

# Bioenergy: Some Stretching Exercises

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*This draft chapter takes the view that contending with bioenergy development effectively will require social movements to respect – but also to update carefully – Marxian accounts of capital accumulation that tie together the labour theory of value, surplus accumulation, the “contradictory unity” of living and dead labour, mechanization, “vampirism,” class struggle, and the tendency toward falling profit rates. Two ways of “stretching” Marx for this purpose are briefly explored. One is to include the creation of thermodynamic energy more explicitly among capital's methods for organizing surplus extraction. Although thermodynamics was essentially a 19<sup>th</sup>-century move, bioenergy only strengthens the links between labour exploitation and fossil fuel extraction that it expresses. The other suggestion for “stretching” is to try to resuscitate, extend and elaborate the concept of living and dead labour in ways that can help anticipate coming patterns of struggle against the bioenergy economy and the inequalities it creates and perpetuates. This is likely to involve the enlistment of disciplines that lie far outside traditional Marxism.*

What are we doing here?

The prospectus for our conference says that we’re trying to find out “how the socially and ecologically intertwined impacts of bioenergy development affect the (re-)production of inequalities.”

Accordingly, the other contributors to this panel have helped open our eyes to asymmetrical knowledge production in the postcolonial Brazilian sugar cane sector, to injustices in the way science is carried out in the pesticide-soaked Argentine countryside, and to the seeming diversity of exploitative or speculative logics that underlie patenting of life forms.

I want to take an approach that, I hope, strongly complements this important work. And also, for that matter, the work of both our commentator David Tyfield and our chair Emma Dowling. I too will be delving into the field of relations among bioenergy development, science, the so-called energy transition and inequalities – and always, I hope, with an eye on labour and the labour theory of value.

However, I should make it clear at the beginning that I’m not following orders to the letter. I’m not starting out by assuming that bioenergy development and inequality are in separate categories, with the one “affecting” the other. Instead, I’m trying to put in the foreground the dynamic processes through which what are (usually belatedly) described or understood as inequalities are generated and perpetuated as an integral *aspect* of bioenergy development and energy transitions.

It’s not that I’m uninterested in inequality or refuse to use the notion. How could I? From the point of view of capital, inequality is sort of the whole point, insofar as you need inequality if you’re going to be able to impose practices that allow you to get something for nothing (accumulate the surplus from labour) and to undermine worker bargaining power, which is what capitalists need to do in order to survive *qua* capitalists. Far from being something eventually to be reformed away, inequality in one form or another is an inevitable, enduring objective. My only caveat is that if you’re seeking strategies to address it, it will be impossible to treat it as something that might be subject to a “fix” that is independent of the dynamics that create it.

We have to remind ourselves that the struggles we are mostly concerned with are seldom “about” inequality. They can be described that way retrospectively, or from “outside,” from different currents of intellectual history, but historically the demand for equality has seldom been at the fore in struggles over commons. In my experience grassroots rural activists tend to be explicit about this. “We don’t expect equality. What we demand is the right to survive.” “Equal income,” “equal pollution”, “equal access,” “equal energy” – these are seldom the first slogans out of the mouths of grassroots protesters. Of course I have to backpedal a bit here into a cloud of qualifications. “Equal rights under the law” often *is* one genuine expression of struggle. But under pressure of open dialogue, even this particular “equality” terminology tends to dissolve into more fundamental demands for greater power to participate in defining what health *is*, what nature *is*, what humans *are*, what bioenergy *is*, what pollution *is*, what the law *is*, what science *is*, what expertise *is* – and not into demands for such items to be more equitably distributed (Permanent People's Tribunal 2019).

My strategy, then, will be not to take inequality as an isolated primitive, but to look at it in relation to a complex of interlinked processes of historical struggle described by Marx. This complex includes enclosure of commons or primitive accumulation, post-Black Death class war, the labour theory of value, mechanization and machine-like organization, the degradation-inducing fusion of dead labour with living labour in the creation of value (vampirism), and the tendency of the rate of profit to fall.

Of course, this complex is continually being redescribed, as Marx himself continually redescribed it. Recent decades have brought timely reminders from people like George Caffentzis, Massimo de Angelis and David Harvey that primitive accumulation is not just primitive, but necessarily ongoing. Connected with this has been a heightened realization that the continuing nature of this enclosure of commons is one with what is clearly capital’s never-diminishing hunger for new living labour. Post-1960s feminist thinking from figures like Mariarosa Dalla Costa and Silvia Federici about the centrality of the unpaid labour of women to the creation and accumulation of value has been extended by people like Jason W. Moore and Nancy Fraser to embrace analysis of the contributions of the unpaid work of nonhumans, as well as to reconsideration of the role of race, gender and speciesism as forces of production. After a gap of close to 50 years, too, Marxist understandings of struggle are once again showing signs of reconnecting with indigenous people’s thinking about territory and *pachamama*. And so on.

What I want to do here is to see what happens when we confront these continually-evolving redescrptions of inequality-generating and inequality-dependent processes with studies of bioenergy and the so-called energy transition, and vice versa.

I’m interested in one question in particular. Setting aside for the moment the important issue of how much the bioenergy economy actually *is* about the creation of value through commodity production rather than just about rent and speculation, what is or would be “needed to *make* it productive” in this way? Or – and this is the angle I will actually pursue more in this talk – at least responsive to lunatic forms of regulation that require biomass to substitute for fossil fuels in the commodity-producing economy? If bioenergy capitalism is, or adds to, a frontier at which living labour is being appropriated in order to be appended, at least indirectly, to dead labour, does that frontier have any interestingly novel characteristics? Or if not, does its existence at least maybe call for a few fresh redescrptions of the Marxian complex mentioned above – redescrptions that can perhaps be used in turn be used to help us once again look at capital’s past with new eyes?

My provisional response will be that there's nothing fundamentally new about this bioeconomy, at least in the ways that are often suggested by the breathless use of terms like "biocapital" or "knowledge economy." There's not much "bio" or "knowledge" about any aspect of today's capitalism that was not also "bio" or "knowledge" in, say, the 17th-century Caribbean plantation economy. For me, there's *no* capital that is not "biocapital." There's *no* labour that is not "knowledge labor." In my opinion, no member of the genus of trendy adjectives that I'm disparaging adds all that much to what we already know about what labour and capital are or could be. Indeed, to pretend that they do can be, I think, unwittingly reactionary. I reckon the only difference I might have with our commentator David Tyfield and my old friend Kean Birch when they inveigh against the "fetishization of the 'bio-'" (2012) is that I might use even stronger language. Similarly, the only difference I might have with our chair Emma Dowling's (2007) careful criticism of the idea that affective labour is "beyond measure" or unmoored from "material labour" is that I'd probably be a lot less "measured" myself. For me, there's no labour that is not "affective," and no labour that is not itself "material". Never has been, never will be.

All that said, however, I think that the bioenergy economy, and the bioeconomy in general, *do* add to the pressures on us to go on trying to redescribe that old Marxian complex that includes the labour theory of value – surplus accumulation – class struggle – mechanization – living/dead labour – vampirism – tendency toward falling profit rates. Such redescriptions, again, are not undertaken for their own sake, just in order to provide a nicer "theoretical fit" with changing circumstances, but also because they may be needed to change those circumstances.

For convenience, let me divide my own redescriptive efforts somewhat artificially into two interconnected parts. The first part rotates the Marxian complex mentioned above so that mechanization swims into the foreground. My colleagues and I have argued elsewhere that a Marxian understanding of 19<sup>th</sup>-century mechanization is incomplete without a grasp of energy (which was once called "duty") as a political construction (Lohmann and Hildyard 2014). Thermodynamics – the theory of conversion engines – was needed in order to help organize the frontiers of appropriation required and enabled by mechanization, with its associated productivity increases and labour discipline. The rise of struggles over bioenergy, I'll argue, calls for this effort to "stretch" Marx to be redoubled. Here as elsewhere, the First and Second Laws of Thermodynamics need to be understood as expressions of, among other things, capital's drive for inequality.

The second part of my remarks rotates the Marxian complex through a few more degrees so that living and dead labour and post-18th century labour processes come into sharper focus. If the value that capital needs to accumulate can be redefined, in a sort of backward way, as that which industrial machines can help increase the creation of, that process is possible only provided that the "dead labour" they represent is supplied with proportionate quantities of living labour – "inside" which, moreover, can always be found increasing amounts of the free-range activity or commons of the more-than-human as well as the human. What I would like to suggest here is that analysis of struggles over the bioenergy economy and its inequalities can benefit from an approach that does not dismiss outright the somewhat woo-woo language of vitalism that is sometimes used to describe living labour (even in Marx), but looks behind it and tries to translate it into more usable terms by recruiting the thinking of Wittgenstein and other thinkers not stereotypically associated with Marxism.

## I

In ancient Greek slave society, the steam engine was a toy. Under industrial capitalism, conversion engines are full-fledged societal abstraction machines, fetish-producing devices. This is as true of wood pellet-fired thermal plants and biofuelled jet engines as it is of nuclear reactors and diesel locomotives.

If the heat engine doesn't know or care where its heat comes from, neither does the air-cooled Google data centre processor care whether its electricity has been converted from heat, kinetic, chemical or some other "form" of energy, or where. This is First-Law-of-Thermodynamics abstraction in action. Under conditions of capital accumulation it participates in the breaking up and recasting of the relations under which mutually-incommensurable "little energies" of commons firewood, horses, wind, agriculture, moving water, shared human muscle and brain tissue and so forth are differently and locally tied to subsistence. Not to mention the breaking up of geophysical carbon cycles in order to tap the accumulated, unpaid work prehistoric organisms performed on sunlight over millions of years in still other contexts.

For capital to "return to bioenergy" on the basis of this history is not an "un-commensurating" of the diverse aspects of thermodynamic energy nor a re-embedding of them in diverse commons practices. On the contrary, it carries even further the 19<sup>th</sup>-century "fossil pattern" tied to the development of the First Law and the expansion of the wage labour relation. Insofar as living biomass is called upon to replace fossil fuels rather than merely supplement them, or merely round out the zero-cost self-provisioning of reserve and other armies of labour, it is jammed even more forcibly down onto the painful Procrustean bed of industrial capital's real abstractions. Four hundred times more forcibly, you might say, given that capital has long been committed to appropriating the thermodynamic "equivalent" of at least 400 years of current plant growth in the form of fossil fuels for every year it continues to exploit human labour (Dukes 2003). I don't need to dwell on the remoter implications for, e.g., respect for the "particularities of the biological," or battles against the political and expert power of the postcolonial sugar cane sector, because Veit Braun and Maria Backhouse have already called attention to some of them.

It's for this reason that a Marxian account of contemporary grassroots struggles over bioenergy – not to mention over hydroelectric dams, thermal or nuclear power plants, oil pipelines, fracking, climate change and so forth – will be incomplete without a grasp of ongoing interactions and conflicts between older, plural, non-thermodynamic or commons "energies" on the one hand and 19<sup>th</sup>-century thermodynamics on the other. Wherever a rural community seeks to defend its complexly socially-entangled agriculture or firewood use against incursions based on the hegemony of a unified, thermodynamic energy (in the form, say, of annexation of land or water for a coal mine, large dam or fuel plantation), or even the local rights of way that highways catering to internal combustion engines threaten to break up, First Law hegemony poses a challenge. Insofar as partly thermodynamics-based sciences such as climatology fall in with industrialism's prevailing methodological blindness toward the multiple Otherness of commons energies, they too are bound to be continually pushed into opposition to the livelihood interests of hundreds of millions of people worldwide whose subsistence is connected with energies that cannot be replaced, but only displaced, by First Law energy. In retrospect, it begins to seem as if the academic taboos that have tended to exclude 19<sup>th</sup>-century physics from accounts of class conflict, mechanization, enclosure of commons and the separation of workers from subsistence, by perpetuating confusions about energy, have also perpetuated confusions about struggle.

Among these confusions, of course, is the idea that the political problem with things like bioenergy is principally "inequality." It's only when the ambiguity in the term "energy" is removed – are we talking about multiple commons "energies" or unitary thermodynamic "energy"? – can we see that the distribution of thermodynamic energy and of its benefits and harms is only one issue among others some of which are, in a sense, logically prior. The First Law is an integral part of a certain political settlement achieved and precariously maintained since the 19<sup>th</sup> century that inherently generates inequalities. Perhaps this is too weak. In a sense, inequalities are what thermodynamics is *for*. This settlement remains active in the whole idea of an energy transition (Bonneuil and Fressoz 2016) and

indeed in the very idea of cane ethanol, wood pellets, and aviation biofuel *qua* energy. Analytically, as long as the thermodynamic concept is allowed to dominate discussions of bioenergy, various mechanisms generating exploitation and inequalities are going to be overlooked regardless of anyone's good intentions. The quixotic quest to make this kind of energy "sustainable" is always going to wind up opposed to the defence of "sustainable" commons energies.

It follows that the battle against what belatedly become depicted as unequal power relations is not only a matter of "getting undone science done", as it often partly is in cases such as the one that Renata Motta describes for us in Argentina. It is also, simultaneously, a case of "getting done science undone." For concerned academics, that may involve showing how bits of science such as the First Law of Thermodynamics are *always and already* being constructively undone every day, at the same time that they are done and redone in different ways, indeed as a part of their very operation, and finding the most strategic or fruitful ways and areas for intervening in support of those partial undoings.

It seems to me that this integrally involves alliance-building. If peasant agriculture and climate movements are to get together better, not to mention indigenous and labour, anti-dam and anti-GMO, and anti-fracking and anti-pesticide movements, to what extent will it be possible not to bring to better articulation deep structures of ingrained resistance to the dominance of thermodynamic energy and the associated demand for resources seen to contain cheap and abundant kinetic or electrical energy "equivalents"? I'm not sure, but it does seem clear to me that notions of "inequality" are by themselves not up to the job.

## II

I now want to rotate that old Marxian complex through a few more degrees so that, instead of being faced directly with the *mechanization* aspect, we have in front of us the amalgam of *living and dead labour*. Of course, that doesn't change the complex itself, and doesn't break our contact with mechanization or any other aspect of the evolving whole.

Nor should it cause us to forget the attempt of the last section to stretch the mechanization aspect of the complex to make space for thermodynamic energy. In fact, that stretching naturally will also affect the concept of living and dead labour. The *Second* Law of Thermodynamics quantifies worries about efficiency and usable "work" that could only have come to such prominence in an age of the First Law and the machines of industrial capital. But it also arguably provides one way of redescribing the relation between living and dead labour. Only via use of the negative-entropy enclaves created by life nourished in commons contexts of little-e "energies" can the massively entropic machines reliant on Big-E thermodynamic Energy work for capital for any significant length of time. Little-e commons "energies" are perhaps to thermodynamic energy somewhat as living labour is to dead labour.

But let me leave that undeveloped and very probably misguided thought to one side for now. What I want to do in this section is suggest a separate, additional project for "stretching" that old Marxian complex. This time I want to concentrate on redescribing that aspect of living and dead labour in a way that I hope will be useful, again, in understanding the bioenergy economy and in supporting resistance to it. I see this redescription effort as essential to the task of connecting bioenergy and its inequalities more clearly with the labour theory of value, with the hypothesis regarding the tendency of the rate of profit to fall, and indeed with the concept of capital itself.

Perhaps the first thing to note is that the bioenergy economy and the supposed coming energy "transition" imply new forms and intensities of mechanization of raw material procurement. How could

it be otherwise? These days the biosphere is hemmed in by the aviation sector's schemes for ramping up biofuel supplies to unheard-of levels, utility demands for wood pellets and other biomass, Brazilian technocracies going all out for ethanol, algae nerds beavering away at biotic oils, not to mention REDD+ and Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) plans for massive expansion of carbon offsets, especially on lands in the global South and their futures, to keep fossil fuel use going at all costs. That "factor of 400" rate of biotic appropriation mentioned above means that in principle there's almost no limit on how high the pressure can be dialed up to achieve the maximum formal and real subsumption of the work of biomass and biofuel species and the ecosystems and human communities that are recrafted for them. In these circumstances there can be, in theory, few restraints on mechanization and machine-like organization across anything that might have been considered the "border" of an organism or community.

These pressures hold, moreover, regardless of whether the ambition is to create new surplus at the biobusiness and bioenergy level itself or (what is likely more significant) just to keep accumulation (and speculation) going elsewhere. On that scenario, biobiz and bioenergy merely seek allocation of rents proportional to the extent they contribute, via state regulation and so forth, to keeping the fossil pipelines open to more or less conventional industry and transport – not to mention the burgeoning interpretation-mechanization sector unleashed by deep learning, big data, and processor-speed acceleration, including cryptocurrencies and all the rest, which, in some analysts' fantasies, could double fossil-fuel burning rates within a few years. In this sense, intensification and extensification in the bioenergy economy – including the call on fresh streams of free-range living labour – is perhaps best seen as largely regulatory, amounting to a defence of system-wide fossil-fuelled capital accumulation rather than trying to open an independent sector of commodity production. Meaning that we perhaps don't need to worry our heads too much, when talking about mechanization and living labour, about whether things like carbon offsets or biopatents are actual commodities, or just assets, claims on rent, speculative entities, or whatever. Because the effects at the grassroots will be the same regardless.

That brings us to the need to spell out what, if anything, we need to "stretch" in Marx when we talk about living and dead labour in the bioenergy economy. Here I would prefer starting out with a concept that has *already* been stretched a good bit by some decades of work in Marxist feminism and world-ecology. This concept takes living paid labour as already partly constituted by its backup in the unpaid work of "women, nature and colonies", to cite Maria Mies' famous phrase. Both are partly organized by capital, indeed organized together, but partly out of the material of commons, which cannot be eliminated from their constitution. That free work, moreover, can't be transformed in ways that produce surplus without being fatigued or debilitated in the process. (Which is different from being "depleted" in any quantitative, linear, predictable, controllable, or "manageable" sense: this fatigue is not like the fizz going flat in a soft drink. Which in turn is why historically-specific class-struggle narratives form an ineliminable part of any analysis of ecological degradation). Capital can't exist without living labour, of both humans and nonhumans, and the commons "inside" it. The labour theory of value, as Marx updated it for his own era, says, in effect, that there can be no purely machine theory of value. There are no perpetual motion machines. At the same time, however, capital can't use living labour without progressively "maxing it out" under the domination of (not replacement by) the "iron man" of mechanization that Marx spoke of. Waste dumps get topped out. Women get fed up. Slaves die, flee or revolt. Soils are poisoned. Species go extinct. Entropy sets in. Colonies decolonize. "Yield honeymoons" go sour. Lucrative moments of "ecological release" pass (Gillespie 2009). Indigenous peoples, workers and environmentalists protest. What environmental economists confusedly call "natural capital" gets depleted. The living labour of humans and others is hard put to keep up with the need to keep "fixing" capital's growing body of machines. As a result, there's no element of capital –

labour, commodities, resources, wages, rent, profit and so on – that can ever be more than an unstable, temporary, contradictory composite. To cite Jason W. Moore's (2015) rewrite of Marx's vampire metaphor, capital doesn't *have* a frontier located on a moving boundary between "itself" and "something else"; rather, it *is* a frontier. Whatever methods happen to be used today for creating capitalist value, they're not going to function very well tomorrow. Fatigue always looms on the horizon, together with the menaces of overcapitalization, overproduction and the lurch into crisis.

What are the challenges, then, of trying to keep steadily in view the relationship between living and dead labour when we talk about the bioenergy economy? One of the biggest, I think, is not to be tempted into thinking that today's bioeconomy is tapping into some wellspring of "vitality" in life that was not already being tapped 500 years ago. And thus not to be tempted into thinking that we are faced with a totally new logic of capital. As I noted rather grumpily above, if there is no capital that is not biocapital, the "bio-" prefix doesn't tell us anything new.

That perhaps helps us concentrate our minds on what I think should occupy us more: using the bioenergy economy to get clearer about the evolution of the continuing relation between living and dead labour in capital, and using our understanding of this relation, in turn, to get clearer about the bioenergy economy. If system-wide capital accumulation now requires a business sector that uses mechanization and machine-like processes to enlist the biosphere in more widespread and "efficient" production of surrogates for, and defences of, fossil fuels, that's going to require new frontiers, new epidemics of fatigue, fresh crises, the organization of still more frontiers, and so on. Can we contribute anything to the understanding of the future course of this dynamic – which is essentially a dance of living and dead labour – that might be of use to grassroots movements?

My instinct is that one part of this line of inquiry will be to try to take living labour more seriously as an analytic category than it may have sometimes been taken by Western intellectuals. To me, this step is impelled above all by reflecting on the dead ends of environmental politics of the last 50 years. For example, enduring divides between labour movements and peasant and indigenous movements; the only partial success of indigenous social movements to seek alliances by translating their practices into problematic terms that nonindigenous can grasp, like *territorios* and "rights of nature"; the evident difficulty ecological Marxism has in getting over Cartesianism once and for all; and, not least, perhaps, left intellectuals' continuing temptation to fall in with narratives of "sustainable capitalist production", "circular economy", "automated communism" and the like. But how do we take this step? The task isn't made any easier when, for example, contemporary commentators pass by Marx's own mentions of living labour in *Capital*, with their sometimes baffling way of combining his residual Cartesian tendencies with a cloud of often-metaphorical nouns including "vital energy", "will", "bodily subjectivity", "form-giving fire", "self-negating capacity", "irreducible creativity", "wholeness", and – especially – the "blood" on which the vampire of dead labour feeds to produce surplus.

Recently, in response to a request from colleagues active in ecological movements in India to investigate so-called environmental applications of blockchain, I've been forced to try to find new ways to clarify my conviction, sharpened by two decades of experience battling ecosystem service markets, that an updated understanding of the contradiction between living and dead labour is crucial to not being fooled in the short or long term by such developments. In the case of the ecology of the information economy, I've found what I expect may be one promising route in that direction: recruiting the thinking of the later Wittgenstein to replace all that talk about "blood" and "vitality" (Lohmann 2019). Wittgenstein (1953) argued that a rule is useless in the absence of communities who come to know when it applies and when it can be broken and apply their "living labour" as needed; and similarly for any second rule anyone might formulate about how to interpret the first rule; and so on.

My feeling is that it will help to understand the information economy struggles of the future if we can see this “rule-following paradox” (Kusch 2006) as being one with the contradiction between living labour and both of the productivity-boosting forms of dead labour that dominate the current era: the 19<sup>th</sup>-century heat engine and the 20<sup>th</sup>-century Turing machine (Caffentzis 2013). The growing, algorithmic 21<sup>st</sup>-century “Iron Man” consisting of blockchain, AI, Google Translate and all the rest of it, like Marx's old “Iron Man” of 19<sup>th</sup>-century industrial machinery, is going to need ever-increasing infusions of the living labour of both humans and nonhumans if its frozen rules are to work for capital, but what happens exactly when that living labour is applied and progressively gets “maxed out”? Once that question is asked, I think, it becomes easier to think strategically about resistance and movement-building.

My question now is whether we can find similar methods for understanding better what happens when living labour meets dead labour in the bioenergy economy and the types of (for example) inequality that are created, sustained and increased in the process. Let's talk, for example, about the labour process of plantation species and the human communities that interact directly with them. The interplay of living and dead labour of humans and nonhumans in the plantation/slave/mill economies of the early modern past shifted in the 20<sup>th</sup> century with the advent of billion-dollar pulp mills, industrial feedlots, molecular biology, genetic modification and the like, not to mention the worldwide spread of thermodynamic energy paired with the wage labour relation (Huber 2009). That interplay is now continuing to change character with the advent of E2G, “carbon-positive” technologies and all the rest of it. Can we find the intellectual resources that we need to track how surplus-accumulating mechanisms are developing in these new economies in tandem with the fresh volumes of living work they require in the form of plantation species creativity, plant improvisation, plant repair capacity, plant adaptability to uncertainty and unpredictability, plant resistance and other capacities dependent on centuries of free-range existence in commons relationships?

I can see I'm running out of space to explore this further, but out of many possible sources of inspiration let me mention two here. One is the interesting work of anthropologist Eduardo Kohn on what he calls “form's effortless efficacy”, including how the Latin American rubber boom was a nested phenomenon capturing, but also integrating into emergent relational properties, other-than-human schemes of tree and river distribution, accessing not resources but rather a “conjunction of physical and biotic patternings” in which wealth was “caught up” (Kohn 2013: 169). Kohn's work, influenced by investigations of consciousness, thermodynamics, information and biology by his mentor Terence Deacon, can be usefully read alongside Kohn's fellow Ecuadorian Nicolás Cuví's description of how in the 19<sup>th</sup> century, capital smuggled the activities of Latin American rubber and cinchona trees out of their original human and nonhuman contexts and brought them into contact with the abundant cheap, fresh, semi-proletarianized labour power it had helped create in Asia, engendering important knock-on effects on both the tree species and the humans involved, all the way down to the present (Cuví 2015).

Another source of inspiration is what the social theorist Brian Massumi (2014: 15-22) calls the “improvisational expressivity of instinct” or “tendency to surpass the normal” or “given” that Niko Tinbergen uncovered in animals in the early 1950s but was unable to accommodate into his machine-inflected theories and so ultimately ignored. Because it appears similar to the capacity of “knowing how to go on” that Wittgenstein articulated in the human case at around the same time, without which algorithms or machines are unable to function for capital, the presence of this ability in nonhumans suggests pathways toward a more coherent, unified, concrete account of what happens when capital appropriates the living work of humans and nonhumans. Pursuing such concepts also holds out some promise of rescuing living labour from the hole it seems to have fallen into in scholarly inquiry, and thus of moving forward more quickly in struggles over the bioenergy economy.

## REFERENCES

- Birch, Kean and Tyfield, David (2013) "Theorizing the Bioeconomy: Biovalue, Biocapital, Bioeconomics or . . . What?" *Science, Technology, and Human Values* 38 (3): 299-327.
- Bonneuil, Christophe and Fressoz, Jean-Baptiste (2016) *The Shock of the Anthropocene: The Earth, History and Us*. London: Verso.
- Caffentzis, George (2013) *In Letters of Blood and Fire: Work, Machines and the Crisis of Capitalism*. Oakland: PM Press.
- Cuvi, Nicolás (2015) "Sobre las formas de apropiación de ideas y cosas: algunas reflexiones para el diálogo." En *Biopiratería*, compilado por Alberto Acosta y Esperanza Martínez. Quito: Abya Yala, 183-202.
- Dowling, Emma (2007) "Producing the Dining Experience: Measure, Subjectivity and the Affective Worker" *Ephemera: Theory and Politics in Organization* 7 (1): 117-132.
- Dukes, Jeffrey S. (2003) "Burning Buried Sunshine: Human Consumption of Ancient Solar Energy", *Climatic Change* 61 (102): 31-44.
- Gillespie, Rosemary (2003) "Ecological Release," in R.G. Gillespie and D.A. Clague (eds.), *Encyclopedia of Islands*, Berkeley: University of California Press, pp. 251-253.
- Huber, Matthew (2009) "Energizing Historical Materialism: Fossil Fuels, Space and the Capitalist Mode of Production," *Geoforum* 40 (1): 105-115.
- Kohn, Eduardo (2013) *How Forests Think: Toward an Anthropology beyond the Human*. Berkeley: University of California Press.
- Kusch, Martin (2006) *A Sceptical Guide to Meaning and Rules: Defending Kripke's Wittgenstein*, London: Routledge.
- Lohmann, Larry (2019) "Blockchain Machines, Earth Beings and the Labour of Trust". Sturminster Newton: The Corner House, <http://www.thecornerhouse.org.uk/sites/thecornerhouse.org.uk/files/BLOCKCHAIN%20MACHINES%20AND%20EARTH%20BEINGS%20AND%20THE%20LABOUR%20OF%20TRUST.pdf>.
- Lohmann, Larry and Hildyard, Nicholas (2014) *Work, Energy and Finance*. Sturminster Newton: The Corner House, <http://www.thecornerhouse.org.uk/sites/thecornerhouse.org.uk/files/EnergyWorkFinance%20%282.57MB%29.pdf>.
- Massumi, Brian (2014) *What Animals Teach Us about Politics*. Durham: Duke University Press.
- Moore, Jason W. (2015) *Capitalism in the Web of Life: Ecology and the Accumulation of Capital*, London: Verso.
- Permanent People's Tribunal (2019) Advisory Opinion on the Session on Human Rights, Fracking and Climate Change, Rome, 12 April, <http://permanentpeopletribunal.org/wp-content/uploads/2019/04/AO-final-12-APRIL-2019.pdf>.
- Wittgenstein, Ludwig (1953) *Philosophical Investigations*, trans. Elizabeth Anscombe, Oxford: Blackwell, 1953.