on a campus lawn (left) and roosting on a rooftop near Makerere University (right). (Photos by Jacob Doherty.)

² Infrastructural violence refers to the interconnected ways that infrastructures participate in slow and structural, as well as more traditionally conceived, forms of violence (Rodgers and O’Neill 2012). First, infrastructures are targets of violence, as in the case of bombings targeting train stations (Rao 2007) or US missile strikes on Syrian airstrips. Second, infrastructures can be the means by which structural violence takes place, be it through forms of explicit exclusion, as in the famous example of Robert Moses’s bridges designed to keep public buses and thus black and low-income New Yorkers from accessing public recreational facilities (Winner 1980); the planning of hazardous and unwelcome infrastructures like incinerators; or the uneven provision of services like water, electricity, and sewerage. Third, infrastructural violence refers to the forms of displacement that occur when informal infrastructures are criminalized (Doherty 2017). As with the concepts of structural and slow violence, infrastructural violence emphasizes the ways in which these forms of violence rarely constitute events and become naturalized background conditions of everyday life. The concept offers added emphasis on the materiality of these processes and their complex imbrication in forms of planning, regulation, privatization, and normative narratives of urban life and urban futures.
deviations but vital para-sites that sustain and subsidize the official waste stream.³

Rather than expose the fantasy of “away” as a falsehood, my aim here is to explore the worlds it constitutes. Building on Michel Serres (2007), I identify these worlds as para-sites: “sites” in order to emphasize the importance of space and location, although these are also often spatially diffuse practices rather than stable locations, and “para” in order to emphasize the relation of proximity, of being beside. As Eve Sedgwick notes, “beside” is a helpful alternative to the linearity and assumed hierarchies of dualistic prepositions such as above/below or ahead/behind, prepositions that “turn from spatial descriptions into implicit narratives of, respectively, origin and telos” (2003:8). In this way para-sites offer a useful way of thinking about infrastructures, be they material, human, or animal. Rather than uncovering a hidden world below, positioning a sturdy material base upon which an ideological superstructure is erected, or signaling residual practices bound to give way under the weight of modernization, thinking through para-sites brings into focus the multiple world-making projects that take shape alongside one another, albeit in unevenly valued and violently egalitarian ways.⁴ As spatial fragments made in relation to other sites (Tsing, Mathews, and Bubandt 2019), para-sites reveal the patchiness of urban infrastructures and economies. Para-sites are contact zones that exist with and alongside mainstreams, although hardly on equal terms, facilitating flows while diverting materials toward unanticipated ends. Rather than a category of place or person, however, para-sites should be understood as a mode of relation.

The term “para-site” has other resonances, of course. “Para-site” can refer to organisms that sustain themselves at the expense of a host, or to individuals who rely upon others and offer nothing in return. These biological and social definitions have great everyday currency in Uganda. The term “para-site” was available for my interlocutors in Kampala in this conventional sense to label middlemen and traders seen to be exploiting the labor of impoverished others. Long before Idi Amin’s “war of economic liberation” and the 1972 decree expelling them, this rhetoric was also used to demonize Ugandan Asians, framing accusations that Asian traders were a parasitic, foreign, and disloyal community engaged in economic malpractice, blocking African economic advancement, and exploiting the African peasantry (Kasozi 1994).² Similarly xenophobic rhetoric has recurred recently in Kampala in “environmentalist” protests against a proposal to give parts of Mabira Forest to a Ugandan-Asian family to develop into sugar plantations (Cole 2013).

To be clear, this is not the sense I mean when I label spaces, species, and practices like recycling kiosks, informal waste collection, dump sites, and marabou stork ecologies as para-sites. On the contrary, the aim of this essay is to illustrate the constitutive ambiguities of para-sites. Parasitism is not strictly pathological but both relational and relative: who is para-siting whom is never stable. Recent work in microbiology shows that the difference between parasitic and mutualistic relationships is far from clear-cut and can, in fact, change dramatically over the life-course of parasites and hosts (Hird 2009; Paxson and Helmreich 2013).⁶ Responding to this understanding of parasitism, mutualism, and symbiosis requires moving from an essentialist to a relational and ecological view of multispecies intra-actions, from seeking to eradicate parasites to learning to live with them.

This relational approach to parasites offers a way to understand the relationships between so-called formal and informal urban infrastructures. While contemporary policy discussions frame the informal as a discrete, autonomous economic sector (Roy and Al Sayyad 2004), Keith Hart’s (1973) original formulation emphasizes both the practical entanglement of informal activities with official economies (in practices such as underpaid government officials moonlighting, e.g.) as well as the ways informality as a concept emerges as a residual category of official modes of knowledge production unable to see or statistically capture work outside of the wage relation. As many ethnographic descriptions have shown in years since, informal economies (in practices such as

3. Systems of circulation and production like waste management work because of, not in spite of, rule bending. James Scott’s (1998) description of work-to-rule strikes in which taxi drivers carry out their duties exactly by the book, forging the informal practices that expedite circulation and, in so doing, paralyzing traffic, illustrates the importance of extralegal activity to the functioning of modernist systems. For Scott, this exemplifies a broader point that modernist planners are ideologically biased against seeing and accounting for the informal practices that enable systems to work and, in a quest to purify systems of this polluting dirt, produce unworkable plans doomed to failure.

4. In this sense, para-sites are Derridean supplements: “necessary supports, which are the conditions of possibility of any system of knowledge, but dangerous to it because they subvert its explanatory power and sovereign claims to self-adequacy” (Gidwani 2008:147; discussing Derrida 1988:17).

5. Raffles (2007) and Mandani (2001) have examined the ways in which comparisons to parasitic insects rhetorically construct exterminable others in the context of the Holocaust and the Rwandan genocide, respectively. The rhetoric of the economic parasite also bears the imprint of a misogynistic bias contrasting “true” productive activity with “mere” reproductive or distributive activity (Ferguson 2015), while nonreproductive queer sexualities have also been violently pathologized as parasitic (Ahuja 2015).

6. Work on the human microbiome, e.g., highlights the importance to human health of a range of microbes once considered parasitic (Benezra, DeStefano, and Gordon 2012). This view reframes disease not as the simple presence of injurious parasites but “as the emergent outcome of complex spatio-temporal interactions between the host immune system and the internal and external microbial environment” (Lorimer 2017:1). Here species give way to intensities as objects of concern. Parasitic pathology is an effect of the intensification and densification of production in plantation ecologies such as those described in this issue for fowl, coffee, and salmon by Frédéric Keck (2019), Ivette Perfecto, M. Estelll Jiménez-Soto, and John Vandermeer (2019), and Heather Swanson (2019), respectively. In addition to this functional dynamic, relationships between parasites and hosts also drive evolutionary dynamics (Brunner et al. 2017), giving rise, e.g., to extravagant displays like peacock feathers (Zimmer 2000).
economies and infrastructures are not only not discrete sectors but are often vital to the operation of privileged official forms of production and, as in this case, disposal circulation (Meagher 2010; Simone 2004). Moreover, they do not, in fact, lack “form,” but they manifest consistent patterns of labor recruitment, organization, and surplus distribution (Guyer 2016; Roitman 2005). While this ethnographic literature has been focused almost exclusively on human economic activity, understanding these practices as para-sites emphasizes not only their relational entanglement with mainstream economies and their active relegation to a secondary status but also the more-than-human composition of these worlds. This is vital for understanding how urban infrastructures work and how they are embedded in and constitutive of patchy urban ecologies, “mosaics of difference” structured by ongoing dynamics of simplification and proliferation (Tsing, Mathews, and Bubandt 2019).

In Kampala, the formal waste collection sector (both public and private) is parasitic on the informal recycling trade, for example, through loaders’ ability to supplement their meager wages with a second source of income they can earn from sorting through the waste they collect in the course of doing their formal work. This work, in turn, benefits from the waste removal that marabou storks perform as they eat their way through the city’s garbage. In their messiness, the waste stream and its para-sites neatly illustrate the incomplete, multiple, and materially heterogeneous nature of urban infrastructure and the disorderly instabilities through which Kampala’s waste landscapes are sedimented. Because the waste stream often depends on, rather than precedes, its para-sites, the hierarchy present between a mainstream and its para-sites should be understood as an effect of material practices of marginalization rather than as an essential feature of the para-site. Just as research on the microbiome and its parasites requires global health practitioners to rethink the antimicrobial essentialism of public health (Lorimer 2017), understanding the dynamics of para-sites should prompt city planners to reconsider the baseline “engineering” (Viveteos de Castro 2019) preference for violent simplifications in the urban Anthropocene.

Animal Infrastructure

Not just symbolic figures of thought or objects of biopolitical environmental interventions, marabou storks are lively participants in the city’s waste stream, coworkers in urban infrastructure. Nor are marabou storks domesticated creatures gone feral. They are uninvited guests who have given up their diets or habitat requirements (Chamberlain et al. 2017). As recent migrants, kaloli do not appear as totems for any of the 52 Ganda clans, nor do they appear in Ganda folklore or proverbs. While rumors link the birds’ presence in the city to the darkest days of the Amin years, when they are said to have come to town to feast on human bodies left in the street, biologists Derek Pomeroy and Michael Kibuule’s (2017) study of the population shows that marabou stork numbers grew most dramatically in the 1990s. The first marabou stork nests were observed on what was then the outskirts of Kampala in 1970 (Pomeroy and Asasira 2011). By 2016, over 1,200 nests existed in Kampala, predominately on the leafy campus of Makerere University. While the rumors do not accurately describe the storks’ population biology, they do speak to their capacity to discursively register moments of social and landscape upheaval. The end of a long guerilla war that devastated central Uganda, the implementation of Structural Adjustment, and the establishment of a new constitution in the 1990s meant population and economic growth in Kampala, giving rise to a flourishing informal economy, the emergence of new peri-urban slums and elite suburbs, and the transformation of the city’s ecology. The growing availability of organic wastes meant a constant food supply, so stork colonies could expand, and patterns of seasonal migration gave way to a permanent urban presence in the city, with an expanded breeding season no longer coupled tightly to the change from wet to dry seasons (Pomeroy and Kibuule 2017).

Even as they are dismissed and despised as polluting dirty birds, marabou storks play a vital, but unrecognized, role in managing the city’s waste. Based on annual counts, there are, at a conservative estimate, 3,500 marabou storks in Kampala. Each stork eats 2 kilos of organic waste daily. Collectively, that amounts to 7 metric tons a day, 210 tons a month, approximately 3% of the municipal solid waste generated in the city. By way of comparison, the formal private waste collection sector together collects 14%, the municipal government 26%. As important as how much they eat, what storks eat is crucial for understanding their contribution to the city’s waste management infrastructure. Kampala’s waste stream is 92% organic matter: heavy and wet, it is unsuitable for incineration and overwhelms the city’s capacity for composting (Komakech et al. 2014). While the composition of the waste stream varies from neighborhood to neighborhood, with wealthier areas generating less organic waste overall, the most significant forms of municipal waste (by weight) come from food: the peels of matooke and other staple starches, banana leaves and other plant-based forms of packaging used to cook and transport foods, as well as rotten meat and butchering scraps. These organic wastes are the staple of the marabou storks’ diet. By eating them, they not only remove them from the waste stream to be managed by the KCCCA, but they reduce the amount of rotting matter that could carry threatening pathogens (Ssemmanda and Pomeroy 2010:27).

For the municipality, “away” is Kiteezi Landfill. Like landfills everywhere, Kiteezi is a multispecies landscape (Hoag, Bertoni, and Bubandt 2018). Storks’ infrastructural contributions are
especially visible at Kiteezi, where nearly 1,000 gather daily to pick through the rubbish dumped by the city’s fleet of public and private waste collectors. Along with storks and vultures, unknown billions of microbes are also at work, breaking down biodegradable waste to produce methane and other gases that the KCCA seeks to tap as an energy source.

These are not the only salvagers at work at Kiteezi. Despite a municipal ordinance prohibiting scavenging, hundreds of people work illicitly at Kiteezi salvaging recyclables, removing plastics, paper, glass, metal, and other scrap materials, sorting them according to the categories introduced by the formal recycling industry, saving them at mobile on-site locations, and selling them by the kilo to off-site traders who sell them by the ton to investors who shred, melt, reuse, or export the recycled materials. Salvagers, predominantly but far from exclusively, men, range in age from 18 to 70 years and come from all over Uganda, primarily from nearby job-poor rural districts. They can earn from $2 to $15 a day, “depending on energy,” in the words of Faith Kadimala, who had been working at Kiteezi for 20 years.

Except for one young man who had once been struck in the eye by a wing, salvagers I met while conducting interviews at the landfill did not mind working alongside marabou storks. “They eat their things, they don’t bother us,” said a salvager who had recently begun to work at Kiteezi. Another worker observed that birds “don’t have any problem with us because we all earn from this place,” identifying the landfill as a productive multispecies contact zone (Haraway 2008:216–220), a marginal ecology where diverse forms of life could sustain themselves. Indeed, as one experienced older salvager explained to me, storks “pick those smelly things and eat them, rotten mangos, rotten meat, whatever. They can help us.” By removing the smelly organic matter from the surface of the landfill, storks ease the burden on the salvagers, making recyclable materials more apparent and graspable, improving the sensory experience of salvaging. The multispecies labor at Kiteezi models a biodiverse form of civility, ranging from muted hostility to tolerance to acknowledged cooperation. Civility here entails politely getting on with the job at hand, regardless of difference. It does not entail anything as impolite as challenging the structures of power that shape the course of the waste stream, the composition of the waste-work labor force, or the unevenly distributed exposures to toxicity. Indeed, civility is often central to facilitating the reproduction of structural violence. As Tobias Kelly and Sharika Thiranigama (2017) observe, “civility can be deeply enmeshed in forms of exclusion. What counts as civil behavior has historically favored white, bourgeois, male, and heterosexual ways of being in the world” (n.p.). In this light, it is important to qualify the significance of this more-than-human civility and to question how civility might become solidarity (fig. 2).

Together, this multispecies salvaging work removes over a ton of waste from the landfill on a daily basis (Mugaga 2006), extending the life of the already over-full infrastructure. This service exemplifies the instability of the para-sitic relation—

Figure 2. Para-sites. A network of informal practices of gathering and recycling plastic bottles and other materials exists alongside Kampala’s formal waste management systems, including sorted plastics set aside at Kiteezi Landfill (above) and a broker dealing in plastic bottles in an industrial area (below). (Photos by Jacob Doherty.)

who is para-siting whom in this case? Salvagers point to this fact and to the proliferation of kiosks and other businesses around the site to show that they are contributing to the development of the city, that their informal, technically illegal but tacitly sanctioned, labor matters and should not be displaced by pending privatization of the landfill. Despite their contribution, salvagers were not officially recognized by the municipality. Salvagers were registered, but this registration was initiated by their own chairman and did not entail any benefits other than limiting the number of salvagers. Salvagers were allowed to store their collections in nonactive areas of the landfill and to use a small tap at the edge of the site to clean themselves, but neither they nor the site managers could construct any structures that would imply permanence. To improve their

8. In October 2014, 423 salvagers were registered to work at Kiteezi. Since at least 2013, workers at Kiteezi have been discussing rumors about privatization. The landfill was maybe going to be tendered to a private company to manage. This, many feared, would mean they would be evicted from the site and replaced by a labor force they assumed would be connected by kinship or ethnicity to whoever won the contract.
conditions, several salvagers said they would like the government or an NGO to support them by buying them the machinery needed to shred plastic so they could, in the hegemonic development parlance of the city, “add value” to their materials, moving up the commodity chain themselves instead of making money for traders and foreign investors. To officially recognize the salvagers would be to officially recognize that the municipality was breaking its own laws and exposing workers to the dangerous matter of the waste stream, potentially exposing the municipal government, in turn, to liability and responsibility.

This uneasy relationship of nonrecognition—constituted by mutual implication in illegality, pending displacement, and vague promises of relocation—exemplifies the logic and practice of the para-site. The economy of salvage at Kiteezi is not adequately described as either formal or informal. It is, technically, illegal, but it is nonetheless central to the provision of both municipal and private waste collection services. Salvagers do not have bosses and enjoy much control over the rhythms of their work, but they have little control over the material conditions of that work or the prices they are paid. Their work requires little to no capital to enter but produces value captured by large-scale foreign investors. Plastic exporters and the municipal government benefit from this work without seeking to control it, profiting from the nonstandardization of modes of economic and ecological production (Tsing 2009). This economy generates shame and stigma but also incomes that sustain social reproduction in ways that can override moral and affective marginalization. In the words of a middle-aged salvager at Kiteezi, rejecting the idea that he should be ashamed of working in trash, “People can say what they want, but when they see what I have earned, they cannot say anything!”

As Kiteezi Landfill approaches closure, the KCCA is soliciting investors looking to capture methane from the waste while seeking out new sites to enact as away. While storks will surely relocate to this new location, the future for salvagers is less certain. Nonetheless, two young men salvaging at Kiteezi identified with the birds, protesting their treatment by the municipal government by claiming that “the KCCA minds less about us, they look at us as those birds. They have never called to us to talk about any vital thing, which I think is improper.” Storks offered a figure through which they could express their own sense of the impossibility of municipal recognition for their work and the unfairness of their silencing in the face of pending displacement. To be treated like a stork was to be ignored, barely tolerated, and deemed fundamentally incapable of exerting a moral obligation on others. As the waste frontier closes in Kiteezi, the patchy ecologies and economies it sustains move on. While municipal landfills are privileged as the state-sanctioned waste frontiers, they are not the only ones.

Waste Frontiers

Waste frontiers are a form of resource frontier—the resource in question is away itself. Resource frontiers, as Anna Tsing (2003) theorizes them, are material processes and cultural projects located at the edges (often, but not exclusively, geographically) of capitalism that constitute landscapes, environments, and materials as resource. Waste frontiers take place through the location and construction of new forms of away. They are multiscalar, opening new landscapes, environments, species, and bodies to toxicity and dumping. As resource frontiers, waste frontiers are critical sites for managing the crises of capitalism (Moore 2015:73). They are internalized-outsides and externalized-insides that temporarily displace the limits of accumulation by locating new sources of value (unpaid work, untapped minerals, unexploited soils) and new sacrifice zones in which to dump negative values (industrial debris, toxic by-products, greenhouse gases). If resource frontiers are typically conceptualized as modes of incorporation into capitalism, waste frontiers are modes of managing exclusion. In both cases, the temporality is “not yet” (Tsing 2003:5100), as frontiers are ephemeral and constantly shifting because naturalized resources, including away, are exhausted and dumps overflow.

Jason Moore asserts that “the end of cheap garbage may loom larger than the end of cheap resources” (2015:305), arguing that climate change can be understood as a crisis of a closing waste frontier, the coming due of unpaid debts accrued over 2 centuries of dumping waste carbon into the atmosphere. The Pacific garbage patch—fatal to the albatrosses of Midway Island—likewise materializes the closing of the ocean as a waste frontier. Throughout the history of capitalism, the costs of wasting have been consistently externalized, relocated off the books of capitalist firms onto those of unevenly exposed publics and into the bodies and environments of indigenous, colonized, and racialized populations. However, it would be inaccurate to consider these simply as the end point of a linear process that follows the commodity chain pattern of extraction, manufacturing, distribution, consumption, and disposal. A linear view begins with resource frontiers seeking to appropriate value and leads on to exhaustion, devastation, and the emergence of wastelands. As Traci Voyles (2015) illustrates, however, settler colonial extractive frontiers often begin with the cultural project of wastelanding, the devaluation of lands and livelihoods as unproductive in order to pave the way for resource frontiers that culminate in the material wastelanding—

9. In different ways, Moore and Tsing extend a genealogy of Marxist thought on frontier dynamics extending to Rosa Luxemburg’s (2003) work on imperialism’s centrality to capitalist modes of production, through David Harvey’s (2004) argument that primitive accumulation is not an original sin no longer present in contemporary capitalism but an ongoing process of accumulation by dispossession, and J. K. Gibson-Graham’s (2006) feminist geography of capitalism’s constitutive dependencies on noncapitalist forms of social life (see also Gidwani and Wainwright [2014] on Kalyan Sanyal’s theorization of the “capital-not-capital complex”). Waste frontiers reveal that these dynamics are present not only during exploration, extraction, and production where “not-yet” capitalist spaces are appropriated, but also during disposal, when “no-longer” capitalist spaces are produced.
the displacement of native populations and the destruction of the dynamic landscapes they sustain. Moreover, as the economy of Kiteezi Landfill makes apparent, waste frontiers have themselves become frontiers for salvaging other kinds of resources, as capitalism’s surplus humanity eked out a precarious living on the refuse of urban life.

Kampala’s waste frontier follows the blurry line between land and water, transforming the unstable grounds where wetlands meet hillsides. Circling above on sunny afternoons, marabou storks signal the presence of the waste frontier in dumpsites where they scavenge for carrion and rotting fruit. A series of such dump sites occupy the edges of Kabalagala, a high-density, multiethnic, low-income, and predominantly low-rise neighborhood a 20-minute walk from the city’s main industrial area. A swampy stream runs between Kabalagala and Nsambya and into the Nakivubo Channel, one of the main drains that empties Kampala’s rainwater, sewage, municipal, and industrial wastes into Lake Victoria. Nsambya is a more prosperous hill, home to one of Kampala’s oldest hospitals, the US embassy, a shiny new mall, and a sprawling set of barracks belonging to the police. For many tenants in Kabalagala, the exact ownership of the land they inhabit is unclear, even if their landlords are known to them. This is due to a complex system of institutional and individual ownership of land that has been accumulating new layers and modes of legalized land tenure since the first treaty was signed between theBuganda Kingdom and the British Protectorate government in 1900.10 The British Crown claimed ownership over Buganda’s wetlands, categorizing them as wastelands (along with forest and other uncultivated lands); individual title was not granted in these areas. While this de jure established colonial control over wetlands, in practice they remained largely unprotected and accessible for customary usage, de facto property of nobody and everybody (Ntambirweki 1998).

At independence in 1962, the government of Uganda took over these rights and established further claim to their water resources. The borders of these lands have never been clear. Individual land titles have been granted to well-connected investors seeking to build industries and real estate developments in central but swampy Kampala locations. Adding to the confusion, in 2014 the government decreed that all land titles on gazette wetlands should be recalled, a policy that has been unevenly and only sporadically enforced.11 The police own the land around the stream and wetland but have not consistently enforced their claim to it on the Kabalagala side. These liminal spaces have been gradually claimed and encroached upon by new residents who build houses and rent them out, acquiring insecure tenure through occupation, even as building in wetlands remains both illegal and precarious, vulnerable to both eviction and flooding.

Garbage has been vital to the transformation of this landscape and the unstable forms of property, residence, business, and terra-formation that constitute it. As is typical in Kampala, many of the houses in Kabalagala were constructed from homemade bricks made from clay harvested from along the wetlands. According to long-term residents, by the mid-1990s the edges of the swamp were pockmarked with holes where clay had been dug out and punctuated by kilns where bricks were baked before being used to build homes on higher ground. Unregulated private waste collection companies serving nearby areas began to use these holes to empty their trucks, gradually filling in the swamp with trash. These dump sites now serve the residents of Kabalagala and make visible the diversity of economies and ecologies that emerge at the waste frontier.

I first encountered these dump sites with Kato Mubiru, a councilor representing Kabalagala Parish, who earned the nickname kasasiro (garbage) for his dedication to improving waste management. A lifelong resident of Kabalagala and former employee of one of Uganda’s oldest waste collection companies, Kato approached the waste stream with an entrepreneurial eye, seeing opportunities for youth development projects he could bring to his constituents. Kato brought me to the wetland edges to show me the history of waste management in his community written into the landscape. Standing on the dumps and looking uphill, he pointed out the steep and eroding slope with one-room houses precariously balanced on crumbling foundations. Heavy rains washed away the surface cover and revealed the texture of the earth below, a combination of clay soils and plastic bags, dropped as litter and over time buried, compressed with soil, and now seeming to ooze out of the hillside. The ground beneath our feet was flat and porous, with water seeping up underfoot as we followed a path along the edges of the dump sites.

Kato explained that while he made an effort to bring a municipal trash truck to Kabalagala every weekend, he could not serve every street every week, so residents had to wait up to 3 weeks for service. Kato encouraged residents to store waste at home, to sort it, and keep it dry to prevent rotting—but this was not always possible. Between visits from the trash trucks, residents found their own way to waste frontiers, improvising waste management by dumping domestic waste by the swamp or burning it on the roadside. As at Kiteezi, marabou storks in Kabalagala scavenged for food alongside salvagers searching for plastic bottles and bags, metal, and other salable scrap mixed into the waste. Younger and less organized than the workers salvaging at the municipal landfill, they nonetheless searched the waste frontier for resources, performing the labor of translating negative value into rent, meals, and school fees. Salvagers here collected plastics in small amounts and cleaned them in the swamp to fetch a higher price at the nearby kiosks where middlemen gathered the larger volumes that attract the serious buyers with connections to plastic manufacturers as near as the industrial area or as far as China. These para-sites, driven

10. The Uganda Agreement of 1900 founded the Uganda Protectorate and initiated a dualistic land regime legalizing both customary and freehold forms of tenure. The agreement divided the lands of the Buganda Kingdom between the Kabaka, his chiefs, missionary societies, and the British crown (Hanson 2003).

by the demand for scrap metal in particular, have radically reduced the quantity of metal arriving at Kiteezi Landfill (Komakech et al. 2014). Clearing plastics from the waste stream, Kato explained, protects the wetlands and keeps them flowing, protecting the rest of the city from more flooding. Even so, he imagined the wetland continuing to disappear under the tide of trash. Pointing to an under-construction home, surrounded by deep trenches to protect it from the water, he recounted, “Here all was garbage, there were holes here, and they were dumping dumping dumping then compacting and compacting. What they do is fill [the swamp] with garbage, then cover with soil until it is firm, and then they can build.”

As these houses go up, Kato tries to prevent more dumping nearby to keep the residents healthy: “People don’t know how to sort their garbage. They put feces, they put condoms, they put everything there so when rain comes, you know these people are suffering a lot. That’s why we stopped them from dumping this side. They are dumping on the other side now.” The waste frontier closes and moves on, making way for homes and hygiene. These are early frontier settlers looking for the cheapest places to build, soon to be replaced, Kato confidently predicted, by businesses and bigger developers. Looking up toward the shopping centers looming over us in Nsambya, he imagined that “in the coming years you’ll find this place and they have already built big houses, they’ll dump more and start building and then some people will start to say this land is mine mine mine,” anticipating future conflicts around ownership and construction on the emergent land (fig. 3).

The waste landscape sustains a variety of livelihoods that connect in different ways with the city’s formal economy, extending waste infrastructure beyond the confines of the municipal government and opening the waste frontier to multiple participants. Taking out the trash was a promising business for unemployed young men (Buyana and Lwasa 2011). As in many of the poorest parts of Kampala, residents could dispose of their waste by giving a 500-shilling coin (US$0.20) to an informal waste collector. These informal collectors, known in Kabalagala as “carriers,” circulate through low-income neighborhoods, charging to pick up trash sacks and take them away from homes and businesses using wheelbarrows or modified bicycles. Kato introduced me to Yusuf Miiro, a carrier who had been working in Kabalagala for 3 years, earning up to 30,000 UGX (US$12) daily, despite regularly having to bribe his way out of police custody. The KCCA opposes this form of collection and tries to arrest and fine informal collectors, impounding their meager tools. These were the only entrepreneurs who had successfully constructed a functioning “cost-recovery” waste collection service in the city’s poorest areas—a task beyond the best-laid plans of World Bank urban experts. Nonetheless, they were seen as polluting the city’s aesthetics, contributing to wetland degradation (if they dumped their collections in wetlands), and taking advantage of municipal services (if they dumped at known KCCA collection points). Rather than criminalizing this work, Kato envisioned linking it up with the official waste stream, constructing easily accessible “garbage banks” where informal collectors could dump trash for the KCCA to collect on a regular basis, as opposed to the wetland dump site that was all but inaccessible to trash trucks. Because it entailed more points of contact between the population and waste, this vision—one akin to projects successfully completed by waste pickers in, among other places, Ethiopia, India, and Brazil (Baudouin et al. 2010; Dias 2016)—ran counter to the image of the hermetically
sealed official waste stream, the simplifying ideal through which planners came to see informal waste collectors as “dirtying the place,” in the words of one municipal worker.

Storks and carriers thus find themselves in a shared predicament. Storks are not only rendered as waste like certain populations. The same set of material technologies, infrastructural transformations, processes of commodification, modes of authority, and visions of the urban future enact Kampala’s ecologies of displacement and disposability across multiple species. State-centric views of infrastructure make no space for informal and animal infrastructures, instead seeking foreign direct investment and creating new markets for private waste collectors to operate. This view of the fully controlled, licensed, and authorized waste stream free from para-sites renders both people and animals disposable, even as they provide essential but unrecognized urban services that underpin city life in post-colonial Kampala.

**Modernizing the Urban Bestiary**

Making a new Kampala entails remaking not only the city’s government, economy, and infrastructure, as if that weren’t enough. The transformation of the city also entails dramatic changes in the urban bestiary, remaking species belonging in the city by purifying its species composition (Tsing, Mathews, and Bubandt 2019). This effort is part of the project of establishing and maintaining the distinction between the city and the country, between rural agriculture and urban consumption. Reporting on the year 2012–2013, the minister for Kampala reported that the municipal government had exterminated 1,600 head of cattle and 900 goats and sheep.12 Increasingly, animals’ presence as living beings and bodies in Kampala is policed and barred, especially when outside the category of pet, while feeding the city relies on animals’ continued presence as flesh.13 Small herds of cattle walking the periphery, a common site when I first spent time in Kampala in 2010, were chased out of the city by 2014, while trucks packed full continued to ferry animals to the city’s abattoir, itself facing imminent relocation, to more fully redraw the geography of animal bodies and flesh.

The biopolitics of the new Kampala is predicated on management of more-than-human forms of life. Animals’ lives are sustained insofar as they sustain human lives; they are welcomed and encouraged within the confines of property relations and with stable futures as flesh for human consumption. The KCCA evaluates animals’ presence through the rubrics of biosecurity and aesthetic cleanliness, figuring animals both as vectors of disease and evidence of incomplete modernity. This biopolitical transformation not only changes the animal order of the city but participates in expanding the commodification of everyday life, as more and more foodstuffs must be purchased on the market rather than produced at home. This enhances the common ambivalence toward urban life expressed by one interlocutor in the informal recycling business: “In my village everything is free, but in Kampala you must ever spend money to eat!”

As Clapperton Mavhunga (2011) has argued of colonial constructions of multispecies belonging, pestilence is unwanted mobility. While the new animal order in Kampala restricts the presence of wide-ranging animals like cattle and goats, the KCCA is encouraging small-scale projects for confined animals such as pigs and chickens, distributing chicks and piglets to women and youth in city slums as an income-earning entrepreneurial opportunity. With chicks and piglets reared to sell to markets and restaurants, these urban farming initiatives blur the country-city distinction but continue to enact living animals as immobile flesh rather than mobile bodies.14 Storks’ mobility is critical for understanding how they become pollution. Storks flout the norms regulating human movement through Kampala’s environment. As comedian Ernest Bazanye observes in his weekly column: “Marabou storks just stroll cockily over whatever lawn they please,”15 referring to the KCCA’s draconian policing of grassy road medians downtown.

Kampala is a highly fragmented city, with clear lines drawn between the clean green spaces of elite recreation and domestic reproduction—leafy suburban homes, golf courses, hotel gardens, college campuses, and downtown parks—on the one hand, and on the other, the geographies of disposal where surplus matter and surplus populations commingle to the abhorrence of municipal reformers. These lines are often drawn by altitude, the hilly city’s high ground claimed by prestigious institutions and wealthy residences, while the swampy, low-lying wetlands are left for slums and dump sites. This topography shapes the practices of disposal in the city. Waste flows downhill, accruing in drains, homes, and bodies, para-sites constituted as the city’s sinks—reservoirs that immobilize pollutants, removing them from broader ecologies. Storks’ movements transgress this spatial order. Storks make their homes in colonies in the clean, green treetops of the city’s hillsides, waking early to feast on the city’s filth, spending their mornings strutting through landfills, wetland dumps, abattoir excreta, and municipal backlogs looking for food before spending afternoons soaring above the city. They perch on trees and rooftops, speckling the ground with fecal reminders of their presence, inverting the downward flow of filth and redrawing the geography of sink and spill in the city. In this way, storks are a classic example of polluting matter out of place, transgressing simultaneously symbolic and material socio-spatial categories as

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13. This distinction between body and flesh draws on Hortense Spillers (1987).
14. I use “enact” here, following Annemarie Mol (2002), as an alternative to “construct” in order to emphasize the ontological consequences of these legal frames.
they move across and between the patches that constitute Kampala’s landscape.

While storks benefit from the increasing availability of waste as the city expands, urban development threatens their habitat insofar as their preferred roosting sites in trees make way for housing, businesses, and urban infrastructures. Power lines, for example, both offer new locations to roost and pose a threat to birds, especially large birds like marabou storks, who risk collision and electrocution, sometimes causing power outages in the area (Kibuule and Pomeroy 2015). In 2007 the Kampala city council provoked environmentalists by chopping down trees to make way for power lines, leaving stork chicks to die on Kampala Road. The carcasses I saw at Makerere were also part of this ongoing struggle. University groundskeepers—residents of the campus who told me that they detest the birds because they spoil their drying laundry and disrupt their outdoor food preparation by scavenging foods left out to dry—left poisoned food out to retaliate. In this case, the groundskeepers acted without administrative authority, but the university itself has targeted the birds by cutting down trees and destroying nests at critical junctures of the storks' reproductive cycle. In 2014, Makerere University planned to cut down trees it deemed to have “out-lived their usefulness,” a move that the organization Nature Uganda, an environmental NGO focusing on Uganda’s birds, objected to on the grounds that it was clearly aimed at displacing the marabou stork from campus. Using the rhetoric of animal rights, Nature Uganda argues that, to eliminate the marabou stork from Kampala, the only humane strategy would be to solve the city’s garbage problems. But humane for whom? The violent simplification of the city’s waste stream would not only displace storks but also transform the landscapes and livelihoods of para-sites.

Conclusion

Although there is no such place as “away,” a lot is happening there anyway. Accounting for life at the waste frontier shows that disposability is a fantasy, that disposable informal and animal infrastructures not only endure but flourish and sustain the formal flows of waste, be it methane harvesting, transnational flows of recyclable scrap, or the supplements to the meager wages of municipal workers. Rather than romanticizing the endurance of animal infrastructures, it remains critical to ask what worlds they sustain and make possible, what regulatory norms support and undermine them, how they distribute power and precarity, what role they play in the reproduction of infrastructural violence, and what solidarities they engender across differences of all sorts, including species.

Far from unequivocally benign, these kinds of para-sites include debilitating subsidies such as toxic body burdens and other hazardous externalities. “Away” too often takes place in bodies, as Vanessa Agard-Jones (2014) and Kate Brown (2019) make clear. Para-sites entail frequent exposure to the hazards of the waste stream. These moments of exposure are typical of what Rob Nixon calls slow violence, “calamities that patiently dispense their devastation while remaining outside our flickering attention spans” (2011:6). Despite the social, medical, and economic tolls they take, they do not attract the same levels of care or attention as more eventful disasters. This is particularly the case in Africa, where epidemics and outbreaks have occupied the medical imagination at the expense of longer-term forms of injury such as the continent’s invisible cancer epidemic (Livingston 2012). As elsewhere, in Kampala slow violence is infrastructural. Para-sites expose residents and workers to dioxins and particulate matter in the smoke of burning rubbish that can lead to cancer, asthma, and heart disease. They expose people to lead and other heavy metals in water sources near dumping sites, as well as to Helicobacter pylori, common bacteria found in organic waste that can cause ulcers and stomach cancer. Urban farming at para-sites pushes the waste frontier into plant and human bodies as wetland crops accrue heavy metals from industrial effluents and car exhaust. Likewise, marabou storks’ bodies accumulate mercury and organochloride compounds from trash burning, vehicle exhaust, mosquito control, cotton farming, and industrial pollution that seeps into their air, water, and diet (Hollamby et al. 2004). It remains to be seen what politics might emerge from these co-contaminations. As it stands, these public health threats are what the normative waste stream is intended to guard against, concentrating away in as few sites as possible to minimize risk, but giving little attention to the everyday exposures that sustain the flow of waste through the city. Salvagers and informal waste collectors nonetheless immerse themselves in the hazards of the para-site. That they recognize these risks, and are willing to take them on, speaks to the multiple forms of slow and infrastructural violence that constitute para-sites.

In the context of ongoing displacement, however, vulnerability to infrastructural violence is translated not into a need for social protection or multispecies care but into another reason for disposability, as the poor are framed not so much as vulnerable but as always already diseased, contagious, and in need of containment or removal. Vulnerability, in this economy of attention, begets the violence of state simplification. Storks, salvagers, and other para-sites add complexity to the urban social and infrastructural order. The municipality has variously tried to incorporate and expel this complexity, violently simplifying the city’s waste infrastructures. On the one hand, at Kiteezi Landfill, and with the variety of recycling kiosks within the city itself, it has tentatively established relations of non-recognition with salvagers, tacitly allowing them to break municipal ordinances and puncture the waste stream that official policy sought to seal. In the city proper, on the other hand, it acts to expel para-sites, criminalizing informal waste collectors and arresting residents availing themselves of unauthorized dump sites. In doing so, the government was itself engaged in the world-making work of cleaning, defining, and enforcing aesthetic, environmental, and sanitary categories in ways that

enact specific norms and practices of citizenship and urban belonging. Ecological and sanitary differences are used to justify and necessitate continued displacement and dispossession of humans and animals. Regulating informal and animal infrastructures, the municipality seeks control over the location and movement of the waste frontier to monopolize the means of infrastructural violence. Despite the valued services they provide in Kampala’s low-income neighborhoods, para-sites are thus rendered disposable as a form of pollution. They do not, however, go away.

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At Play with the Giants
Between the Patchy Anthropocene and Romantic Geology

by Naveeda Khan

I consider how the ideas of the patchy Anthropocene forwarded by the editors of this special issue provide a way to do anthropology otherwise by reversing the relationship between the background and foreground in our studies. This switch allows me to bring to the fore the Brahmaputra-Jamuna River as both a hydrological entity and a geological event and the interrelations between these two as explored in geological writings. It helps grow the kinds of accounts that are appropriate to the complexity of the Anthropocene. At the same time I also pose that the inner structure of the imagination must change to be in step and similarly appropriate to our entangled and scaled-up present. The romantic geology of the early nineteenth century, particularly that of the German romantic Novalis, provides interesting experiments with commensurating humans to the geological. It does so by thinking the human as tending toward the nonhuman, thus possibly at play with the mountainous giants who shaped the earth’s topography in romantic imagination. I consider how gigantism may be explored as a dimension of human existence in the Anthropocene even as we consider the human in her particularity.

The Patchy Anthropocene and the Messy Question of Subjectivity

As is by now well known, the geologist Paul Crutzen is credited with suggesting the label of the Anthropocene to demarcate our present as an epoch marked by human impacts on a global scale (Crutzen and Stroemer 2012 [2011]). While Dipesh Chakrabarty’s “Climate of History” is among early writings within the social sciences and humanities asking how we as scholars are to take stock of this new phenomenon in which we have likely been immersed for an epoch already (Chakrabarty 2009), there have been only scattered responses within anthropology. The most exhaustive, but also by its nature unsystematic, is the accumulation of concepts, “a lexicon to think the anthropocene yet unseen” to allow us to see “this time otherwise” (Howe and Pandian 2016). Meanwhile, the idea of the Anthropocene has spread far and wide, encompassing efforts at setting a start date of the epoch within the deep history of human actions (Lewis and Maslin 2015; Swanson 2015; Zalasiewicz et al. 2011) to efforts at pushing back on the recentering of the humans by asking if we might think of humans as affected rather than affecting Earth (Clark 2010; Groves 2015).

The introduction to this special issue (Tsing, Mathews, and Bubandt 2019) is perhaps the most comprehensive approach to the challenges posed by the Anthropocene to anthropology and its mode of engaging with the changing world. Without rehearsing its arguments, I home in on its claim that to adequately take on the challenges posed by the Anthropocene to anthropology we need to start with landscapes, specifically their internal structures; that this focus will necessarily displace attention from the human to nonhuman relations and the forms and properties of their surround; and that such structures better enable patches, necessarily awkward, to systems, with the climate being one of the pervasive systems at work at present under the rubric of the Anthropocene. There is a certain elegance to this framework as in one fell swoop it deals with the problem of anthropocentrism, it avoids the fetishizing of the nonhuman, it takes up myriad elements (humans, nonhumans, landscapes) in their complex configurations, and it allows for actual scenarios and fallouts from not just climate but also plantation modes of organization and production, vast circulation and transportation systems, that is, the interrelations and interstices of systems (see Connolly 2017). And what is particularly thrilling is that they see this move to thinking the landscape in this manner as a way to change the background and foreground relationship within anthropology. In other words, anthropology has always been attuned to landscape but has mostly treated it as the background to human organization and action. The editors ask what it would take to make the landscape itself, with its structure and patches to systems, with its internal heterogeneity and sociality in an expanded sense of the word, as the subject of our inquiry. It is this provocation that leads into the exploration ahead of thinking the Brahmaputra-Jamuna River, the site of my fieldwork, as the subject of my inquiry, to ask what we can elicit of its internal structure and relation to wider systems from available geological...
scholarship, in order to produce complex accounts of landscapes adequate to the realities of the Anthropocene.

Yet I cannot help feeling that one enduring dimension of anthropology falls out of view with this resolute attention to landscape architectonics, which is a consideration of subjectivity, within this patch framework. By an expanded subjectivity, I mean perception, cognition, feeling, experience, even a sense of self and interiority, imagination and not just limited to humans alone. Subjectivity does the work of giving dimension to the actors and actants within this landscape in the manner that history, which is resolutely pressed by the editors, brings the quality of the palimpsest to landscapes. If their framework is not to seem a recasting of patch ecology but rather its reanimation, we need to continue to struggle with one of the central questions posed by Chakrabarty in his 2009 article and again in his 2014 article "Climate and Capital: On Conjoined Histories," which is, How do we cognize beyond the scope of our current historical sensibility and imagine nonhuman scales of time? Another way to orient Chakrabarty’s question for the purposes of this short meditation is to ask, How does the scale of the gigantic pose a problem for thought and experience?

Again Tsing, Mathews, and Bubandt’s (2019) fecund introduction provides some productive pathways for exploration. In it they write that they are agnostic to scale. I take them to mean that they do not feel that there are universally accepted or scientifically neutral areal units superimposed on the earth’s surface that we have to take as given, to be constrained by their nature to order thinking according to a given progression, say, from the local to the global (see Herod 2011). Second, it is the editors’ sense that humans and nonhumans have to be considered together to be adequate to the realities of the Anthropocene, that is, we have to be done with considering the human alone. Applying these provocations to my question of the scale of the gigantic leads me to speculate that gigantism may present itself to sensations as the means by which to experience something outside of ordinary apprehension, often marked as the exterior, the infinite, the gigantic (Stewart 1993). The relationship sought between oneself and the material other, which is more usefully cast as making oneself, one’s experiences, and one’s actions and expressions commensurate with the gigantic, seems a useful way to think the human as simultaneously human and nonhuman within the Anthropocene. In other words if we consider the Anthropocene to be both an era ushered by humans in which they function as a geological force and one in which human “implicatedness” escapes apprehension for being outside of the scope of cognition and imagination, then romantic efforts to make humans as the “corporeal double” (Heringman 2004:42) of material forms and processes seems pertinent in redressing this problem. Alongside accounts of the patchy Anthropocene it seems important to consider the changing contours of subjectivity, thought, experience, and imagination, if only to retain the scope for the possible within them.

In this short paper I begin with a classic scene of Henry von Ofterdingen in a mine in a bildungsroman of the same name, placed there by Friedrich von Hardenburg or Novalis, the German romantic (Novalis 2015 [1802]). Novalis is particularly interesting in orienting us to romantic geology, and not only because he is considered the romantic par excellence. He trained in geology at the Mining Academy of Freiburg in Saxony, studying under Abraham Gottlob Werner, who propelled a then-influential theory of the watery origin of the earth as opposed to its volcanic origins. Among the extensive notes that Novalis kept for the encyclopedia he was composing but which he never published were his scientific observations, many of which were on geological topics, such as the physical appearance and chemical behavior of different rocks (Novalis 2007). His protagonist Henry’s pleasure in mountains and caves, the latter crafted through the labor of miners, militates against any easy association of nature within wilderness in contradistinction to a distinctly human realm. It is the site of making commensurate human bodies to different temporal and spatial scales, providing us an orientation to romantic geology. I next turn from this scene from within mountains to my field site of the Brahmaputra-Jamuna River to effect a shift in viewing it as a water body sustaining riverine communities to understanding it as the side effect of a series of earthquakes that impacted the topography of the region over the course of the nineteenth and twentieth centuries. This shift in perspective is captured in geological writings on the Brahmaputra-Jamuna River that are analyzed for the purposes of showing how romantic aesthetics continues to inform postcolonial geology.

What interests me in this trajectory of romantic geology is the manner in which the surface of the earth was experienced as an other but also one by which to know oneself as an other, to be able to use the impasses on one’s mind and the body’s proportions and sensations as the means by which to experience something outside of ordinary apprehension, often marked as the exterior, the infinite, the gigantic (Stewart 1993). The relationship sought between oneself and the material other, which is more usefully cast as making oneself, one’s experiences, and one’s actions and expressions commensurate with the gigantic, seems a useful way to think the human as simultaneously human and nonhuman within the Anthropocene. In other words if we consider the Anthropocene to be both an era ushered by humans in which they function as a geological force and one in which human “implicatedness” escapes apprehension for being outside of the scope of cognition and imagination, then romantic efforts to make humans as the “corporeal double” (Heringman 2004:42) of material forms and processes seems pertinent in redressing this problem. Alongside accounts of the patchy Anthropocene it seems important to consider the changing contours of subjectivity, thought, experience, and imagination, if only to retain the scope for the possible within them.
to see how the Brahmaputra-Jamuna River provides a patch between the Bengal delta and the Anthropocene. But we still need romantic geology to push us to ask how humans in the delta take on aspects of the human and nonhuman within the Anthropocene, how their gestures and actions mimic the earth and carry the hint of the gigantic within them. However, this sense of the gigantic as a dimension of one’s being is different than those of giants at play imagined by Novalis as those who originated the earth’s topography with its deep canyons and soaring mountains. The difference in the perception of the gigantic within the Bengal delta points to one of the final comments of Tsing, Mathews, and Bubandt (2019) that I take into consideration, which is that even as the Anthropocene seems to further abstract the human from that of a species to a geological force, the specificity of the individual human or community is never entirely lost within patchy landscapes. The challenge is to hold all dimensions of the human together, as human as species and force and as particular humans. Novalis provides us some orientation to this particularity through the importance he gives to art, leading me to turn finally to two dancers, one of whom is from Bangladesh, attempting to express movements across the earth in order to explore how they might help us to newly comprehend humans as creatures of the patchy Anthropocene.

Henry in the Mine: The Lineaments of Romantic Geology

In Novalis’s Henry von Ofterdingen: A Romance (2015 [1802]), Henry seeks to know himself and goes on a voyage of self-discovery. This is the most conventional of motivations for travel within the romantic era and also perhaps the most associated with colonial dispossession and violence (Said 1978). However, there is a minor tradition even in this, and it is one in which one travels in one’s own country to learn to be curious about its physical contours, which otherwise appear to have “a dead, repulsive appearance” (Novalis 2015 [1802]:42). Henry wishes to go up close to the hills and mountains that he can see at the far distance, to see if they “might speak to him in explanation of their wonderful origin” (2015 [1802]:42).

Once in the shadows of the mountains, Henry is taken to a vast cave system by a retired miner. Through Henry’s systematic descriptions he attempts to capture the nature of the cave he is shown. His words are those of a dispassionate observer:

The entrance was low, and the old man took a torch and first clambered over some fragments of rock. A perceptible current of air blew towards them, and the old man assuring them that they could follow with confidence . . . The path, at first narrow, emerged into a spacious and lofty cave, which the gleam of the torches could not fully illumine. Some openings, however, were seen in the rocky wall opposite. The ground was soft and quite even; the walls and ceiling were also neither rough nor irregular. But the innumerable bones and teeth which covered the ground, chiefly attracted the attention of all. Many were in a full state of preservation, some bore marks of decay, whilst some projecting here and there from the walls seemed petrified. Most of them were of extraordinary size and strength. (Novalis 2015 [1802]:53)

Further on, as Henry stands contemplating the bone remains of large prehistoric creatures within this enormous cave, he is stirred to think,

“May it not be possible,” thought he to himself, “that beneath our feet there moves by itself a world in mighty life, that strange productions derive their being from the bowels of the earth, which sends forth the internal heat of its dark bosom into gigantic and preternatural shapes? Might not these awful strangers have been driven forth once by the piercing cold, and appeared amongst us, while perhaps at the same time heavenly guests, living, speaking energies of the stars, were visible above our heads? Are these bones the remains of their wandering upon the surface, or of their flight into the deep?” (Novalis 2015 [1802]:54)

We find a direct parallel between Henry’s musings of wandering creatures from a subterranean kingdom and the miner’s understanding of the mountains as themselves wandering, which “exhibit the traces of their former ways, and perhaps they desired to support themselves without foreign aid, to take their own way to Heaven” (2015 [1802]:60).

These deliberate parallels between biological beings and physical forms are not coincidental. Heringman shows how descriptive poetry enabled rocks to come into focus as an object of study, helping coin environmental concepts, such as the “rock record” and “natural resources,” and enabling and sustaining an economic interest in Earth’s matter at the start of the industrial revolution. But there is a bit more to it than the complicity of romanticism and geology with extractive economies (Groves 2017). There are in romantic science the deep beliefs that the imagination can produce an aesthetical encounter with the geological and the determination to encounter and think poetically with rocks. This thinking with rocks proliferated beyond thinking of human susceptibility to Earth’s eventfulness or, as more recently, Earth’s susceptibility to human eventfulness, to a thinking through association, which included causation but also extended into thinking through resemblance, mimicry, and contiguity. So, for instance, Heringman writes of the poet William Wordsworth that his writings attempt to testify to the more-than-human physicality that haunts existence. The literary critic William Blake wrote of rocks as the parents of man. There is both the insistent theme upon the “alien vestiges of a prehuman world” (Heringman 2004:8) and an effort to produce human figures, such as “an old man [who] dramatizes the qualities of this rock in the service of the geological explanation of materiality” (2004:37). Rock, which initially appears as illegible, is made legible through its “corporeal double” (2004:42). As Novalis muses through the figure of the hermit whom Henry and the miner find within the caves, “Nature approaches man; and if she were once an uncouthly teeming rock, then is she now a quietly thriving plant, a silent human artist” (Novalis 2015 [1802]:61).
expressed itself through the movements of rock, it is now to be found on the face of a plant or the body of an artist at work.

The Brahmaputra-Jamuna River as a Geological Event and a Hydrological Entity

The year was 2015 and I was in Chauhali, Shirajganj, standing in the courtyard of a house on what I called a silt island but was more scientifically described as *char* or a braid bar in the middle of a channel of the Brahmaputra-Jamuna River. I was speaking to two *chauras*, as those who live on chars were called. One broke off in the middle of speaking to look searchingly at the other standing with us to ask, “Did you feel it?” The second nodded affirmatively. My feet were shoe shod, whereas the two were barefoot. At my look of puzzlement, the first explained, there was just a rumble under the ground. I asked if it was an indication of avulsion or erosion that frequently beset char land but both insisted that it was a small earthquake (*bhumikompo*).

I knew that chauras were very attuned to the movements of the soil under their feet. Many had feet whose toes splayed impressively to allow them to grip the soil when they walked along the river’s edge as large chunks of land are known to topple over into the water without any warning. But this earthquake was not the same as avulsion. It was located farther down, making it hard for my companions to estimate how far down it was. I asked if they had ever experienced anything more substantial than these tremors. They introduced me to an octogenarian who recalled a period in his early twenties when the grounds shook, the river waters turned red with mud, entire forests slid into the water with their trunks clogging the channels downstream providing ready bridges for people, while fishes and other dead animals floated to the surface choked by mud. I traced his memory to the 1950 earthquake in Assam.

F. Kingdon-Ward, the botanist who experienced the earthquake firsthand, would later write:

On the evening of 15 August 1950, one of the biggest earthquakes ever recorded took place in south-eastern Tibet, close to the Assam frontier. Its epicenter was about twenty miles north-west of Rima, in the valley of the Lohit river, or rather, in the valley of its north-western branch, called the Rong Tho Chu. Incalculable damage was done in the mountains, but there was little direct loss of life, either here or on the plains. Since that date the Brahmaputra has overflowed its banks every year; both Sadiya and Dibrugarh [two other rivers] have been partly destroyed—the latter especially in 1954—and worse may happen. (Kingdon-Ward 1955:290)

The ominous, quasi-prophetic tone in his writing reflected his almost intimate concern for the Himalayas and for the fact that the rivers would be forever changed, if not destroyed, in order to bear the brunt of an earthquake with the status of a megathrust. A megathrust is produced by the collision of two continental plates and is generally considered to be exponentially more powerful than an earthquake produced at a subduction zone or the sliding of an oceanic plate, generally thinner, under that of a continental plate. However, his other major concern was the fact that floods, which were decadal in the Brahmaputra, would now become an annual affair. In other words, what was previously an unusual event caused by the fluke coincidence of monsoon rains and the simultaneous rise of waters of all three major rivers (Padma, Meghna, Brahmaputra-Jamuna) in the Bengal Delta leading to an unusual overflow of river channels had just become a regular feature of the lives of those living by the river. To draw out the implications of this prognosis even further, floods that had been reliant on the coincidence of local factors had just been regionalized and made into a seasonal event, as has proved to be the case since the 1950s.

The Assam earthquake in 1950 produced the Brahmaputra-Jamuna River in the form in which I encountered it while conducting fieldwork among the communities living alongside the river and on its chars. The insight that this river originated from an earthquake or a series of them did not come from my interlocutors whose memories went back only as far as their great-grandparents, as I ascertained from the kinship charts I made with them. They came from reading the geological scholarship on the river. Geology as a scholarly discipline did not take root in colonial India until the early nineteenth century, in part because it was not readily evident to the East India Company how it could profit from it, and there was a lack of practical expertise in carrying out the work (Grout 1990). It was only after the British government took over ruling India that the Crown sought to make a tally of its holdings and to acquire as much empirical information as possible of the territories under its control. The geological surveys were a powerful tool that they deployed to this end. As Andrew Grout writes in his history of geology in South Asia, the geological surveys well integrated economic and scholarly interest in geology and continued under the jurisdiction of the relevant ministries even after the Partition of India and the subsequent separation of Pakistan and Bangladesh. While the Asiatic Society of Bengal, with its geological museum and journal, served as the early venue for the publication and distribution of geological knowledge without it needing to be routed through the British metropole, geological education stagnated for a long period, held back by racist attitudes regarding the aptitude of Indians for scientific thinking. In postcolonial Pakistan and later Bangladesh, geology was first established as a stand-alone discipline at the University of Dacca in 1949 and was further institutionalized in Rajshahi University in 1975 and Jahangirnagar University in 1985.

Grout notes an interesting colonial formation by which East India Company servants and British scholars worked together to do what was called “network research” and about which he writes: “The ‘network’ was largely composed of Company servants who were interested in their study of natural history but who were directed in their studies from London” (Grout 1990:10). In other words, patronage was an important aspect of geological research. While it is not clear from the existing hist-
tories and websites speaking of geological education in Bangladesh, it would seem from the order of authors and their designation in scholarly papers that there may still be a network component to current configurations of knowledge production. So while contemporary geological science on Bangladesh appears to be produced predominantly by scientists, engineers, and practitioners located in the first world, notably the Netherlands, England, and the United States, there is considerable involvement of scientists and practitioners in Bangladesh. The few geologists with whom I have spoken in the United States underlined that their work would be impossible without collaboration with Bangladeshi scientists who are attuned to the nuances of differences in rock and soil types, who can more easily access government-held data sets, ranging from the Water Development Board to the state-run Space Agency’s historical archives on satellite imagery, and who are in Bangladesh all year round. But there was an apparent difference in terms of the interests of local and international scholarship. Perhaps because of the availability of development funding or nationalist concerns, Bangladeshi scholars tended to be more interested in the coupled nature of hydro-geomorphic and ecosystem responses to natural and human-caused change, such as arsenic poisoning and climate change, whereas the scholars, at least from the United States, were more focused on the early earth, the earth’s interior, and the relationship between surface processes and the earth’s deep processes. But an interesting overlap in their scientific works was trying to determine how to understand the Brahmaputra-Jamuna River within many timescales.

During the 1950 Assam earthquake, entire mountains in the Himalayan range collapsed and fell into the Dihang/Brahmaputra River, as the river is called farther north of Bangladesh. The sediment produced of that collapse clogged the river, requiring its sediment for the Brahmaputra-Jamuna to pump to the ocean, unless there is another earthquake to produce a build up of sediment for the Brahmaputra-Jamuna to pump to the ocean, it is likely that the river will widen and disperse as braids across the landscape even as it migrates westward:

The Jamuna’s braiding index is currently about 2.5 and its average width is around 12 km. In response to a 20% increase in monsoon flood, discharge accompanied by a proportionate increase in sediment load, the regime depth will increase by about 40 cm. Under this scenario, the width will increase, but the braiding intensity will be unchanged. However, if the discharge increases but the sediment load remains unchanged (due to reduced sediment yield from the basin and river upstream), the bed will be lowered by a greater amount because adjustment to a new regime condition will be delayed due to the lack of sediment. The river will widen and become more braided, with a braiding index of 3 to 3.5. . . . It is also distinctly possible that a future major earthquake could generate another pulse of sediment input, like that associated with the 1950 Assam earthquake. (Sarkar et al. 2014:56–57)

Although the 1950 earthquake may appear as an originary event for the Brahmaputra-Jamuna River, with the early geological claims being that the Jamuna changed course and became a braided river largely as a consequence of the earthquake, Sarkar et al. (2014) provide a useful corrective to this. They write that in 1830 the Jamuna River had a single-thread meandering planform or outline when looked at from above. It continued to be meandering through 1914, although it moved westward and its channel narrowed. Between 1914 and 1954, the river continued migrating westward, although by this time its channel had widened and it had metamorphized or transformed from meandering to braided. Thus, it was an already mobile river in mid-transition when the 1950 earthquake occurred. While Sarkar and Thorne (2006) and Sarkar et al. (2014) are careful to insist on this prior nature of the river, they also emphasize that the river’s inherent dynamism should not be mistaken for a state of dynamic equilibrium after the event of the earthquake. In other words, the river did not simply absorb the effects of the earthquake and continue on as usual but, rather, the earthquake transposed its temporality in the form of a sediment wave through it with consequences for the river’s fluvial geomorphology or channel shape and size.
It is suggested that the fine fraction of this sediment (silt and clay) travelled quickly through the system, without disturbing the morphology of the channels, before settling in the Meghna Estuary. In contrast, the coarser fraction (sand) has taken half a century to travel through the system, moving as a wave of bed material load, with a celerity between 16 and 32 km yr. Analyses of historical maps and satellite images, together with records of discharge, water level, sediment transport and cross-sectional form, reveal a sequence of morphological change in the Jamuna-Padma-Lower Meghna system, with a downstream phase lag that is commensurate with the celerity of the coarse sediment wave. (Sarkar et al. 2014:58)

There is an inner debate as to whether the passage of sand produced more aggradation or degradation of river beds, more braiding or fewer channels, more channel width or less. But the more important aspect of this discussion is that the river has acquired a highly complex character in which its branches maintain their own distinction as meandering, braided, or sinuous, leading to speculations as to whether the river is anastomosing, that is, differentiating into many rivers while forging new lines of connection across them. This discussion underlines the importance of sediment flow in evolving the river's complex character but, as well, the river’s own tendency toward inner complexity.

Andrew Grout notes that even after geology became a professional practice in Britain and colonial India it showed its romantic proclivity through its fascination for "natural recesses such as caves, grottoes, and mines, or unusual rock formations, isolated boulders, waterfalls, gorges and mountain peaks" (Grout 1990:13). And he maintained that such romantic elements stayed within an institutionalized geology. One is initially hard-pressed to see aspects of romantic geology, explored in the previous section, within scholarly treatments of the Brahmaputra-Jamuna River in which the river appears only in terms of water discharge, sediment load, channel morphology, braiding index, etc. These geo-fluvial landscapes are notably shorn of humans who once served as the measure of the scale of the observed geological phenomenon, by lending his or her body to suggest a proportion far in excess of the human or to invite an isomorphism of sorts.

Yet there are distinct echoes of romantic aesthetics within the postcolonial geology of the Brahmaputra-Jamuna particularly in its understanding of the river as an event in time and its nature to undertake metamorphosis. The eventfulness of the river is the particular temporality introduced by the earthquake that made the river into an extension of the earthquake, a passageway for the sediment buildup that the earthquake produced, slated to taper off once the sediment has been successfully transported. While every ecosystem is always changing, and elements within it come and go, this particular element of the river seemed to me to be something else, an extrusion not of a material object but of a movement with its own internal temporality from below the surface of the earth. Here I see the river serve as a proxy for the human body and mountains within romantic geology in communicating the movements from a subterranean kingdom.

Within romantic science more broadly, metamorphosis is understood as change with respect to oneself as opposed to change imposed by external conditions. While Goethe is the figure most obviously associated with articulating this understanding of metamorphosis through his study of plants, Novalis extends Goethe’s understanding of metamorphosis to the observation of nature more broadly in his Novices of Sais (2005 [1802]) in which he represents all things in nature, including humans, changing in themselves. The geologists' insistence that the Brahmaputra-Jamuna River was already changing when it experienced the 1950 earthquake and that it has maintained its own dynamic, even heterogeneous, nature despite the superimposition of sediment flows, suggests a certain, perhaps enduring, romantic commitment to understanding how the river is both in itself, as a hydrological entity, and a trace of a seismic event.

From the River to the Delta: Sediment as a Patch

How do we go from the romantic elements within geological writings on the Brahmaputra-Jamuna River to the Anthropocene (see also Kelly et al. 2018)? As we see from the interrelation between the 1950 earthquake in Assam and the Brahmaputra-Jamuna River, sediment is an important materialization of the movement produced of the earthquake through the river. Sediment helps to evolve its character and structure, but it is also important for the Bengal delta as a whole. The delta is the product of the interrelation between different waves of sedimentation occurring on the earth’s surface and tectonics or processes determining the movement of the earth’s eight plates. The collision of continental plates that produced the Himalayas produced an enormous sediment supply. Currently the delta fans out of the Asian subcontinent in the shape of a triangle. This is because it was largely extended by the flow of the sediment away from the collision site and the subsequent accumulation of sediment over the edge of the paleoshelf or the former land surface. But the delta has not formed through the aggradation of sediment alone. It relies on the sediment settling on its existing form for its continued stability and protection from the ocean waters. And the sediment is coaxed into settling by the deeper tectonics of the delta.

The delta lies in the junction of three tectonic controls. The Himalayan range puts pressure along the northernmost margin of the delta basin. There are local processes, such as overthrusting, compression, strike slips, and faulting occurring within the basin. And the basin is also under the force of deformation by the Indo-Burman fold belt to the east and the Shillong Massif overthrust from the north. These have caused the floodplain terraces comprising the basin to be uplifted, producing subsidence and subbasins that are not well connected to one another. When sediment moves across this landscape, these geological features slow and catch the sediment (Goodbred et al. 2003). The loss of sediment means the deepening of these basins, with the result of worsening floods and the setting up of sharp gradients, creating conditions for the future avulsions of rivers, that is, their movements elsewhere.
John Bellamy Foster (2000) shows how Marx was as attentive to soil as to resource transfer as an important aspect of the production of marginalization through colonial capitalism. In other words, the transport of what seemed like waste products out of India was actually a deprivation of naturally occurring fertilizers from its soil. A more patchily scaled-up version of this produced inequality for our present would be the control or, rather, disruption of global sediment flow. James Syvitski and Albert Kettner (2011) make such a case for human impact at the level of global stratigraphy or stratas within the rock record corresponding to the geological time line. Human imprint is already available through their interventions against the force of gravity, decelerated and accelerated natural processes, focused energy, and altered ecosystems. To this they add that humans have had a significant impact on sediment flux starting 3,000 years ago.

While I do not here account for all the different ways that they show humans to have done so, I focus on what consequences this impact has on deltas. For many deltas, choked of sediment, their aggradation or growth rates have decreased or been nearly eliminated. Furthermore, they are also subsiding or sinking faster than in any other period of Earth’s history as humans mine for groundwater and petroleum and continue to collapse the earth’s internal structure. In the midst of writing this paper I received an inquiry from a young journalist writing for GlacierHub asking if I could comment on the recent escalation of tensions between India and Bangladesh over water sharing arrangements for the Teesta River, a tributary of sorts of the Brahmaputra. In preparing to speak to her I realized that the representatives of both countries kept using the same terms, “water for irrigation for our farmers,” making it appear that the two countries had a shared problem. In reality, irrigation means different things to each. For India, irrigation is the physical rerouting of river waters to parched fields, while for Bangladesh, irrigation is the annual flooding of the fields and their enrichment by silt or sediment. So while a clearly worded treaty on water sharing might make rational sense, by avoiding its distinction as a braided river with a heterogeneous sediment load, while still maintaining the vulnerability of humans is found in the plumbing for groundwater in places such as Bangladesh. It pulled arsenic from the subsurface into malnourished bodies, affecting no fewer than 100 million people across South and Southeast Asia (Weinman et al. 2008). An interesting finding is that the development effort to raise village homes onto soil plinths with the intention to protect people from floodwaters inadvertently mimicked the stratigraphy of flood plains associated with high levels of arsenic. It made the home a further support for arsenic on the earth’s surface. Through a series of conduits—the tubewells, the human body, the soil plinths—humans came to express the structure and chemical composition of the landscape on which they live.

How is the above scenario comparable to the image of giants at play that we get from Novalis’s novel, the early earth was characterized by giants, be they primeval animals or mountains, cavorting in nature. And Novalis is simultaneously the one for whom the subject of the geologic sublime is one who could imagine a bark of stone growing over his own body, registering the identity-dissolving effect of the other. There is simultaneity in the fantasy of losing oneself and becoming a giant at play. Despite being an overly cheerful image, it nonetheless has the potency to suggest the kind of human-nonhuman creature one has to be within the Anthropocene to be equal to its challenge of nonhuman scales, to recognize that one’s every gesture holds the potential for the “dissolution of subjectivity” or self-annihilation and for gigantic destructiveness, that one is affected and destructive at the same time. But is this necessarily an insight into all human gestures?

In the geological descriptions of the Brahmaputra-Jamuna we focused on the aspect of the river as communicating its past of seismic activity through its sediment load, while still maintaining its distinction as a braided river with a heterogeneous nature. The river served as the surface being privileged to express the seismic underground. Yet humans too serve as surface beings to express the underground. The most prominent example of this facility or, rather, the vulnerability of humans is found in the plumbing for groundwater in places such as Bangladesh. It pulled arsenic from the subsurface into malnourished bodies, affecting no fewer than 100 million people across South and Southeast Asia (Weinman et al. 2008). An interesting finding is that the development effort to raise village homes onto soil plinths with the intention to protect people from floodwaters inadvertently mimicked the stratigraphy of flood plains associated with high levels of arsenic. It made the home a further support for arsenic on the earth’s surface. Through a series of conduits—the tubewells, the human body, the soil plinths—humans came to express the structure and chemical composition of the landscape on which they live.

How is the above scenario comparable to the image of giants at play that we get from Novalis and romantic geology? There is the becoming of nonhuman through the infiltration of arsenic into one’s body, there is the threat of self-annihilation of both body and mind, but surely there is not the same gigantic destructiveness of the kind that I propose above for a latter-day Western romantic subject? Although I maintain that there are dimensions of the nonhuman within the ordinary gestures of Bangladeshi villagers and river dwellers whose houses on plinths and bodies poisoned by arsenic suggest how they express the subsurface of the earth, it is important to maintain the differences in being human in the two settings, notably the differential conditions for self-flourishing.

At Play with the Giants

Continuing his exegesis of the importance of becoming nonhuman to oneself within romantic geology, Noah Heringman notes its radicalness:

My emphasis, however, is on the other-than-human rather than the other-than-self. The Hegelian dialectic of self and other, or master and slave, turns on the “truth of self-certainty,” just as the Kantian sublime turns on the integrity of the self. Psychoanalytic and postcolonial theory also emphasize questions of identity-formation, accounting in part for the great influence of “the other” as a theoretical category. By contrast, the dwindling or dissolution of subjectivity is at issue in period accounts of geological otherness, as in literary accounts of the sublime. (Heringman 2004:55, my emphasis)

In Conclusion, Two Dances

By way of conclusion, I turn to two dances, both of which attempt to express the earth’s movements, including those of
humans across its surface. This turn is again in the romantic spirit of Novalis by which I have been most guided in this paper. For Novalis, it was feeling that produced a sense of becoming with the absolute rather than reason. Such feelings were only ever attempted, if not always successfully, by art. He defined art as that which made feeling its object.

Moon Ribas is a Spanish artist who wears sensors on her body that vibrate anytime there is an earthquake in the world. She dances as she feels the impulses in her body and according to their intensity. Given that I am interested in exploring how one feels the movement of the earth within oneself and the romantic exploration of the subsequent dissolution of subjectivity, this effort to express the earth interested me. Ribas explains how she imagines the sensors as sculpting her brain, making her into a cyborg, and giving her two heartbeats. While fascinated by Ribas’s art, I ultimately do not find her expression and interpretation convincing. I think the impersonal tone is noteworthy in allowing her to cast herself as an instrument or, more explicitly, a cyborg, but this seems to me to be a problematic expression of the dissolution of subjectivity as the experience of the geological. The problematic aspect is that the dancer purports to express the inner movements of the earth without the mediation of the socialized body; it has an unquestioned universalizing aspect to it. But the art still helps raise the question of whether the dissolution of subjectivity necessarily entails the embrace of the impersonal. According to Novalis, it is art that takes feeling as its object that expresses the dissolution of subjectivity; in other words, it is “feelingfulness” and not the flatness of the impersonal that best expresses this condition. I would further argue that the dissolution of subjectivity entails acknowledging the dimension of the nonhuman at the edges of human gestures, the aspect of gigantism at play within them, but without allowing the particularity of the human from falling away from view. A second dance suggests how this particularity matters in making feeling more prominent and poignant.

A snippet of a longer dance titled “zero degrees” by Akram Khan and Sidi Larbi provides an instance of what I mean. Akram Khan is a British dancer of Bangladeshi origins, and Sidi Larbi is a Belgian dancer of Flemish and Moroccan descent. Their dance grew out of their desire to dance together, to seek out a point at which the different aspects of their identities find equilibrium. In it two men dance their attempts to connect with and carry the bodies of mannequins, being weighed down by them but refusing to leave the stage without them. This snippet of the longer dance feels compelling to me as suggesting the pain of separateness and the desire for relatedness as a way to understand the attraction between humans and the geological as the nonhuman. The effort to express a collective movement through the human and the nonhuman by stringing together one’s body with mannequins seems very poignant to me in terms of suggesting the weight of the geological and corporeal efforts to sense and carry it as one’s own. It suggests a different way to understand the conjoining of the human and the nonhuman, subjectivity and its dissolution, frailty and gigantism, that works precisely because it makes feeling its object.

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Farming Odd Kin in Patchy Anthropocenes

by Yen-Ling Tsai

How do we make sense of the uneven landscape in Yilan, Taiwan, where small-scale organic farming and luxurious country houses grow side by side? This essay suggests that we see both the rise of luxurious housing and eco-friendly farming as different patches of human-to-land relationships woven together through a landscape structure undergirded by the rise and fall of nuclear-family farms in post–World War II Taiwan. The uniqueness of the eco-friendly farmers in Yilan lies in their abilities to foster new livelihoods through creative assemblages of more-than-human economies and ecologies. By taking care of the wandering ghosts in the paddies, for example, new farmers join old farmers and villagers to enact a more-than-human world where both the material and the formless matter. By taking care of the paddy creatures, new farmers also join the health- and environmentally conscious urban consumers in enacting a more-than-human world where human well-being depends heavily on the well-being of nonhumans. Recognizing these interweaving practices of both normative and odd kinship making in relation to farmscape making helps us to think of more nonexclusive ways of farming and co-living in patchy Anthropocenes.

This essay is about the hope and despair of living and farming in Yilan, an alluvial plain in northeast Taiwan. As can be gleaned from the aerial photograph (fig. 1), what lies behind the beguiling bucolic scenery is a landscape changing so fast that in the past decade, on average two luxurious country houses were built each day in Yilan.1 Meanwhile, with every spring planting season comes not only a new batch of seedlings but also a new batch of novice farmers. Both landless and experience-less, many new farmers prefer eco-friendly farming over conventional farming and see in agriculture not just a career or business but also a way of life.

I joined this modern back-to-the-land movement in 2012 and have since become the farmer-manager of 0.16 hectares of rice paddy for a women’s cooperative farm called the “Land Dyke Farm” (Tolaku Farm 土拉客農場, “landdyke” hereafter).2 Quickly, however, I began to see a deep-seated irony rooted in the landscape I work, where small-scale organic rice farming and luxurious country houses grow side by side. Moreover, the eco-friendly farmers are using low-input, less fossil-fuel-intensive and more cost-efficient farming methods on what has arguably become the most expensive farmland in the world.3 How do we make sense of this uneven landscape, and what does it say about the patchy nature of our current space-time now understood as the Anthropocene?

Sociologists are quick to identify this landscape as emblematic of what Karl Polanyi calls the “double movement” (Polanyi 1957). That is, capitalism has gradually encroached on the fictive commodity of farmland in Yilan, while the new farmers’ movement has become the social protectionist countermovement seeking to decommodify farmland and restore it to a position of fundamental value (e.g., Lii 2010, 2011). Such interpretation situates the new farmers’ movement outside capitalism without explaining why. It also preempts discussion of what is involved in the process of land commodification, while to me that process is precisely what needs to be explored rather than assumed. This essay takes a different approach by taking seriously the entangled socialities found in processes of farmland commodification. Having been alerted to the fact that many retiring farmers in Yilan are selling their land to ensure their children’s or even grandchildren’s education or urban home ownership, I suggest that it might be more fruitful to contextualize the land crisis in Yilan within the larger crisis of

1. Since the opening of a highway connecting Yilan to the capital city of Taipei in 2006, which is now about an hour’s car ride from Yilan, more than 7,000 luxurious country houses have sprung up locally and have driven the average land price up threefold.

2. Founded by four LGBT farmers, the name of the Land Dyke Farm pays homage to the 1970s separatist lesbian back-to-the-land movement in the United States. As of 2019, the farm has three full-time farmers and two part-time farmers, collectively managing 0.8 hectares of rice paddies, 0.5 hectares of vegetables, and 0.2 hectares of bamboo garden (for bamboo shoot production), plus 0.9 hectares of citrus orchard under the mentorship of an experienced male fruit farmer. Because of Land Dyke Farm, every spring my life is a race between the rice paddy and the university: I go to the rice paddy to check on water levels first thing in the morning and replace some seedlings that have been eaten by golden apple snails. Then, it is teaching and research during the day, and back to snail-picking in the paddy at night for 2 hours before sleep.

3. The average price of arable land in Taiwan is $50,000 per hectare, far more expensive than average arable land prices in Europe and Japan (Tang 2015).

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family farming in Taiwan. Perhaps not unlike the coffee rust which has spread across the world through unshaded monoculture plantations (Perfecto, Jiménez-Soto, and Vandermeer 2019), luxurious country houses have spread across Yilan under the precondition of the aging nuclear-family farms. To put it crudely, it first took the aging nuclear-family farm, with its declining labor power, simplified land ownership (see below), and desire to exchange land for intergenerational reproduction, to allow the luxurious country houses to become an epidemic. But on the other hand, the eco-friendly back-to-the-land movement, too, is contingent on the overall weakening of nuclear-family farms, which are the dominant form of farm organization in Taiwan (Directorate-General of Budget, Accounting and Statistics 2017). Although unable to afford a piece of farmland, the new farmers nevertheless have plenty opportunities to lease paddy fields and fruit orchards in a Yilan whose farmer-owners are getting too old to work them.

In other words, I propose that the key to understanding the patchy farmscape in Yilan lies not in seeing luxurious country houses and new eco-friendly farmers as essentially antagonistic to each other—with the former being the embodiment of land commodification and the latter the embodiment of dec commodification. Instead, I suggest that “friendly farming” (youshan gengzuo 友善耕作)—a local term referring to farming practices that are more eco-friendly than conventional farming but without organic certification—too contributes to land commodification. I wish to argue that luxurious country houses and friendly farming are different but related “forms-in-relation” woven together through a landscape structure (Tsing, Mathews, and Bubandt 2019) undergirded by the rise and fall of nuclear-family farms in post-WWII Taiwan. The tensions between country housing and friendly farming arise when owners of luxurious country houses and new farmers form different more-than-human assemblages in their relationship to the land. Most owners of the luxurious country houses cemented their farmland and consumed the surrounding farmscape without taking care of the land. The eco-friendly farmers, on the other hand, perform care work for the land through multispecies collaborations between the farmers and the fauna, flora, and nonliving beings in wet-rice ecology. Furthermore, by adopting eco-friendly farming methods, these new farmers are able to sell their produce directly to health- and environmentally conscious urban consumers at a price much better than that of the conventional producers, hence creating a rural livelihood based on a new set of contingent foundations for themselves as well as others in the assemblage. Although not without its limitations, it seems to me that this more-than-human collaboration harbors some hope for a differently aligned politics and a more inclusive and livable Anthropocene.

In what follows, I will first explore how nuclear-family farming became Taiwan’s basic unit of farm organization in...
the post-WWII project of agricultural modernization. Such historization shows that nuclear-family farms are anything but the “natural” or “traditional” unit of agricultural production and family reproduction as they might appear today. As will be demonstrated, they are one of the homogenizing effects of the mid-twentieth-century land reform and Green Revolution, which not only promoted monocropping but also promoted nuclear-family farming and the associated individual land ownership by marginalizing other messier forms of human-land relationship (see the next section). The result is a modern farmscape controlled by the intertwined logic of capital and nuclear kinship. And when nuclear-family farms are in crisis, so is the land they control (see “Nuclear-Family Farms in Crisis”).

Meanwhile, the persistent existence of other forms of farm organization in Taiwan, past and present, suggests that the regime of the nuclear family never really monopolized how farmers bond with each other as well as their land. The section “Survival through More-than-Human Entanglement” of this paper demonstrates that the farmscape in Yilan is in fact shaped as much by ties made by nonblood, nonmarriage, or even cross-species practices of kin making as those made by ancestry or genealogy. That is the “patchy Anthropocenes” this paper wishes to foreground and identify. I believe, if it is indeed true that “hope is patchy because capitalist and ecological structures themselves are patchy” (Tsing, Mathews, and Bubandt 2019), then recognizing the patchiness of normative and odd kinship within Yilan’s farmscape might direct us to possible ways of transforming the landscape as well as overcoming the agriculture and farmland crises we face today.

The Cold War Production of Nuclear-Family Farms in Taiwan

In 1953, 4 years after the embattled Chiang Kai-Shek–led Chinese Nationalist Party (Kuomintang, KMT) fled China and set up a government in exile on the Japanese ex-colony of Taiwan, the “Land Rights for Tenant Farmers” (geng zhe you qi tian 耕者有其田) Act was implemented. This was the beginning of the largest social engineering program to take place in Taiwan in the postwar period, and it deeply influenced the fate of Taiwanese agriculture and land use. Within 10 years, the KMT state transferred nearly half the farmland from the former landlords to the tenant farmers who worked the land. Researchers in favor of the land reform emphasize that it promoted the even distribution of wealth and successfully modernized rural land ownership. Skeptics, however, believe that the land reform was in the service of an iron-fist state, through which the KMT effectively weakened the local elite class and took control of Taiwan’s food resources along with other rural surplus values.

The reality was of course more complicated than either side made it out to be. Recently published in-depth studies (e.g., Chu and Liao 2015) have pointed out that the local Taiwanese elites, mostly members of Taiwan’s Provincial Parliament, came to a political compromise with the ruling KMT government in the final days before implementation of land reform, raising the limit for individual land ownership from 2 to 3 hectares. In contrast, however, “collectively owned land” (gong ye di 公業地; see below), which lacked any strong backing in political institutions, was expropriated by the state in its entirety, regardless of size, in order to help meet the land reform targets established by the KMT technocrats. In practice, then, the 1953 land redistribution program spared each individual landowner 3 hectares of land while denying collective owners any chance to keep even the smallest plot. A great majority of land expropriated and transferred to the ownership of former tenant farmers in the 1950s was therefore collective land previously owned by large groups of people loosely connected to each other through extended familial or village ties. As a consequence, many collective shareholders who made their living off of collectively held land were thrown into destitution (Hsu 2010).

A further elucidation on the rules ordering human-to-land relationships in pre–land reform Taiwan can further shed light on the weight of this displacement of collective land ownership. From the eighteenth to the nineteenth century, waves of Han Chinese pioneers/militias moved from southern Taiwan to the north and from the east to the west. Armed with weapons and hoes, the invading militias brought with them wet-rice farming and violently replaced the swidden farming originally practiced by the indigenous Taiwanese, paving the way for the Qing dynasty government to move in on their heels. From that era up to the early 1950s, the Han Chinese used the so-called Ye–Dian System to order human-to-land relationships. Simply put, Ye (業) refers to land proprietors, and Dian (佃) refers to tenant farmers. Tenant farmers paid rent to proprietors, while proprietors were morally obliged to work with the tenant farmers on irrigation, defense, and social welfare as well as village worship. In other words, the Ye–Dian relationship in Taiwan’s Han Chinese settler colony was never simply about land ownership; rather, it was part of a comprehensive social mechanism of local autonomous rule, covering matters from economic livelihood, to cosmological ordering, to social well-being. Seen from this view, the KMT land reform in fact played a crucial role in converting the more extended, relational, and community-bounded Ye–Dian relations to the absolute, exclusive, and individualized notion of modern property ownership (Ho 2015).

Moreover, this post-land reform individuated land ownership is heavily bounded by practices of a male-centered nuclear family, which was at the core of the US imagination and promotion of land reform in postwar Asia. According to Nick Cullather’s study (2010), Wolf Ladejinsky, the US advisor to the KMT land reform program, had intentionally associated the tenant-to-owner Asian farmers with the Jeffersonian yeoman—the idealized all-American independent homesteaders. He had a clear vision about winning the cold war against communism through replicating and multiplying the American “owner-cultivator” farm families in Asia, citing Thomas Hart Benton’s 1826 dictum that “the freeholder . . . is a natural supporter of a free government” (Ladejinsky 1977:287). Specifically, the 3 hectares allotted for each individual in the reform program was
based on the assumption that a man could support a family with a farm of that size. As such, the “individual” at the center of Taiwan’s land reform was also a specifically gendered individual: the working, married male farmer.

The land reform and Green Revolution encouraged large extended families to transition into nuclear families in more ways than one (Chu 2017:153). In anticipation of the implementation of the 3 hectare per person limitation, many landowners preemptively split up their landholdings among their sons. Together with the family planning program promoted in full force in the 1960s (Huang 2016) and the state-sponsored Agricultural Association that, to this day, only grants membership to the head of the farm family household, while organizing women and rural youth separately according to the US 4-H Club model, the nuclear family farm, along with its culturally defined male supremacy, had been institutionalized and naturalized in rural Taiwan by the 1960s.

The result is a peculiar “small farmer system” characterized by highly fragmented farmland managed by highly self-reliant and entrepreneurial farm families, maneuvering through Taiwan’s fast-changing postwar economy. When, during the 1950s, land reform and the use of chemical fertilizers enabled farmers to generate profits, owner-cultivator agriculture became a business with bright economic prospects. The nuclear-family farms used their unpaid and flexible labor to turn their farmland into an effective production machine (Greenhhalgh 1988). Later, as the emphasis of economic development shifted toward industry, the family farms started to turn their farmland into textile or plating factories, forming part of the extensive global supply chain that turned Taiwan into a tiger economy (Hu 1978, 1991). As subcontracting capitalism moved again to Southeast Asia and China in the search for cheaper labor, the main source of income for the Taiwanese family farm shifted once again, primarily relying on the urban industrial or service sector income of their sons and daughters. At this point, the vast majority of wet-rice paddies were no longer farmed by owner-cultivators but were rather outsourced to large-scale farming contractors who owned large-scale farm machinery. Now, the remaining significance of owning farmland, besides the exchange value of the land, was that it allowed old farmers to receive social benefits and subsidies and served as collateral for financing loans for the entrepreneurial endeavors of the next generation. Like its owner-farmer, the farmland has drifted further and further away from farming.

Nuclear-Family Farms in Crises

So far in this article, my analysis has treated the family farm as a seemingly unified whole, but the very notion of a free and freedom loving, self-cultivating farming family in fact depends heavily on an imposed sexual division of male and female labor. Despite demonstrating a degree of participation in farm labor that does not fall short of their adult male counterparts, women’s role in farm production is rarely acknowledged. When the members of landdyke first moved to Yilan, to a village called “Deep Ditch” (Tshim-Kau 深溝), we were frequently questioned by villagers passing by our fields: “Whose daughter or daughter-in-law are you?” as though female farmers can only work for men. When the value of their contribution goes unacknowledged, women and children often feel alienated from farm labor. I often chatted with elderly village women while they cooked for temple events and had a moment’s rest. Much to my surprise, I heard story after story of hardship, drudgery, or even abuse—bitter memories about their early lives coming from the double burden of having to work both on the farm and at home. Such conversation with these women sometimes ended in tears.

Male farmers also talk about the hardships of the past, but they tend to frame their hardship in a different narrative structure. While women farmers have almost unanimously agreed that their lives are much better now, many male farmers lament a “golden age” long past. This golden age was after land reform, when all of a sudden tenant farmers could enjoy the freedom and satisfaction of being the owner-cultivators. The availability of small farm machinery as well as chemical fertilizers and pesticides in the 1950s also alleviated the burden of farm work in very significant ways. Based on their narratives, the good old days of the male independent owner-cultivators came to an end after the 1970s, when the state-sponsored amalgamation of rice paddies encouraged the rise of large-scale rice farming machine contractors.

The result was a lose-lose situation. For the machine contractors, large machinery was so expensive that they were pushed toward endless expansion of the contracting area in order to pay back their debts before the next faster and more expensive machines hit the market. Meanwhile, the smallholder owner-cultivators were forced to outsource farm work to machine contractors in order to catch up with the sped-up rhythm of the public rice-buying system. As a consequence, their already meager profits suffered from further cutback.

5. But statistics show that the villagers are probably right. In 2015, 80% of family farms in Taiwan were headed by men. Although the civil law has since 1930 ensured equal inheritance rights to men and women, the total size of land owned by men according to the latest statistics is 2.7 times more than land owned by women, and the total worth of properties inherited by men is 3.5 times more than that inherited by women (Ministry of Finance 2016). Most revealingly, when it comes to farm land inheritance, the male percentage goes up to 89% (Directorate-General of Budget, Accounting and Statistics 2017).

6. Once, a friend’s mother excitedly said that she wanted to come to Yilan to see my rice paddy. As soon as she arrived beside the paddy, however, she insisted on leaving immediately. Her son apologized repeatedly for his mother’s peculiar behavior, but it was not until much later that I have come to appreciate the important lesson her brief “back to the land” drama has taught me. Despite having succeeded in becoming a teacher and advanced her way into the urban middle class, and despite having a real nostalgia for her farming childhood, standing beside my rice paddy that day, she was nevertheless still overwhelmed by the memories of hard labor half a century ago.

4. Note the resemblance of this system to the allotment of 3 hectares of forest territory for each indigenous Taiwanese family during the Japanese colonial period (Kuang-Chi Hung, personal communication).
In short, the land reform and Green Revolution did once transform a majority of Taiwan’s male rice farmers from tenant farmers to autonomous owner-cultivators as was envisaged by Ladejinsky. However, in its endless pursuit of efficiency, the Green Revolution also pushed for the reseparation of land ownership and on-the-ground farm management, and in so doing alienated the once-happy male owner-cultivators from their work and their land. Meanwhile, let us not forget that the work that was defined as female—such as childcare, cooking, farm animal care, vegetable growing, harvesting of pulses, and so on—has undergone only a very limited degree of mechanization to reduce the burden on women (even though such small machines were readily available, at least in Japan and the Philippines). Therefore, it is not hard to understand that when one after another export processing zone (jiagong chukou qu 加工出口區) was established along Taiwan’s west coast in the late 1970s, they were promptly embraced by young women from the countryside. Having enjoyed the relative financial autonomy and physical mobility that factory work offered in contrast to work on family farms, these rural young women began to choose to marry men with urban, nonfarming backgrounds. Beginning in the 1980s, the number of Southeast Asian immigrant women marrying rural Taiwanese men increased significantly (Hsia 2002). This is a sharp reminder that by then, rural young women had already rejected the postwar nuclear-family farms en masse, and their collective decisions have foretold the crisis into which nuclear-family farms in Taiwan have fallen today.

It is critically important to recognize that it is the “nuclear-family farm” that is collapsing, not the “nuclear family” itself. To the contrary, just as the number of nuclear-family farms is declining while those remaining rapidly age, the nuclear family in Taiwan seems to be thriving. I believe this is an emergent phenomenon brought on both by the increasing privatization of personal well-being under neoliberal globalization and by the fact that, in the absence of strong social welfare, families have typically functioned as the site of resource and financial allocation in Taiwan.

Regarding the former, Melinda Cooper (2017) forcefully points out that neoliberal reformers of the 1980s successfully revived the tradition of private family responsibility in the idioms of household debt through politics designed to democratize credit markets and inflate asset values. Advocating for the privatization of education, housing, health care, and childcare, more and more states now expect the market to make up for the lack of public infrastructure, turning the nuclear family into the primary safety net or even the last resort for those who cannot afford to purchase the necessary service. Correspondingly, the resource distribution of the twenty-first century is no longer channeled through the instrument of the Fordist family wage (and I would add: its rural sibling in the Ledinskyanian “owner-cultivator family farm”) as was the case in the mid-twentieth century. Instead, it operates more and more through the wealth-transmitting mechanism of private inheritance (Piketty 2014). Recent studies on the increasing income gap between wealthy and poor families in Taiwan confirm this trend (Lee and Lin 2017). Meanwhile, it is necessary to add that Taiwan’s social welfare distribution mechanisms, in particular housing and medical care, have always been inseparable from the practices and idioms of the heteronormative family. The queer people, the homeless, and the single people are therefore in danger of a “double marginalization”—first for falling outside of the heteronormative household and second for falling outside of public welfare systems (Chao 2005, 2017).

The nuclear-family farms in crisis and the trend of privatizing personal well-being through intergenerational familial reproduction have formed a critical conjuncture. Essentially, the more the states turn the nuclear family into the primary safety net for personal well-being, the more pressure is placed on the farming families to sacrifice their farmland in exchange for family upward mobility. And the stakes get higher and higher. In January 2000, in anticipation of the first party alternation through election in Taiwan’s history, the KMT worked hand in hand with its opposition, the Democratic Progress Party, to liberalize the farmland market in Taiwan. Both parties were bidding for populist votes. As a consequence, the landholding system in Taiwan has since shifted from the post-WWII “farmland owned by farmers” (nongdi nongyou 農地農有) policy to a “farmland for farm use” (nongdi nongyong 農地農用) policy, allowing nonfarmers to buy farmland provided that they keep the farmland for agricultural use—essentially a deliberate strategic loophole to encourage farmland speculation. Unsurprisingly, the next 2 decades witness a surging of farmland prices all over Taiwan. Between 2000 and 2017, more than 30,000 country houses were built in the name of “farmers’ residences,” while quite ironically, the total number of farmers in Taiwan had been in decline. It shows that the family farms that were once the backbone of Taiwanese agriculture are now cashing out from agriculture by selling off their farmland. The family-farm crisis has thus become a farmland crisis, which is further evolving into a crisis of agriculture in Taiwan, and which, in turn, is leading to new ways of living and being on the patchy landscape of paddies and sprawl. It is with these histories and futures in mind that I now invite you to visit my rice paddy in Yilan.

Survival through More-than-Human Entanglement

A night at the beginning of March, which is also the period of the “Insects Wake” (jingzhe 驚蛰), I’m wearing a hunter’s headlamp, bent down in the midnight rice paddy picking golden apple snails (Pomacea canaliculata Lamarck, 1822). That morning at 6:00 a.m., 20 trays of rice seedlings were rolled up at the nursery, trucked to and transplanted into my rice paddy. These seedlings sprouted in the typical Yilan February of endless cold fronts and misting rains. Tonight, less than 20 days old, they are already facing a competition for life and death where every second counts: underneath, in the mud, more than 20,000 golden apple snails are wide awake from a good long winter’s sleep.
waiting for their first bite of young seedlings since last April.” The moment these snails surface above the mud and make contact with the paddy water, two antennae extend out from their shells. The antennae can detect chemical particles of the seedlings, so that the snails know exactly which way to crawl despite near-sightedness. Meanwhile, the seedlings quickly develop new roots, to strengthen their bodies, and toughen the sightedness. Meanwhile, the seedlings quickly develop new roots, to strengthen their bodies, and toughen the sightedness.

There are other protagonists in this competition. One month before the transplanting, farmers begin to prepare the paddies, pick snails, cut weeds, and adjust the water levels. The goal is to maintain the lowest possible water level after the seedlings are transplanted, in order to give the seedlings just enough water to grow, while minimizing the mobility of the aquatic golden apple snails. Meanwhile, the transplanting machine stirs up the snails, along with little shrimps, fish, water scorpions (Laccotrephes spp.), mole crickets (Gryllotalpa spp.), paddy frogs (Fejervarya limnocharis Gravenhorst, 1829), toads, Chinese river snails, pointed snails (Stenomelanina plicaria Born, 1778), and native clams. These little creatures seem harmless to both snails and the seedlings, but they do attract the spot-billed ducks and moorhens. The round-bodied ducks knock over rice seedlings when they swim, and the narrow moorhens pull the seedlings out of the mud, leaving a ready feast for the golden apple snails. On the other hand, the movement of the waterfowl also disturbs the paddy water, stirring up microorganisms and organic matter to be more easily absorbed by the seedlings. “Human feet are fertile,” is what senior farmer Grandpa Chang used to say to encourage new farmers to walk and work in their paddies more often. Now I’ve learned that the waterfowl have fertile feet as well. The difference is that these paddy birds take off from work as soon as the sun sets, but we human farmers like to wait until midnight to pick the snails—when they are said to be most active. And while picking the snails, I easily get distracted by the cacophony of mole crickets, paddy frogs, and toads, spending minutes or hours watching tiny shrimps and other small creatures swimming, eating, copulating. Midnight snail-picking may sound strange or even crazy, but it is also a ticket to the late-night congress of paddy beings, for unless a cold front keeps things quiet, an organic rice paddies is at its most boisterous and vital on such spring nights.

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What is unique and important about the friendly farmers and their collective endeavors in Yilan lies in their ways of fostering new local livelihoods through various creative assemblages of more-than-human economies and ecologies. As mentioned previously, the crisis of family farms has made way for both a new friendly farming movement and a luxurious country housing market to flourish in Yilan. At its core, this crisis of Taiwanese family farms is the crisis of Taiwanese rural kinship compounded by other general crises in agriculture as well as urban home ownership. Selling off their farmland in order to facilitate intergenerational reproduction in the cities, these retiring farming families, along with the houses and land released by them, allowed outsiders to gain traction in Yilan’s farmscape, which had heretofore been largely inaccessible to nonkin others.

Golden apple snails, too, participated in one such friendly farming assemblage. First imported to Taiwan in 1979 as a food source, golden apple snails have become a major agricultural pest, feeding on rice seedlings and other aqua produce such as Manchuria wild rice (Zizania latifolia (Griseb.) Turcz. ex Stapf), taro, and lotus roots. Hand picking is by far the most effective but also most labor-intensive method of snail removal, by which farmers can minimize the damage of golden apple snails while keeping the rest of the paddy animals alive. It is more ecologically friendly than the state-sanctioned and certified organic rice farming method, which encourages farmers to use camellia seeds as pesticides and kills the majority of paddy creatures along with golden apple snails. Many friendly farmers therefore pride themselves on forging a less antagonistic relationship with the golden apple snails: if friendly farmers can make a strange bedfellow even with the golden apple snails, we surely can make peace with everyone—and everything—in the paddies!

From the start, “friendly farming” in Taiwan has been in critical conversations with the state-controlled organic certification system. But besides contesting who gets to define organic farming, there is more to the story. Organic certification in

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7. Based on the estimation of field ecologists and fellow friendly farmers, Fang-Yi Lin and I-Han Chen (Lin and Chen, personal communication).

8. In January 2018, the Agricultural Council of Taiwan launched a new farm subsidy scheme to encourage eco-friendly farming. In February, the council revised the current farmers’ health and social benefits plan to cover tenant farmers. In May, Taiwan witnessed the birth of its first Organic Agriculture Promotion Act. It is worth noting that the term “friendly farming” (youshan gengzuo 友善耕作) is used in all three of the new regulations, to refer to farming practices that are more eco-friendly than conventional farming but have no organic certification. Generally, the writing of a concept into law indicates general acceptance of said concept within Taiwanese society; however, that was not the case with the codification of the term “friendly farming” in 2018. The general public’s understanding of “friendly farming” ranges from produce with no detected pesticide residue to “organic” farming with higher ecological standards than “certified organic.” In short, there is no agreed-upon standard on what it means to be "friendly farming.” I discuss the history and development of friendly farming extensively in Tsai (2016).

9. In 2007, Taiwan passed the Organic Foods Management Regulation that forbade the use of the term “organic” to describe any product that had not undergone official organic certification. This regulation would criminalize farmers like Chin-Sung Lai and A-Bao Li, two leading figures of Taiwan’s back-to-the-land movement, who have been farming organically but did not want to or were unable to receive organic certification. Developing a discourse on “friendly farming” in this context, then, was their way of reasserting their rights to farm organically outside of the state-sanctioned space of the certified organics. Moreover, in its emphasis on a comprehensive, “all-friendly approach” (quanshengwei youshan 全方位友善) to the environment, the farmer, as well as the consumer, as opposed to the narrow emphasis on organic inputs in the 2007 Organic Foods Management Regulation, the discourse of “friendly farming” also offers a sharp critique to the technicized and conventionalized certified organic system in Taiwan.
Taiwan requires a long-term lease on farmland. However, such leases have become nearly impossible in the post–land reform Taiwanese countryside. Out of fear that reallocation of land will occur once again, few farmers are willing to formalize the landowner-tenant relationship on paper. This fear applies even to kinsmen who are within the same extended families, because this is exactly what land reform did: it first reclassified communal relationships between kinsmen as landowner-tenant relationships before redistributing land accordingly. Consequently, at least up to 2010, almost only landowners or the very close relatives of landowners (plus a minority of farmers who lease public lands for organic farming) have been able to successfully apply for organic certification. The material condition of organic farming is thus highly contingent on either one’s ability to own a piece of farmland or one’s ability to secure a long-term land lease through kinship ties.

Seen from this angle, “friendly farmers” are often those who are without official access to Taiwan’s farmland ownership—through either kinship or market. In fact, because Taiwan’s legal system defines farmers based on farmland ownership, and because the majority of friendly farming land use occurs with only a verbal contract, these “landless” plus “lease-less” friendly farmers are essentially nonexistent in the eyes of the state. The official legal codification of “friendly farming” in 2018 therefore represents a novel attempt by the state to render legible this grassroots initiative as well as its heretofore illegitimate hope—that is, hope for long-term, stable access to farmland, which is the precondition for a more ecologically sounding approach to farming.

Notwithstanding all the difficulties, since the 2010s a community of friendly farmers has begun to take root and thrive in Tshim-Kau. Why Tshim-Kau? Because the wife of a pioneering couple, By-Hoong Chu and Chin-Sung Lai, was a village native. Through By-Hoong, Chin-Sung was able to lease paddies from her relatives, although still without any written contract. When there were more paddies than Chin-Sung could farm independently, the couple decided to make them available to other friendly farmers—not through kinship ties nor commercial mechanism but through a project called “Two Hundred Hectares” (liang bai jia 两百甲). For an aspiring farmer to get access to a piece of paddy via this project, all it takes is to go through an interview with the project leader, provided that s/he agrees to care for his/her rice without using any chemicals. The project also provides the basic know-hows of organic wet-rice cultivation, including eco-friendly ways to manage the golden apple snails that I try to illustrate in the ways that I have described above. Now, instead of having nuclear kinship ties or land ownership, it is the promise and practices of taking care of the paddy creatures that grants a friendly farmer access to farmland. Land ownership and kinship ties still play a role, but they are no longer exclusive roles. They are now part of the socioecological web of connections that allows a community of friendly farmers and the creatures they care for to co-thrive in Tshim-Kau.

I wish to emphasize that the rise of the friendly farming community in Tshim-Kau is a story of surviving-together and becoming-together through forging more-than-human alliances. The mainstream media often tells stories of new farmers as people “running away” to the countryside to “escape” urban boredom and start life anew. But in a very tangible way, what friendly farmers encounter in the countryside are in fact ecological and social wastelands resulting from a long regional and transnational history of uneven development carried out in the name of Progress. Think, for example, about the farmland left fallow due to foreign agricultural imports since Taiwan joined the World Trade Organization (WTO) in 2002. Or those irrigation channels with water quality so poor that only golden apple snails can survive. Or the acidified soil in vegetable fields from years of excessive fertilization. Or old farmers in dialysis treatment after years of pesticide poisoning. These sites and bodies are ecological “ruins” created by an ever-expanding transnational industrial food regime that Taiwan is still trying hard to further integrate with.

Think also of the village elders being taken care of by Southeast Asian migrant domestic workers. Or of the elementary schools facing shutdown year after year due to low enrollment rates, which resulted from the flow of rural to urban out-migration combined with Taiwan’s world’s third-lowest fertility rate, which, in turn, has to do with Taiwan being one of the top five longest-working countries in the world (Central Intelligence Agency 2017). The empty schools and houses in the countryside are the social ruins created by Taiwan’s export-based economy, which has failed to deliver the alleged “multiplier effects of employment and income growth” that it theoretically should have offered (Gibson-Graham 2011:6). What has happened instead is that, after the countryside has been gutted of its resource, youth, and talent, thousands of luxurious country houses owned by nominal farmers not stand obstructively in the middle of thousands of rice paddies in Yilan. These luxurious “farmer’s houses” further convince old farmers that they should cash out from agriculture once and for all, by selling their farmland to speculators in exchange for a piece of property in Taipei, which promises better opportunities for long-term familial upward mobility.

However, when human and nonhuman species meet each other in these ecological and social ruins, things start to change. When working-poor youth met fallow paddies, they turned the over-abundance of “weeds” in those former wastelands into “biodiversity” much appreciated by the UN-Satoyama Initiatives (Takeuchi 2010). When golden apple snails were given the chance to survive in friendly farmers’ paddy fields, they became a food source for various paddy animals as well as an extra source of income through selling to fish hatcheries who prefer the quality of chemical-free snails. When former office workers encountered rural elementary schools in danger of closing, they started to bring vegetables grown by old villagers to elementary school lunch tables, triggering the interest of the school principal to further invite old and new farmers to teach students how to use eco-friendly farming methods to plant rice. This and other initiatives were promptly recorded by young farmers in various media forms, who later turned these stories into highly acclaimed publications (Chen 2015) and online media.
sensations (Agriculture Design Workshop 2016). Within 5 years, more than 70 families and individuals have started a farming career through Two Hundred Hectares in Tshim-Kau and nearby villages. By regenerating local knowledge and social alliances, as well as promoting identity and culture that strengthen local economic viability and diversity, these new farming units rebuild the social, political, economic, and cultural web of life that allows one to advance in the transformation of a failed and harmful industrial agro-food system (see fig. 2).

In short, practices of friendly farming in Yilan are retro-fitting the nuclear kinship ties that, since the land reform, have largely confined the access to farmland and agriculture knowledge within nuclear-family farms. By taking care of various paddy creatures while killing fewer golden apple snails, friendly farmers join health and environmentally conscious urban consumers to enact a more-than-human network where human well-being depends heavily on the well-being of nonhuman fauna and flora in the foodway. And by strengthening material and nonmaterial ties with urban consumers, new farmers also strengthen their foothold in the patriarchal countryside to enact a more-than-human network where both kin and nonkin matter. Significantly, more and more old farmers are joining these more-than-human assemblages by bringing in their own creative projects. In spring 2017, a citrus farmer approached landdykes to offer his knowledge in organic fruit farming in exchange for our commitment for a 4-year apprenticeship. He was convinced that neither the state-centered agricultural extension system nor his family was capable of passing down his 20 years of accumulated farming expertise. We accepted his offer; since then, this family man has become the guru of five LGBT farmers.

Active participation in local storytelling and listening also reveals alternative modes of associating and becoming-with through farming. Quite incidentally, landdykes learned that one of our paddy fields was once cultivated by a well-respected widow who worked the land to raise three children through the help of many nonkinsmen villagers, while her close kin repeatedly plotted against her. The story of this strong-willed and collaborative woman farmer predecessor serves landdykes well, not only because it affirms what we are trying to do as a collective but also because it reminds us of more historical precedents of farming with nonkin.

Another example came directly from the early Han Chinese settler-colonizers to Yilan, who organized themselves based on an autonomous system of brotherhood, jie-so (結首). Bachelors from the same dialect group were formed into bands of aggressive farmer-militia to take over the indigenous Kabalan land and open irrigation canals (Wang 1999). These earliest batches of wet-rice farmers also farmed with certain strange and odd kin at the expense of their racial others. The gender nonnormativity and violent racial exclusion behind the story of early Han Chinese settler landscape-making in Yilan creates even more memories of patchiness.

Indeed, despite the emphasis on blood ties and kinship within the Han Chinese moral universe, in different times and places the Han Chinese have strategically gathered in kinship-like communal identities and established these imagined communities as the medium for estate inheritance. Fictive kin ties had always served the Han Chinese traders, sojourners, and settlers as well as they trod unfamiliar waters and terrains. It is worthwhile mentioning, though, that recent research findings of the so-called “Huanan School” (huanan xuepai 華南學派) of Chinese historians and anthropologists also suggest that practices of fictive kin-making happened frequently “at home” as well (Faure 2007; Faure and Liu 2000). Reexamining the Han Chinese notion of the “clan” (zongzu 宗族) through archival materials of southeastern Chinese provenances, they suggest that the “clans” that developed in the Ming dynasty were not the hereditary lineage group found in anthropological textbooks, nor were they some kind of traditional institutions specific to the Han Chinese culture and society. Instead, they were part of the civilizational projects of the Song and Ming Confucius intellectuals, who deployed various kinds of kinship-making techniques—compiling clan genealogy, building ancestral halls, elaborating on rituals of ancestral worshipping, in order to compete with popular Taoist and Buddhist practices at the grassroots level. In other words, it turns out that the Han Chinese just as frequently mobilized each other along fictive-kinship ties and that “blood” relations were only one of the many organizing and solidifying principles in Han Chinese societies.

Living and farming in Yilan, however, we even find prevalent practices of worship based on neither kinship ties nor fictive-kinship ties. “Big Brothers” (lau-tua-kong 老大公), we were told, are the deceased who have no descendants to regularly worship them. Thus, cutting loose from the conventional web of sociality strung through kinship or fictive-kinship ties, these lone souls like to wander around and may find shelter by a piece of rock or take residence in a paddy field as they please. According to elder villagers, it is advisable to make offerings to appease them, both at the beginning and the end of each planting season. Alternatively addressed by local villagers as “Lord of the Paddy” (tsan-tau-tsu 田頭主), these wandering ghosts are a force to be reckoned with if anyone wishes to yield a good harvest. When novice farmers got into car accidents or became ill, village elders also helped us to read signs given by these invisible beings residing in our paddy fields. In a way, they have also become a touchstone of a good tenant farmer for many old farmers/landowners. Just like they would quietly stroll by their paddies and check whether the tenant farmers are diligent enough to keep all the weeds down, old farmers also keep track of whether or not their tenant farmers are paying due respect to the Big Brothers and the Lord of the Paddy. In this perspective, tending a plot of land also means having to tend the ghosts there, who in return may help the farmers to tend the land. This chain of reciprocity grows and extends. Gradually, we have learned that what is produced through agricultural work has never been limited to the agricultural products whose prices rise and fall. Instead, a farmer is expected to take care of the tsan-thau tsan-bue (田頭田尾), literally, the paddy field in its entirety. Such a task
Figure 2. Mapping various assemblages of friendly farming in Tshim-Kau. (Copyright: AgriCulture Design Workshop.) A color version of this figure is available online.
Figure 3. Farming multispecies co-livability in Yehliu. (Copyright: AgriCulture Design Workshop.) A color version of this figure is available online.
encompasses all paddy beings, both material and formless. By taking good care of them, we will also be taken good care of (Tsai et al. 2016) (see fig. 3).

Conclusion

This paper is based on my long-term participation in, and contemplation of, ecological farming in Taiwan. As recent conversations about the Anthropocene acknowledge the planetary influence of agriculture in shaping the earth systems (some even proposing that the invention of agriculture be considered the beginning of the Anthropocene), could practitioners of agriculture contribute to the greater project of learning and relearning to survive in the Anthropocene? What kinds of agriculture, and what kinds of imaginings for the relationship between humans and land, could possibly bring forth better opportunities of coexistence and justice between the human and the nonhuman?

In my view, the current farmland crisis in Yilan urges us to see that, while ecological farming works hard toward creating new interspecies connections among humans and nonhumans, the logic of land distribution nevertheless remains under the control of capital and kinship that works through the entwined logic of property and intergenerational “reproduction.” Such logic encourages the continuous pursuit of human-centered, monospecies, self-perpetuating communal reproduction, regardless of how fictive the community under pursuit may be. It would not be an overstatement to say that, just as agriculture in Taiwan has slowly but gradually transitioned toward a new paradigm of respecting difference and striving toward biodiversity, the prevalent logic of farmland use in Taiwan is in stark contrast, growing in the direction of sameness and homogenization. Needless to say, when the commercial value of land increases, its options for use essentially become restricted to exclusive housing, thus eliminating space for multispecies cohabitation.

The irony I am trying to paint here entails a more ambivalent understanding about the seemingly hopeful alternative agro-food network movement as experienced from the ground up. It seems clear to me that a new set of agricultural practices that emphasize biodiversity alone is insufficient to save us from the predicament of farmland speculation. What champions of ecological diversity cannot afford to ignore, I suggest, is the simultaneous pursuit of economic diversity, which requires careful reflections on dominant forms of social organizations within our current system. We need to ask, for example: How do particular forms of human organization, such as family farming, enable or limit our agricultural practices? As I have demonstrated, the specific configuration of contemporary family farms in Taiwan is a contingent product that arose from the complicated history when Taiwan as an ex-Japanese colony encountered the Chinese Civil War, Cold War geopolitics, and the post-WWII US export of the Green Revolution. And as land speculation has driven the price of farmland to a record high, family farms in Taiwan are now facing another historical conjuncture. How does the changing relationship between the “family” and the “farm” open up new forms of destruction as well as livability? Is it possible to belong in the patchy landscape of paddies and sprawl in ways beyond capital and kinship?

I believe that the answer to the last question is a yes, and recognizing that ideologies of family may be in the service of land commodification is an important start, but certainly not enough. It is equally important to come up with other possible ways to imagine as well as institutionalize human and land connections, wherein inheritance and ownership are only two among many options rather than the only exclusive options. The section “Survival through More-than-Human Entanglement” of this paper demonstrates that the paddy landscape in Yilan is in fact shaped as much by nonblood-, nonmarriage-based kinship ties as it is by ties of ancestry or genealogy. The wandering spirits of early bachelor-settlers from Southeast China are now being taken care of by modern LGBT-friendly farmers. Golden apple snails from Latin America have coevolved with native snails, water birds, reptiles, and many kinds of fish to form multiple food chains both inside and outside the post-industrial wet-rice ecology. Urban precarities have assembled new livelihoods in the countryside by fostering new commodity chains that straddle hobby and work, artisanal and industrial, and capitalist and noncapitalist modes of production. Taken together, they formed a world of friendly small farming permeated with strange kin ties and have broadened our imagination of how to build alliances and make odd kin in and through farming. Significantly, while some people might prefer to tell these as heroic stories, to me they are stories of cosurvival, of human and nonhuman refugees helping each other out and turning industrial ruins into livable, inhabitable refugia (Haraway 2015; Latour et al. 2018; Tsing 2015). Most important, all of these are done with relatively little institutional support. Autonomous and spontaneous, these cases are among the best instantiations of “agricultural multifunctionality” in the fullest sense of the term.

Perhaps all of these stories past and present are not unlike the wandering Big Brothers and Lord of the Paddy that we friendly farmers have learned to respect in Tshim-Kau; their bones were said to be found, or spirits said to be residing, in the paddies; they were also said to be the deceased who voluntarily or involuntarily cut loose from the familial bonding that extends beyond life and death with an imagined endless male bloodstream. Scattered but ever-present, shadowy but all the more significant, they continue to remind us that the paddy landscapes in Yilan are as much shaped by normative kinship as by other strange and odd kin. It is hoped that, by recognizing the interweaving practices of kin-making and farmscape-making, we can better tackle the regime of intergenerational familial reproduction and its accompanying farmland crisis, and to think of more nonexclusive ways of farming and co-living in patchy Anthropocenes.

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