BIOMIMETIC FUTURES: LIFE, DEATH, AND THE ENCLOSURE OF A MORE-THAN-HUMAN INTELLECT

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ABSTRACT:

The growing field of biomimicry promises to supplant modern industry's energy-intensive models of engineering with a mode of production more sensitively attuned to nonhuman life and matter. This paper considers the revolutionary potentials created by biomimicry's more-than-human collectives and their limitations. Although biomimicry gestures towards a radical re-ontologization of and re-politicization of production, we argue that it remains subject to entrenched onto-political "habits" of social relations still dominated by capitalism and made part of a "terra economica" in which all is potentially put to profitable use and otherwise left to waste. With reference to Marx's notions of general industriousness and the general intellect, we find that this universalizing tendency renders myriad biological capacities and ways of knowing invisible. Drawing a comparison with the reworkings of life and knowledge explored in Londa Shiebinger's work on nineteenth century abortifacients, we show how biomimicry's more recent ontological remakings reproduce some forms of knowledge—and of life—at the expense of others. Reflecting upon biomimicry's inadvertent erasure of nonindustrial ways of knowing, we advance the notion of a "pluripotent intellect" as a framework that seeks to take responsibility for the co-curation of forms of life and forms of knowledge. We turn to Wes Jackson's Land Institute as a grounded alternative for constructing more-than-human techno-social collaboratives.

KEYWORDS: Bioeconomy, Nature, Marx, New Enclosures, Knowledge Production, Critical Feminism

Introduction

Expanding our collective consciousness beyond Enlightenment ideologies and liberal humanism seems to be an increasingly central task of the humanities and social sciences, particularly given current pressures of ecological change. Bruno Latour's (2009) renovated political ecology, the "thing theory" of Bennett (2010) and Connolly (2013), the "multi-species knots" of Haraway (2008), and the "agental realism" of Barad (2007) offer important new frameworks that are more sensitively attuned to nonhuman life and matter than the anthropocentric accounts of Enlightenment origins that remain predominant today. These propositions offer more nuanced tools for socio-ecological diagnostics and open up space for political imaginaries that extend beyond the human.

The field of biomimetic innovation seems to provide a practical expression of these theoretical propositions. Encompassing a diverse range of efforts to apply insights from the biological sciences to military and industrial applications, biomimicry is as much an ideal as it is a paradigm for research and development. Biomimeticists cast nature as a participatory "mentor" of engineering, an inventive companion capable of generating solutions more sophisticated than our clunky, industrial society can imagine. By working with "nature" in this way, biomimicry elevates what William Connolly (2013) has called "pluripotentiality"—the generative capacities of living and nonliving processes—as the driving force of technological innovation. In doing so, biomimicry promises to beget a new form of production that decenters and devalues human ingenuity, leaving open the possibility of a new industrialism that is more attuned to nature's needs.

Such a transformation in the political economy of knowledge production would seem to

be cause for celebration, and indeed mainstream accounts of biomimicry view the paradigm with joyful approbation (see Hawkins, et al. 1999; Benyus 1997; Forbes 2006; Allen 2010; Harman 2013). Here, however, we want to encourage caution and critique. Although biomimicry gestures towards a radical re-ontologization and re-politicization of production, in practice it must contend with the entrenched onto-political habits of social relations still dominated by capitalism. Instead of regarding capitalism as a set of overbearing structures, we see instead an unstable performance, repeated with difference; regularly renewed and diligently maintained, but far from inevitable (Gidwani and Reddy 2011). Or as Raymond Williams would write, a set of weakly determined relationships that nonetheless pattern our social, political and ecological lives (Williams 1977). Biomimicry offers an example of how capital's onto-politics habituate creative producers to channel emerging assemblages of human and non-human potentialities back into a paradigm of industrial progress, renewing and even accelerating the ongoing "treadmill of production" without destabilizing its unsustainable trajectory.

In this essay, we consider how biomimicry draws nonhuman participants into an ongoing process of enclosure, which we understand first and foremost to be the creation of capital's ontological conditions of production. The project of creating an enclosed nature entails the production of a world apprehended as "*terra economica"*— an undifferentiated landscape in which all is potentially put to profitable use and otherwise left to waste.

Biomimicry's transformations of nature's productive capacities parallel the social transformations under industrial capitalism that Marx described. Lauding the emergence of a technoscientific society made possible by capitalism and united by a "general intellect," Marx promoted a highly selective vision of knowledge and value production. We locate our critique of biomimicry around a similar universalizing gesture. We argue that the most troubling element of

biomimicry's emergence is not the privatization of specific forms of life (although this too creates numerous issues), but the way that life and all of its pluripotent potentials are incorporated into *terra economica*. In other words, biomimicry reduces, channels, and flattens a more-than human "pluripotent intellect" into a general intellect focused on commercial and industrial advance. This follows in the wake of earlier (and ongoing) forms of colonial conquest that have entailed the erasure of local knowledges, ontologies, and sciences, all lost in the pursuit of a generally industrious, universally rational mode of (profitable) progress. Drawing a comparison with the reworkings of life and knowledge explored in Londa Shiebinger's work on nineteenth century abortifacients, we show how these more recent ontological remakings validate and reproduce knowledge—and forms of life—created in some human-nonhuman collectives while laying others to waste (Povenelli 2014).

If we are to acknowledge, as Jane Bennet (2010) suggests, the "vibrancy" of nonhuman matter in order to generate "healthy and enabling instrumentalizations" (12), we may need to look beyond the creation of a more-than-human ontological framework to recognize how dangerous combinations of capitalism and colonialism reduce our sensitivity to life's pluripotency, as well as the inescapable and uncomfortable responsibility of curating life and death. In thinking through our more-than-human *(and more-than-capital)* potentialities, perhaps concepts such as Marx's general intellect need to give way to a conceptual language capable of proliferating more-than-human affiliations and trans-species subjectivities along multiple forms of knowing and being. Reflecting upon biomimicry's inadvertent erasure of nonindustrial ways of knowing, we ask what such a pluripotent intellect and attendant biomimetic practices might look like, offering one provisional example in the work of Wes Jackson's Land Institute.

Where the Bedbugs Bite: Biomimicry and the Making of More-than-Human Production

Throughout the early part of the 21st Century, cities across the US have been plagued by the return of bed bugs. While the widespread use of synthetic pesticides in the 20th Century had all but eradicated the pests, an evolved resistance to chemical deterrents has led to their resurgence and an urban public health crisis. Existing options for bedbug control range from the ineffective to the prohibitively expensive, prompting a team of biomimetic scientists at UC Irvine to explore an old trick used by Balkan women: kidney bean leaves. Spread along a bedside overnight, the leaves trap bedbugs as they look to feed and have been known to eradicate the pests without chemical pesticides. UC Irvine scientists have studied the precise mechanisms for the bean leave's success in harvesting bedbugs. Using scanning electron microscopy, they revealed that tiny barbs protruding from the underside of the leaves called trichomes hook into the legs of any traversing bedbugs, impaling them as they struggle to escape. Drawing on the trichomes as "a source of inspiration," they are working to "design and fabricat[e] biomimetic surfaces for bedbug trapping" (Sznydler, et al. 2013). As part of the advancing field of biomimicry, the kidney beans are inspiring scientists and engineers to work with some natures—the bean leaves—in order to work against others—the bedbugs—as part of an effort to engender more healthful, enduring ecologies suitable for human life. Although the recipe for these synthetic trichomes has yet to be perfected, it promises a new, pesticide-free way of eradicating one of the most tenacious irritants of urban life.

Since the 1990s, biomimicry has made biological research an increasingly important element in technological innovation. Here, nonhuman life and human production meet anew: rather than raw material to be put to work, biomimicry draws on nonhuman life as a source of

inspiration. It is a fractured field, driven by diverse aims.[1] Many advocates and designers view mimicking natural processes as a means to develop "green" technologies as well as a catalyst for thinking—and making—beyond anthropocentric approaches to production.[2] While for some, the eco-friendly narrative that accompanies biomimetic innovation is little more than a new greenwashing ploy, biomimicry's most ardent believers insist that it is much more. Following Janine Benyus, the appointed "guru" of biomimicry and author of *Biomimicry: Innovation Inspired by Nature* (1997), designers, naturalists, investors, and biologists have come together to catalyze what they see as a paradigm shift in production, one that not only looks to natural systems to solve problems of climate change and ecological degradation, but that also promises a new—non-toxic, non-exploitative—future mode of production modeled on nonhuman processes.

Discursive claims that have emerged alongside the field insist that biomimicry flips conventional scripts of human-nonhuman relations. Against ideologies of nature as a passive resource to be extracted and enslaved by "*Homo industrialis*," biomimicry recasts the nonhuman world as a collection of active, collaborative participants, recognized for their "genius." For these advocates and practitioners, biomimicry is a praxis capable of leaving behind Francis Bacon's cruel vision of nature as something to be violently subdued and harnessed. Benyus's vision of a biomimicry-inspired "Parliament of Species," for example—reminiscent of Latour's "Parliament of Things" (1993)—gestures towards a would-be democratic body in which human and nonhuman agents (or Latour's "actants") can no longer be easily separated or hierarchized, but together collaborate in the constitution of new worlds. The practice seems to offer a way toward what Haraway has referred to as a more-than-human cosmopolitanism: a framework for creating the world together while proliferating the ties that bind human and nonhuman life (Haraway, 2008; see also Johnson 2010).

Terra Economica: Enclosure as Capital's Ontological Conditions of Production

While biomimetic discourse promises to catalyze a future of expanded human-nonhuman relationships, actually-existing biomimetic research and development may do more to constrain our perceptions of this more-than-human world. From within the extant political economy of techno-science, biomimeticists isolate parts of a comprehensively creative, wise, and innovative nature, harnessing individual kernels of wisdom that can be translated into intellectual property and mobilized for commercial application. Examples are manifold: the silk-making capacity of the golden orb weaver spider inspires the production of durable, bullet-proof fabrics; the ventilation structures in a termite mound inspires greener building designs; lotus leaves inspire self-cleaning paint,; and, as we saw above, the bedbug-snaring capacity of the bean leaf inspires new pest-resistance commodities.

There is nothing inherently wrong with the biomimetic approach to industrial design, and in fact many biomimetic projects offer inspiring ways to envision a much more benign form of industrial production that mitigates the materially intensive model of chemical engineering undergirding modern industry. But, born of the realities of industrial funding streams from government programs (DARPA, ARPA-E) through to the neoliberal university and the high returns that the financial industry expects from early stage technologies, biomimicry remains beholden to the entrained pursuit of profitable, commercially (or militarily) viable technologies.[3] Accordingly, it contributes to the perpetuation of the very same techno-social infrastructure that it intends to transform in the first place. As we've written elsewhere, the reproduction of life is supplanted by the reproduction of capital (Goldstein and Johnson, forthcoming).

As biomimicry draws nonhuman life into the process of production, its re-ontologizations of nature or embrace of its pluripotent possibilities are presently occurring through the ongoing expansion of capital's own ontology, which casts nature as a general condition of production, a whole earth available to become capital (see, Smith 2008; Cronon 2003). Goldstein has termed this distinctly capitalist ontology of nature *terra economica*, tracing its emergence through the process of enclosure that transformed the early modern English countryside and providing the conditions of possibility for the transition to capitalist social property relations (Goldstein 2013, Wood 2002).

It is important to consider the ways that enclosure entails discrete acts of dispossession and the attendant violence enacted upon those made newly landless, separated from their means of production and reproduction and therefore left to the whims of the labor market. Here however, we consider the ways that enclosure, as a more general project entailed the production of a new nature, one that was no longer a world of diverse, non-capitalist productivities (what we call a pluripotent nature), but was instead re-conceptualized as a site for potential capital accumulation. This new nature, or *terra economica*, was a world waiting to become capital, and otherwise left to waste in its unimproved state. In this way, enclosure represented, and still represents, a re-ontologization of the more-than-human world, whose potentials (or the *potentia* of nature) are reduced and narrowed into the potential to become capital.

Accordingly, we consider biomimicry's predominant practices as one example of what many political economists refer to as "new enclosure." These new enclosures revive the originary land grabs of the seventeenth century, only instead of extending the process of privatization across territory, they are said to be intensive, targeting a diverse set of matter and practices. Elements like water, wildlife, fisheries, as well as forms of matter once considered

incompatible with the notion of enclosure have led to novel forms of privatization (Shiva 2002; Robbins and Luginbuhl 2006; Correia 2006; St. Martin 2006). The establishment of regulatory markets and intellectual property patents has generated frontiers for profit-generation around what James McCarthy has called "impossible subjects of enclosure" (McCarthy 2004, 337). In other words, the process of enclosure allows for specific objects or relations to be incorporated within established patterns of valorization by apprehending objects formerly considered "impossible" to commodify as potential capital.

Along with emerging research on cell lines, nano particles, animal bodies, air molecules, and other forms of knowledge, biomimicry has become one frontier of new enclosure, generating novel forms of property that must be regulated through patents on intellectual processes as well as material products (Katz 1998; McCarthy 2004; Prudham 2007; Robertson 2012; Sunder Rajan 2012; Jansanoff 2012). To reiterate: this process is more than theft and dispossession. It represents a profound shift in how meaning is attributed to land and to life.[4] For example: agricultural crops (providing starch and sugar) are grown, harvested and consumed as raw materials. By contrast, through the lens of biomimicry plants are instead made evidence of nature's "genius," repositories of skills—for killing bedbugs in the above example, or as "photosynthesis reactors" guiding solar cell research to take another example (Benyus 1997). In the latter case, Benyus goes so far as to explain that while plants have become "experts" at producing sugars out of sunlight, the biomimetic challenge is to apply the genius of photosynthesis to the production of more desirable energy products—such as hydrogen—that can be used to fuel industrial machines. Instead of being considered objects to be cultivated and consumed, plants and other nonhumans are put to work as the bearers of creative wealth. The evolutionary process—said to unfold within nature's own "laboratory" for "research and

development" (Benyus 1997)—becomes a site bursting with potential for commercial revenue. This is part of an active effort on the part of biomimeticists like Benyus who strive to suture production practices that "create conditions conducive to life" together with conditions conducive for capital. The pluripotent potentials of the not-capital, non-human world appear, to them, as not-yet-capital.

The Eco-Social Promises of a Generally Industrious Nature?

A return to Marx's writings on industrialization will help locate a kernel of transformative optimism in the biomimetic project, while also providing grounds for a feminist critique (of Marx and of biomimicry). In his often-cited "Fragment on Machines," (1993) Marx suggests (albeit vaguely) that the rise of technological development radically transforms labor by prioritizing innovation and intellectual creativity over manual labor. For him, the systemic violence of enclosure and wage-labor relations re-made human life by creating conditions for social unification. Marx saw therein the creative capacity of humans, which he termed the "general intellect." This source of collective social power was made manifest in the advance of science and technology that accompanied industrial production. Marx uses the term "general industriousness" to describe the modernizing potential of the techno-social system made possible by this general intellect, in which production for money—or general social need—releases human productivity from the narrow constraints of local, particular needs.

Marx's excitement for the techno-social possibilities of general industriousness ground his hope for a non-capitalist future, characterized by a new kind of communality realized through "call[ing] to life all the powers of science and of nature, as of social combination and of social

intercourse" (Marx 1993, 706). He thought this transformation would unify human production with technological apparatuses, gesturing to the dissolution of the very class relations that brought capitalism into being in the first place. For Marx, as well as more recent autonomous Marxist thinkers, these techno-social possibilities are one of the most promising residues of capitalism's advancing intensity (Marx 1993; Negri 1992; Casarino 2008).[5]

In many ways, biomimicry's narrative extends Marx's analysis to a more-than-human sociability. Biomimicry, and for that matter the broader bioeconomy, attribute to "nature" the same innovative capacities that Marx attributed to social labor. The non-human world is seen as a contributor to the general intellect of a more than human socio-natural body, and therefore a more-than-human general industriousness. Along these lines, biomimicry offers a further twist to the contradictory pathway toward revolutionary forms of production pursued by Marx and Marxists alike. It simultaneously furthers the process of capital accumulation while also encouraging a fundamentally transformed vision and practice of world-making inclusive of nonhuman life. It may in fact be that biomimicry's more-than-human collaborators are the long-awaited "gravediggers" that capital itself will hail into being, threating the ontological habits of a social logic that can only see the entirety of the world as an extension of itself.

However, what troubles here is the ontological limitations imposed by the seemingly universal conception of a "general" condition of intellectual or industrial advance. While Marx's conception of general industriousness provides a way of imagining that profound socio-political change will emerge from within the capitalist economy, it also shares with biomimicry a tendency to mark Western techno-science as a preferred means of making use of nature and its productive capacities. Biomimicry not only makes some lives—and not others, certainly not bedbugs—seem "naturally" worthy of reproduction and mimesis; it also endows the progress of

technological development and the tendencies of the market with decisive power to laud some collaborations and forms of knowledge—those considered "productive," capable of incorporation into regimes of innovation, and "conducive to life"—while erasing others. This runs parallel to Marx's tacit and somewhat uncritical endorsement of the "general needs" established by the community of money and the specific forms of technology and science aimed at meeting them. It is most evident in the numerous passages in which Marx describes non-modern, non-capitalist forms of social production as lacking the dynamism of capital's general industriousness. In those passages, we find a pre-modern world filled with the idiocy of peasant life, nature idolatry and encrusted forms of customary production that are predicated on maintaining existing social formations, as opposed to progressing down the unquestionably desirable path of modernity.

We dwell on these parallels between Marx and biomimicry to reveal the uncritical embrace of industrial progress coursing through otherwise radical or even revolutionary discourses of total social transformation. The problem with biomimicry—and with Marx—is not that a "general intellect" categorically supports the onto-habits of enclosure, but that this generalized world view tends to presume that all of life—human and non—is enrolled toward a singular emancipation through industrial advance. In order to consider what is lost in the rise and reproduction of Western techno-science, we now turn to other transitional histories well before the advent of biomimesis when life similarly entered new trajectories of production.

The General Ignorance: Erasing Knowledge through Production

Feminist-Marxist critique has already done much of the work for us in condemning this

Promethean tendency in Marx's work. Feminist historians and theorists, such as Carolyn Merchant, Maria Mies and Sylvia Federici have documented the ways that Enlightenment thought and the project of modernity came at the expense not only of nature—which had been reduced to an enslaved machine—but also at the expense of many indigenous and feminized forms of knowledge that were either incompatible with or at the very least uncontrollable by the emerging scientific order (Mies 1986; Merchant 1990; Federici 2004). Federici's history of the European witch-hunts, for example, demonstrates how women were demonized and, often, executed for displaying their autonomous relation the world—human and nonhuman alike. Elsewhere, regimes of knowledge production were erased as Western medicine took hold as the only legitimate form of knowledge. Londa Schiebinger's work (2004) on the history of women caregivers in the West Indies during the eighteenth and nineteenth centuries offers one notable example.

As Schiebinger writes, late eighteenth century knowledge of how to induce abortion using several native and transplanted species was the product of a globalized form of medicine. Through loosely interconnected networks of Native Americans, African slave populations, and West and East Indians, knowledge of women's bodies and nonhuman materials supported women's autonomy and provided traction for forms of political and social resistance (Schiebinger 2004; Proctor and Schiebinger 2008). Enslaved women opposed the conditions of their lives by cultivating plants such as the peacock flower, an abortifacient that could help women manage the liveliness of their pregnant bodies. With the plants, women caregivers offered their communities a choice between bringing new life into the world or terminating unwanted pregnancies in a place and time where the conditions of life were considered not fit for living.

As a male-dominated medical profession began to systematize the study of pharmacology, these circuits of women's medicinal knowledge were no longer considered valid or safe. The rise of the university system and the professionalization of medicine forcibly excluded women from learning and barred non-professionals from practicing their knowledge. As a result, a once vibrant and well-circulated system of knowing—and the attendant relationships between human and plant species—was overturned for commercial and ideological reasons, changing how life was managed and by whom across the West Indies. Even the history of these practices and the social relevance of certain forms of plant life were largely lost. Male botanists and physicians exploring the West Indies failed to recognize the effectiveness of species like the peacock flower for women's reproductive health. As Schiebinger explains, "funding priorities, global strategies, national policies, the structures of scientific institutions, trade patterns, and gender politics all pushed investigation toward certain parts of nature and away from others" (Schiebinger 2004, 226).

This story of abortifacients in the eighteenth and nineteenth centuries parallels what we see happening today with biomimicry's re-valorization of nonhuman life. The biomimetic imaginary legitimizes itself, in part at least, through the inadvertent erasure of any alternative techno-scientific approaches to engaging with more-than-human counterparts. By glorifying discrete portions of nature as a distinctly non-human source of inspiration, practices that have historically bound humans to nonhumans are ignored, as nature contra society is lauded for its ingenuity.

We see this production of ignorance taking shape in our example of kidney bean leaves and bedbugs. By glorifying the bean plants as a distinctly non-human source of inspiration, the UC Irvine biomimeticists exploring synthetic trichomes effectively erase the Balkan women who

were initially part of this human-bean plant collective. Consider the implications of this erasure: while attempts to synthesize trichome technology are met with failure, the wider public remains without any public health efforts to promote the far simpler, and more direct use of actual bean leaves to manage these pests. Indeed, what may be most troubling of all is the loss of an imaginary capable of bringing into being human-bean leaf collectives that might ameliorate an ongoing urban health crisis. There is no shortage of urban growing space, even in a city such as New York. Yet community kidney bean patches, bean sprout give-aways and city-wide campaigns celebrating the history of these Balkan women as leaders in a public health revolution all seem somehow more fantastical than "simply" patenting the production of synthetic bean leaves and letting the market do its work.

Even more, the production of biomimetic trichomes suggests a way of "choosing life" through eco-friendly products without addressing the highly political question of "which life?" (Neyrat 2010) and even more uncomfortably, "which deaths?" Each of these examples illustrates that cultivating some lives in order to inhibit others, would seem, at times, a socially desirable necessity.

As feminist historians such as Federici and Schiebinger demonstrate, this erasure of knowing-ecologies is part of an ongoing tendency in Western knowledge production. Historically, recognition of non-modern innovators only takes place—if it takes place—when those populations are coded, as Himani Bannerji writes, as "people of the body," or in biomimicry's case, people of nature (Bannerji 1998). Agency and intention on their part as creative and knowing participants in the more-than-human environment is often either dismissed or reinterpreted as local source material for the "real" and universalized (i.e. industrial) forms of innovation. The result is a denial of the particularity of Western knowledge, and the erasure of

other, indigenous epistemes (Sundberg 2013).[6]

Given this set of problematics, how might we think more-than-human planetary eco-social realities—and future imaginaries—without resorting to either a universalizing discourse or a naïve embrace of Indigenous or "alternative" forms of knowledge production? How might we consider a more-than-human, many-bodied form of production that is neither "generalized" nor exclusively "industrious"?

Unimagined and Re-imagined Futures

As we suggest with the bean leaf example, it is important to push back against narratives of industrial socio-natural production and narrowing presuppositions of what *we* want and what *nature* does. When evolution is codified as "research and development" we lose site of the pluripotency of (re)productive forces that exist, whose potentials exceed the narrowing ontology habituated through capitalist social relations. It may not be possible to re-pattern capital at an individual scale, but it does remain possible, at every scale, to think against and break with these ontologies and even to work through an alternative biomimicry that might develop conditions conducive not to a generalized life, but to some chosen form of it.

One final example of a more-than-human collaboration, offers an imaginary that moves beyond biomimicry's naïve sense of a future guided by nature's "will." Wes Jackson's Land Institute is researching the complex dynamics of prairie ecosystems in order to develop a viable alternative to soil-depleting agricultural practices based on the cultivation of annual monocultures. Through the technologically-mediated, yet ultimately age-old practice of selective breeding and hybridization, the Land Institute is attempting to develop perennial grains, legumes

and oilseed crops that can be cultivated as part of complex perennial polycultures. Jackson thus offers a different kind of biomimicry. Instead of looking for inspiration in specific plants or isolated characteristics of discrete non-human "innovators," Jackson and the Land Institute are inspired by the complex and resilient prairie ecosystems that once thrived on the Kansas plains. This includes a diversity of plants, animals and ecosystemic interactions, as well as a diversity of local and traditional information embodied in the everyday practices and ingenuity of the people who have historically lived upon the land.

This is a project fully aware of and responsive to the political economy in which it is situated. After years of research and development, the Land Institute hopes to release their first perennial grain, Kernza, within the decade. Rather than privatizing the seed as a commodity, they plan to make it—and their methods of production—available for farmers to experiment with and continue to refine. They know that their ultimate success will depend upon further experimentation in different ecological and social contexts. This kind of collaborative, distributed project serves as an invitation to continually recombine with other forms of life, other ecologies, and other systems of knowledge production. As the Land Institute's website explains:

> We are often asked when we will be done. The honest answer is never. Our germplasm must constantly evolve to be useful in different agroecosystems all around the world. For us there is no "endgame." We openly share our research and germplasm with scientists all around the world… (The Land Institute 2013, http://www.landinstitute.org/vnews/display.v/ART/2013/03/06/513a22329f471)

We point to the Land Institute as an example of post-productivist scientific inquiry and non-enclosing biomimicry—a collaborative process that seeks to learn from the more-than-human so as to co-produce a more beautiful, livable and sustainable world. For Jackson, coming

out of the appropriate technologies movement of the 60s and 70s, another less acquisitive science is possible. In fact, he believes that evolutionary processes are capable of generating conditions that are useless, unproductive and inefficient for capital, yet still valuable for more-than-human communities. As he writes, “The fundamental question is not, ‘what can we do?’ but rather, ‘what kind of world do we want and what will nature require of us?’” (Jackson 2006, 23).

Conclusions

Biomimicry is at the forefront of a quiet confrontation between the acquisitive techno-science of industrial fabrication and other forms of knowledge production, including indigenous and “folk” knowledges. Simply put, nature’s innovative capacities look much different depending on what social-industrial-technical project its “wisdom” is imagined to be in dialogue with. Thus, the question is not only, as Cindi Katz asks, “whose nature and whose culture?” but also “whose science, whose technology?” and “which forms of life?” are made and unmade in the development of eco-social alternatives to our present condition. In posing these questions, we do not merely offer a critique of biomimicry as a form of greenwashing, but flag a much greater problem: that of the necessity of our own position as co-curators of life and death on earth. Biomimicry’s future imaginary reduces our political imperative to merely "choosing" life over the “hubris” of human history. But, if life is neither unified nor benevolent, we remain faced with the question "which life?" In the example of the bedbugs, it is clear we have already begun to choose: we may yet develop ways to live with and care for bedbugs, but these disagreeable parasites are presently uninvited participants in our eco-social present.

The history of scientific racism, which regularly deploys natural metaphors to legitimize

systemic violence, should provide pause to consider just how fraught this terrain can be (see Magubane 1996). There are no easy ways to navigate these questions; a naïve embrace of all life (and disavowal of all death) is simply an abrogation of our ethico-political responsibility to be, as Haraway writes, "in responsible relation to always asymmetrical living and dying, and nurturing and killing" (2008, 42). Mimicking and abiding nature and its processes will not save us from the constant and dirty politics of having to "choose death" even as we "choose life."

In our encounter with a global ecological and economic systems whose expanded reproduction has come to threaten the very viability of our entire planetary ecology, it is becoming increasingly apparent to us that we may need to question whether the "real sources of wealth" are in fact aligned with a general industriousness that "know no bounds" (Marx 1993, 224). If we are to craft a different kind of eco-social future, we must consciously shift away from this celebratory—and decidedly humanist—account of innovation's potential and the historical arc of progress.

Beyond any vibrant metaphor of more-than-human industriousness, we will need to actively consider what technologies and what sciences we want to pursue. This is not, to suggest that modern science and technology be categorically disregarded, but that we must continually ask how and in what ways these forms of knowing can be re-habituated with other forms of inquiry. If projects such as biomimicry are to further a more-than-human, and more-than-capital eco-social future, it will only do so by recognizing both the recuperative powers of capital's logic and its tendency to evacuate the political from notions of progress. Such questions, positioned at the intersection of material and knowledge production emanating from multiple forms of life, may help us locate the possibilities of a new form of (re)production, one focused on holding as much as it is on making, and with it, the quickening of a new eco-social future.

[1] Corporate and military interests have championed biomimetic science for diverse reasons, many having nothing to do with "greening" technological production. Here, however, we focus on the more popular arm of biomimicry, which views the field as a powerful means of re-making the relationship between nature and production.

[2] Humans have fashioned behavior on nonhuman life for millennia. Historical examples include Leonardo De Vinci and Otto Lilienthal's (failed) flying machines, the Wright brothers' (successful) airplanes, and Georges de Mestral's development of Velcro®. But, scientific researchers, engineers and designers have only recently begun to embrace biomimicry as a new industrial paradigm.

[3] Elsewhere, the authors have explored the empirical conditions of biomimetic production, exploring the relationship among its historical emergence and venture capitalism, the US military, and the neoliberalization of university research (see Johnson 2010).

[4] This is not so different from the mid 20th century warnings of Heidegger (1977 [1954]) and Horkheimer and Adorno (2002 [1944]), who feared that a logic of instrumental reason had begun to govern perceptions of life, labor, and land. The crucial distinction, however, is that biomimetic approaches reconstitute life's ontology as a productive participant, rather than a passive object.

[5] We also find this expressed in recent texts on "Accelerationism," which suggest a temporary embrace and acceleration of capitalist innovation as a means toward a post capitalist future (Williams and Srnicek 2013).

[6] Juanita Sundberg's critique of the Eurocentricity of some posthumanist geographers and their tendency to sanitize knowledge production into a singular and universal form implicates our own disciplinary work as well. Many scholars critiquing nature-society dichotomies in the Western philosophical tradition (Sundberg calls out her own work, as well as Wolfe 2010; Braun and Whatmore 2010; and Bennett 2010) have failed to present our own intellectual tradition as spatially and temporally particular—or, more to the point, provincial. Sundberg argues that this inadvertently replaces one universalizing tradition with another.

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