



Artifacts have consequences, not agency: Toward a critical theory of global environmental history

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Abstract

This article challenges the urge within Actor-Network Theory, posthumanism, and the ontological turn in sociology and anthropology to dissolve analytical distinctions between subject and object, society and nature, and human and non-human. It argues that only by acknowledging such distinctions and applying a realist ontology can exploitative and unsustainable global power relations be exposed. The predicament of the Anthropocene should not prompt us to abandon distinctions between society and nature but to refine the analytical framework through which we can distinguish between sentience and non-sentience and between the symbolic and non-symbolic. The incompatibility of posthumanist and Marxist approaches to the Anthropocene and the question of agency derives from ideological differences as well as different methodological proclivities. A central illustration of these differences is the understanding of fetishism, a concept viewed by posthumanists as condescending but by Marxists as emancipatory.

Keywords

artifacts, distinctions, ontology, posthumanism, semiotics

There is currently a strong movement in the human sciences to recognize what is often referred to as ‘distributed’ agency. Originally stimulated by Bruno Latour and other proponents of Actor-Network Theory (ANT), a fundamental point of this perspective

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is to reject the 'Cartesian' dichotomy between subject and object, in which the human subject is perceived as acting upon passive, non-human objects. The alternative, endorsed by ANT and a number of exponents of the ontological turn in the human sciences, is to perceive the various non-human entities with which humans interact as similar sources of agency. This view has proven congenial to several categories of researchers aiming to relativize and challenge traditional paradigms associated with a 'Western' or 'modern' ontology, whether natural science, Eurocentric anthropology, or the anthropocentrism of humanism. Central to what these researchers have in common is the conviction that the Enlightenment view of nature is inextricably tied to colonial European ambitions to dominate the world. Over the past three decades, there has thus been a discursive convergence between Latourian Science and Technology Studies (STS), postcolonial theory, feminism, and avant-garde ethnography. I refer to the world-view in which these schools of thought converge as *posthumanism*.¹ Their proponents tend to present their perspectives as subversive of the hegemonic worldviews associated with the powerful interests of Euro-American science and technology, siding instead with repressed categories such as indigenous peoples, women, and non-humans. This is paradoxical, as the attribution of autonomous agency to inanimate entities such as artifacts has been regarded by Marxists as a capitalist illusion mystifying relations of unequal exchange. What to Marxists is capitalist ideology to be exposed is thus conceptualized by posthumanists as a subversive concession to be endorsed (Latour, 2004, 2010), and yet both perspectives claim to be emancipatory.² Given the recent trend to approach the deliberations on the so-called Anthropocene from posthumanist perspectives (Latour, 2013; Haraway, 2015), the contradiction between posthumanism and Marxism becomes particularly clear in their divergent understandings of global environmental history.

In this article, I shall argue that the ontological strategy of the posthumanists leads in a direction diametrically opposite to their professed emancipatory concerns. I shall not devote limited time and space to an exegesis of Descartes, Marx, or even Latour, since what they have or have not said is not the issue here, but will focus instead on the validity of some central claims frequently encountered in posthumanist ethnography, environmental philosophy, and other strands of social science research. My aim is to question the current urge to dissolve purportedly 'Cartesian' distinctions such as between subject and object, society and nature, and human and non-human, and to trace its implications for our capacity to analyze and challenge the global power structures with which they tend to be associated.³ Precisely because I am in complete agreement with the professed ambition to challenge these power structures, I hope to show that some analytical distinctions that are conventionally dismissed as 'Cartesian' are in fact indispensable for a truly critical social science. Only by applying such distinctions are we able to grasp the predicament of the Anthropocene and to expose the exploitative global power relations underlying the ideology of economic growth and technological progress.

The anthropogenic global environmental changes which these power relations have generated over the past two centuries have received the attention of several disciplines, such as environmental history and Earth System science, but have not been adequately theorized. I shall begin by considering some of the theoretical options currently offered for an understanding of the historical relation between human societies and the

remainder of the biosphere, arguing that in order to assemble an integrated theory of global environmental history, we shall have to clarify our position with regards to some contested distinctions commonly referred to as ‘Cartesian’, including our position with regards to posthumanist conceptions of distributed agency.

Options for theorizing environmental history

Most of the literature on global environmental change over the past few centuries has been content to describe the observed ecological transformations, without providing any explicit theoretical framework with which to understand them (Hornborg, 2010). There has been extensive empirical documentation of processes such as deforestation, biodiversity loss, soil depletion, eutrophication, the spread of invasive species, chemical pollution, changes in land use such as industrialization and urbanization, changes in energy use, greenhouse gas emissions, climate change, and ocean acidification. However, these accounts of biophysical processes have generally not been juxtaposed with social theory. They have either refrained from elaborating explicit social theory or offered rather crude analytical tools such as ‘economic development’, ‘technological progress’, ‘energy transitions’, or ‘population growth’. Such conventional categories reflect mainstream narratives founded on an implicit worldview in which recent planetary processes are understood as consequences of the progression of the human species from less to more advanced conditions. Such ‘progress’ is generally assumed to be beneficial for humanity at large, even when it is conceded that it has troubling ecological repercussions which urgently need to be addressed. To alleviate the various risks generated by human development is viewed as yet another challenge for the advanced economic and technological infrastructures which brought us here – this approach is often referred to as ‘ecological modernization’. Such understandings of global environmental history do not claim to be grounded in social theory, but rather imply that social theory is not relevant to accounting for environmental change. Whether natural scientists or historians, the researchers who have traced global environmental change have not been equipped with adequate analytical tools to relate such change to societal processes.

Alongside the mainstream trust in human progress, modernization has from its very beginnings provoked more pessimistic narratives envisaging societal decline or even collapse. This set of critical narratives include Marxian interpretations of accumulation as based on exploitation and the related, zero-sum game perspective of world-system analysis (Wallerstein, 1974; Chase-Dunn and Hall, 1997). In this category I would also include ‘Malthusian’ concerns with ecological limits to growth and diminishing net energy (Tainter, 1988; Hall and Klitgaard, 2012). Some of the most explicit and elaborate attempts to provide critical perspectives on the trajectory of human societies over the past few centuries, addressing both inequalities and ecological limits, have been offered by so-called eco-Marxists (O’Connor, M, 1994; O’Connor, J, 1998; Foster et al., 2010). I will here be concerned with how the conceptual framework of Marxian social theory relates to the ‘post-Cartesian’ convictions of posthumanism. Before discussing this topic, however, I shall declare my own position regarding distinctions such as subject-object and society-nature, and argue for a more restricted understanding of agency than that currently offered by the posthumanists.

Life, agency, and the subject-object distinction

Let us begin by reconsidering some fundamental categories of the worldview that post-humanists following Latour (1993) would dismiss as the obsolete ‘modern constitution’. Although I advocate retaining much-maligned ‘Cartesian’ categories such as the distinctions between subject and object, society and nature, and human and non-human, the basis for these distinctions, as offered here, is quite different from the dualist ontology of René Descartes. To begin with, I hold that the distinction between living and non-living entities hinges on the occurrence of *agency*, that is, the capacity to act. Agency is propelled by *purpose*. All living organisms have purposes inscribed in their composition, whether the amoeba’s absorption of nutrients from its surroundings, the tree’s extension of branches into the sunlight and roots into the soil, or a human preparing and ingesting a meal. Such various processes are all examples of agency generated by purposes internal to living beings. When purposes are consciously reflected on, as is often the case among humans, we talk about *intentions*. To attribute agency, purposes, or intentions to non-living objects is tantamount to fetishism. The purposes which define biotic entities presuppose a certain capacity for sentience and communication (Kohn, 2013).⁴ Amoebas, trees and humans are all equipped to register specific aspects of their environments and to somehow respond to them. This capacity for sentience and communication is what defines a subject. Abiotic entities such as rocks or artifacts do not have such capacities. They are objects.⁵

Anticipating objections from the posthumanist camp, I hasten to provide some qualifications to this contested framework. First, the purposes internalized in living organisms are indeed products of their external relations, whether through phylogenetic or ontogenetic learning. Second, the purposive agency of organisms – most dramatically that of human organisms – is indeed partly shaped by and extended through their current engagement with other entities, both living and non-living. Third, consciousness, reflection, and intentionality are never equivalent to absolute or definitive knowledge, but a situated, partial, and provisional representation of the conditions of agency.⁶ Fourth, subjectivity is a similarly relative concept, encompassing every instance of sentience from the information-processing capacity of amoebas and trees to the emotional life of humans. Finally, we must distinguish between positing the ontological condition of subject versus object, on the one hand, and the perception and/or treatment of entities as subjects or objects, on the other. To posit the existence of subjects and objects is *not* tantamount to repressing animals, women, or colonies. Humans and many non-human animals are able to perceive and/or treat an external entity either as a subject with which to communicate or as an object with which no communication is possible. This means that both humans and non-human animals can make mistakes, treating subjects as objects or objects as subjects. It also means that they can find it pragmatic or instrumental to disregard the sentience of other subjects, as in predation, repression, or some everyday contexts of social life.

Non-living objects do not have agency, but they can impact on their surroundings (that is, have consequences for them) in at least four ways. First, they can form physical *constraints* on the agency of living entities, for instance, by restricting their movement. Second, they can serve as *catalysts*, prompting them to respond, for instance, to weather

events. Third, they can be *delegated* specific functions, as in the famous example of the door stop and other human artifacts and technologies. And, fourth, they can be *attributed* agency, as when artifacts or other entities are *perceived* as having autonomous agency that they do not have. This category can be exemplified by objects such as monetary tokens, ancestral mummies, sacred mountains, astronomical bodies, and computers, but also by fetishized living organisms such as sacred trees or divine emperors. In all these cases of ‘distributed’ agency, objects (and living fetishes) may constrain, prompt, or mediate the agency of living organisms. But in no case is it justified to dissolve the crucial difference between purposive agency and merely having consequences.⁷ When a fetishized object has the appearance of having agency, it is the perception of the object which influences human agency, not the object itself that acts.

Symbolism, semiotics, and the society-nature distinction

The distinction between society and nature, reflected in the division of labor between social and natural sciences, is not merely a modernist conceit serving the interests of European colonialism. The concept of ‘nature’ has of course been endlessly discussed by philosophers, historians, anthropologists, and other social scientists, and no one can claim to have an overview of the vast range of positions taken over the centuries, but inasmuch as we contest the rejection of the society-nature distinction as a modernist construction, it is appropriate to explain why. Rather than thinking of ‘nature’ as a certain kind of physical things or spaces uncontaminated by humans (cf. Cronon, 1995; Ellen, 1996), I regard it as an analytical category encompassing all those aspects of socioecological processes that derive from forces and regularities that do not require explanations referring to the symbolic capacities of human beings. ‘Social’, on the other hand, refers to those aspects which do require references to symbolism. ‘Nature’ would thus include, for instance, thermodynamics, gravity, and photosynthesis, but only the non-symbolic aspects of agriculture, markets, or consumption.⁸

In positing a distinction between society and nature, this view (or ‘representation’) does suggest a variety of what Descola (2013) calls ‘naturalism’, but it disrupts Descola’s quadripartite scheme in two ways. First, it posits discontinuities not only with regards to ‘interiorities’ but also among ‘physical’ entities, based on the criterion of whether or not they are in part generated through symbolic processes. Second, it recognizes a fundamental discontinuity between non-human physical entities that are alive versus those that are not. In this view, not only are interiorities and physicalities as intermeshed (albeit analytically distinct) as culture and nature, but nature is itself discontinuous. Culture or society is distinctly anthropogenic but permeates the physical world, whereas nature encompasses both subjects and objects. While both are justified, the culture-nature distinction does not coincide with the subject-object distinction.⁹

Although increasingly intertwined in empirical reality, society and nature denote aspects that should be kept analytically distinct. This distinction can be expressed as that between symbolic and pre-symbolic phenomena. Symbolic phenomena such as language are products of uniquely human social processes of negotiating meanings. They are contingent on human subjectivity but are causally influential components in socioecological processes. The social sciences have developed analytical tools and

concepts for dealing with human subjectivity (e.g., culture, semiotics), whereas the natural sciences generally have no need for such concepts. The social and natural sciences will certainly need to collaborate much more extensively in order to grasp the 'hybrid' socioecological processes shaping the biosphere, but the traditional division of labor between them reflects undeniable differences between the character of social and natural phenomena.

If symbolic phenomena actively participate in shaping the human environment, it is appropriate to ask to what extent this phenomenon distinguishes humans from other animals. The perspective of *ecosemiotics*, going back to the insights of the Estonian zoologist Jakob von Uexküll (1940 [1982]), acknowledges that all species engage their environments by representing them and communicating about them in highly specific ways.¹⁰ An ecosystem can in fact be understood as the complex interaction of a great number of subjective perspectives, determined by the sensory and communicative capacities of different species. The physical flows of matter and energy through an ecosystem are only that aspect of ecology which can be registered by natural science; these material flows are contingent on the semiotic or communicative flows which are equally diagnostic of ecosystems.¹¹

Viewing ecosystems as in part constituted by semiotic flows leads us to ask what kinds of such flows contribute to ecological change (Hornborg, 2001b). An ecosemiotic perspective implies that non-linguistic, sensory signals such as animal sounds, odors, and flavors all participate in the formation of ecosystems, and that this must have been the case throughout the history of life on Earth, billions of years before the emergence of human language. Language added a new dimension to ecosemiosis, most fundamentally by introducing symbolism and culture into the processes by which species transform their environments. Symbols, as defined by Charles Sanders Peirce, are that special kind of signs defined by the conventional nature of the relation between the signifier and what it refers to. The two other major categories of signs are indices and icons. In the case of the index, the relation between signifier and signified is one of contiguity or direct connection, like the odor or sound of an organism or the aroma or flavor of a wild fruit. In the case of icons, this relation is based on similarity, like the mimicking of poisonous or unsavory animals known to occur in ecosystems. The examples I have provided illustrate how such signs – indices and icons – are regular components of ecological processes, whether there are humans involved or not. The novelty of human language, from this perspective, is that representation and communication introduce an element of cultural choice or arbitrariness. Rather than being encoded in genes, the specifics of linguistic sign systems are the results of cultural processes of innovation and negotiation. Linguistic representations only occasionally mimic the phenomena to which they refer, as in onomatopoeia, but are generally the products of implicit agreement about the meanings of words. The symbolic nature of human representation is fundamental not only to language, but to cultural phenomena in general. While the general perspective of semiotics provides the basis for a distinction between living and non-living 'actants' (cf. Kohn, 2013: 91–2), the specificity of symbolism and culture justifies the distinctions between society and nature and between humans and non-human animals. The attempts by many posthumanists to dissolve both these distinctions are highly misleading.

To briefly indicate some of the problematic conceptions frequently encountered among posthumanists, we may first note their general inclination to replace analytical distinctions such as those outlined above with broad homologies or even equivalences which disavow important differences. It is as if the distinctions in themselves are somehow oppressive, provoking deconstruction. To some STS scholars, there is no fundamental difference between the agency of living and non-living entities, and the distinction between society and nature is presented as a modernist conceit (Latour, 1993, 2005). These deconstructions disavow the difference between sentience and non-sentience, and between symbols and other signs. To some feminist scholars, there is no difference between humans and non-human animals, again disavowing the difference between the symbolic and the pre-symbolic, and what is disparagingly referred to as 'human exceptionalism' (Haraway, 2007).¹² In postcolonial ethnography, the inclination is to present indigenous ontologies asserting the animate agency of abiotic entities such as mountains as valid challenges to modern science (de la Cadena, 2010), in effect, disavowing the difference between sentience and non-sentience. The hyper-relativism of the ontological turn in anthropology and sociology proposes that we should take radically different ontologies seriously, and that their proponents are in fact living in a separate reality in which our 'Western' categories are inapplicable (Viveiros de Castro, 1998; Goldman, 2009; Blaser, 2013; Law, 2015).¹³ Many have understood the idea of the Anthropocene as evidence of the invalidity of the society-nature distinction (Latour, 2013; Haraway, 2015; Law, 2015: 134). Such attempts by posthumanists to dissolve modern analytical distinctions often appear to derive from genuine aspirations to challenge global power structures, but, as I shall argue below, they only result in the dissolution of their capacity to do so. Whether or not its categories in part coincide with those of Descartes, a truly critical social science requires a realist ontology and rigorous analysis.¹⁴

Marxism and posthumanism: fundamental differences and possible dialogue

ANT has frequently been criticized for a disinterest in challenging power and social inequalities (e.g., Bessire and Bond, 2014; Gregory, 2014; Hornborg, 2014a, 2015a; Martin, 2014; Kipnis, 2015: 54). In part, this appears to be a consequence of its radical empiricism, advocating detailed studies of the interaction of particular humans with particular artifacts (Kipnis, 2015). Latour has explicitly rejected macrosociological categories such as 'capitalism' and even 'society'. This has predictably generated a contradiction between Marxism and ANT which seems difficult to reconcile. At the same time, Marxist theory can be criticized for being content with a framework of abstract categories that is rarely anchored in concerns with the operation of concrete social relations and artifacts. I shall briefly suggest how the abstract Marxist critique of capital can be concretized in a scrutiny of how the ubiquitous artifacts we know as money and technology contribute to shaping social relations of power and inequality. The connection seems obvious, but the methodological and ideological differences between the two approaches have precluded theoretical convergence.

The radical empiricism of ANT was established through Latour's pioneering studies of the formation of scientific knowledge and technological infrastructure in modern contexts such as laboratories and urban planning (Latour and Woolgar, 1979; Latour, 1996). The meticulous attention to concrete detail in these case studies is made theoretically interesting through Latour's innovative reflections on the interaction between humans and their various artifacts. Rather than perceiving artifacts as mere extensions of human agency, as was the traditional view, Latour discovered that the specific artifacts themselves contributed to shaping not only the forms of human agency, but also human perceptions. This is the fundamental insight which has guided ANT, a generation of STS scholars, and a great number of researchers in other social sciences, such as sociology and anthropology. It provided Latour and his followers with a platform from which to critique traditional understandings of modernity, technology, and scientific knowledge production. However, although subversive of our trust in science, this critique has not been directed at capital, power, and global inequalities.

This latter omission is significant and remarkable, considering that Latour's initial insights on the role of artifacts in human societies emerged in the context of understanding the circumstances of power, dominance, and hierarchy in a comparison of humans and baboons (Strum and Latour, 1987). Collaborating with the primatologist Shirley Strum, Latour realized that what had made it possible for humans to extend their fields of social interaction beyond face-to-face relations was precisely their use of artifacts, widely defined so as to include language and symbols as well as physical implements. Given Marxist concerns, the most obvious human artifact to scrutinize from this perspective is *money*. It seems difficult to explain Latour's and ANT's lack of interest in how this uniquely human artifact has shaped, and continues to shape, human social networks extending beyond face-to-face relations and constituting a truly global society. The crucial difference between humans and baboons is capital.

Money is indeed an artifact attributed with spectacular agency. Moreover, it is a prerequisite to the systems of technological artifacts that merge with it in integrating world society (Hornborg, 2016). These are the artifacts on which capitalism is founded. It seems inexplicable that a school of thought concerned with how artifacts shape human social relations has neglected to focus on money, and refrained from theorizing its significance for the very feasibility of phenomena denoted by the T in STS. On the other hand, it is no less remarkable that Marxism has neglected to anchor its theoretical analysis of capitalism in the concrete operation of the fundamental artifacts on which it rests. 'Capitalism' is the logic of the everyday operation of money and technology in human societies, but the inherent features of general-purpose money generally appear to be as invisible to Marxists as to mainstream economists, like water to fish. Latour says that there is no such thing as capitalism, but why has he not shown an interest in examining how money and technology generate and reproduce human inequalities? Marxists shun the empiricist preoccupation of ANT with individual artifacts, but why have they not questioned money itself? The answers to these questions implicate ideological differences as well as different methodological proclivities regarding modes and levels of abstraction.

Marxist environmental history: acknowledging nature, exposing fetishism

Latour would consider Marxists a paradigmatic example of thinkers constrained by the ‘modernist constitution’. In their extensive deliberations on the role of nature in capitalist processes, eco-Marxists generally do not lose sight of the analytical distinction between the social and the natural.¹⁵ The particular mode in which natural conditions such as thermodynamics are incorporated into Marxist theory is a contested and important analytical issue in its own right, but unlike the posthumanists, Marxists are not inclined to relativize scientific knowledge or challenge the conviction that we all live in a common universe. Sharing such common ground makes it possible to deliberate, for instance, on the precise relation between the Marxian concept of surplus value, on the one hand, and the physical reality of energy, on the other (cf. Hornborg, 2014b, 2015c, 2016). While there are inevitable disagreements on how this relation should be understood, categories of thermodynamics such as energy and entropy are not in question.

In recognizing a distinction between subjects and objects (living and non-living), Marxists are also committed to understanding and exposing fetishism. Fetishism is a useful category for the illusion that an object is animate, in Marxian theory exemplified by our inability in capitalism to grasp that our seemingly potent artifacts are ultimately expressions of social relations. Marx applied this insight to money and commodities, but its most difficult ramification is a radical reappraisal of what we have come to celebrate as modern technology. To understand the accumulation of fossil-fueled ‘technomass’ (Hornborg, 2001a) in core areas of the world-system in terms of fetishism is to recognize the expanding mass of technological artifacts as a manifestation of unequal societal relations of exchange. The capacity to invest in steam technology in nineteenth-century Britain was largely contingent on the market-mediated difference between the cost of raw cotton harvested by African slaves, on the one hand, and the income from selling cotton textiles to the traders and owners of slaves, on the other. The Industrial Revolution was founded on asymmetric flows of embodied labor time and natural space in the world-system. As an extension of Marx’s observations on the fetishism of commodities, we need to grasp that the operation of machines is a matter of societal relations masquerading as relations between things. Technological progress is thus not only a question of local ingenuity, as suggested by conventional narratives about James Watt’s steam engine, but ultimately of the rates of exchange orchestrating global flows of embodied labor and other resources. What keeps our machines running are global terms of trade.

Fetishism is the attribution of autonomous agency to inanimate or abiotic things. The externalized interaction of their artifacts – whether money, commodities, or machines – tends to be perceived by humans as determined by the intrinsic properties of the artifacts themselves, rather than by the regulations and features bestowed upon them by human agents (Hornborg, 2016). Humans thus become subservient to their artifacts, rather than vice versa. Much as players of chess or a board game will refer to the rules, mainstream economists tend to refer to the logic of money and engineers to the logic of their technologies. The extent to which humans are themselves the authors of the social games enacted by their artifacts is obscured from view. The responsibility for human social

relations – and for human-environmental relations – is delegated to things, as if they were the ultimate sources of society. But the crucial distinction we need to make is between the notion that artifacts such as money have agency and the observation that they simply have consequences. The former is fetishism, whereas the latter opens up possibilities for seeing artifacts for what they are: products of *human* agency that humans could potentially transform. I have argued (Hornborg, 2015b) that the Anthropocene is ultimately a consequence of the logic of general-purpose money, but that the design of this artifact – and its consequences – are not inevitable products of human biology.

Anthropocene, Capitalocene, Technocene

In a recent article in *The Anthropocene Review*, Will Steffen and colleagues (Steffen et al., 2015: 91) confirm the argument that Andreas Malm and I made in the same journal a year earlier (Malm and Hornborg, 2014), that the designation Anthropocene misleadingly suggests that the global environmental changes it refers to have been propelled by humanity as a whole. What Steffen and colleagues call ‘the profound scale of global inequality’ is clearly reflected in statistics showing that the OECD countries in 2010 accounted for 74 per cent of global GDP but only 18 per cent of global population. ‘Until very recently’, they observe, the so-called Great Acceleration has been ‘almost entirely driven by a small fraction of the human population, those in developed countries’. However, they continue, this is beginning to change. The most compelling figures they refer to in illustrating this shift are statistics indicating that in 2013 per capita emissions of carbon dioxide in China had surpassed those in Europe. At first glance, such figures do indeed seem compelling, but unless they tell us if the emissions derive from production or consumption, they cannot in themselves be used in support of an assertion that the planetary transformations of the Anthropocene are increasingly being propelled by humanity as a whole. In Sweden, for instance, it has been estimated that *total* per capita emissions of carbon dioxide, including emissions from the production of all goods consumed in Sweden, are about twice those suggested by the official statistics used in comparing the carbon emission performances of different countries. Such figures confirm my earlier argument (Hornborg, 2015b) that current processes of global environmental change ultimately reflect unequal relations of power, exchange, and distribution in world society.

This argument is not tantamount to having made the choice to understand the Anthropocene in terms of the history of capitalism rather than in those of the history of the human species. For Dipesh Chakrabarty (2014, 2015), seconded by Clive Hamilton (2015), Malm’s and my intervention appears to signify such a choice. Hamilton classifies us as historians of an ‘orthodox Marxian persuasion’, objecting that the Soviet Union and Maoist China were no less Promethean than capitalism, and that the ‘broad populace’ has willingly collaborated with capital in destroying its own future. Apparently to indicate the inadequacy of Malm’s and my position, Hamilton reiterates Chakrabarty’s (2009) call for an integration of the history of our species with the history of capital. But this is in fact precisely the point in my recent chapter (Hornborg, 2015b: 62–5), in a book co-edited by Hamilton. It is the uniquely human capacity for abstract representation that is a prerequisite to money, and money was prerequisite to the Industrial Revolution that

inaugurated the Anthropocene. To my mind, this account does adequately integrate the history of our species with the history of capital. The semiotic capacities of our species made it feasible for us to generate unprecedented intra-species inequalities. No other species could have developed capitalism. To underscore the inequalities underlying recent global environmental change is not to deny that the capacity to develop such inequalities is uniquely human, but Malm's and my point was that to refer simply to the 'Anthropocene' risks leaving the inequalities out of the picture altogether. The designation of our present time as the 'Age of Humans' seems to suggest that climate change is the inevitable consequence of how our species is constituted. My objection is that although the potential for capitalism is inherent in our species, it is not an inevitable product of our biology, nor something for which we all have a common responsibility.

It is ironic that the intervention I co-authored with Malm should be interpreted as an expression of orthodox Marxism, considering how concerned I have been to transcend the industrialist or productivist biases of conventional Marxist theory (Hornborg, 2014b, 2015c, 2016). To evoke conflicts and material inequalities is not automatically to qualify as an orthodox Marxist. Nineteenth-century steam power was a particularly spectacular example of the processes of capital accumulation that had precedents going back several millennia. The Marxian emphasis on 'use values', not least the use value of labor power, suggests an emergent concern with thermodynamics (Burkett and Foster, 2006; Foster and Holleman, 2014), and the prediction of a decline in the rate of profit an intuitive understanding of the problem of net energy (EROI) and diminishing returns (cf. Tainter, 1988; Hall and Klitgaard, 2012). Alongside the biases of a Promethean trust in technological progress, the most difficult conceptual hurdle for early Marxism was to extricate these concerns with the expenditure of physical energy in production processes from the all-encompassing discourse on monetary profits and economic value. Rather than a genuinely transdisciplinary argument on the relation between energy and money, as presented much later by Nicholas Georgescu-Roegen (1971), parts of the theoretical edifice of traditional Marxism remain impaired by the aspiration to analytically derive monetary gain from expenditures of energy. Although both phenomena are quantifiable (by economists and physicists, respectively), monetary gain is a social construction in the sense that it is contingent on subjective perceptions of human artifacts, while expenditures of energy are physical processes irreducible to human subjectivity. The Anthropocene illustrates how social constructions such as money can have very material consequences, but we cannot hope to grasp or remedy our current predicament unless we retain the analytical distinction between them.

Conclusion: why distinctions are indispensable for critical social science

I hope to have shown that, in order to conceptualize the currently disastrous anthropogenic changes in the biosphere, social theory will need to critically scrutinize the ecological and political consequences of our most celebrated artifacts: money and technology. In order to do so, we must retain our capacity to analytically distinguish between the semiotic and the biophysical aspects of socioecological processes. I have elsewhere suggested that the political solution to our justified anxieties about

sustainability and escalating inequalities must be to redesign money so as to distinguish between a local sphere of exchange committed to survival, on the one hand, and a sphere of global communication, on the other (Hornborg, 2015b, in press). The key must be to redefine economic commensurability so that infant mortality and environmental degradation in Sub-Saharan Africa are not geared to financial speculation on Wall Street. Rather than delegating the destiny of human society and the planet to the insufficiently understood, inherent logic of our entropy-accelerating artifacts, we must achieve societal control over the operation of those artifacts. In order to be able to regulate global social polarization and environmental change, we must transform the artifacts that generate these processes. Only by simultaneously recognizing the two seemingly incompatible aspects of conventional money – its inexorable material and political trajectories *and* the feasibility of its transformation through democratic processes – can we stand a chance of surviving the Anthropocene.

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Notes

1. Kipnis (2015: 44) defines posthumanism as ‘analytic stances that grant agency to nonhuman entities and that downplay the differences between human and nonhuman agency’.
2. It is not difficult to understand why a social philosopher trained in Catholic theology would want to rehabilitate fetishism (Latour, 2010), but it is more complex to unravel why a generation of social scientists has so eagerly sought to emulate him. There appears to be a widespread confusion between attempts to dissolve hierarchies, on the one hand, and attempts to dissolve analytical distinctions, on the other. In other words, political critique is confused with ontological critique. The dissolution of ‘Cartesian’ distinctions between humans and non-humans is perceived as a democratic, if not revolutionary, project, but is tantamount to disarming the very possibility of political critique. Paradoxically, theology could provide a solid foundation for critiques of capitalist fetishism, but this is not a direction pursued by the proponents of ANT.
3. This urge is currently so widespread in the social sciences that I cannot agree with Blaser’s (2013: 548) claim that the ‘assumption of an all-encompassing modernity has come to dominate both scholarly and political analysis to the point that anything that might try to contest it is automatically treated with contempt’.
4. Kohn (2013: 91–2) criticizes ANT and STS for not distinguishing between living, semiotic ‘selves’, on the one hand, and objects and artifacts, on the other, succinctly concluding that ‘selves, not things, qualify as agents’.
5. To deny the ontological reality of the subject-object distinction may be related to the pervasive psychological denial of the fact that we shall all reach a moment when we are irrevocably transformed from subjects into objects.
6. The recognition that knowledge is always situated, radically endorsed by posthumanist feminists such as Haraway (1988), is quite compatible with a realist ontology (Bhaskar, 1975).

7. Although I share Kipnis' (2015: 55) aspiration to distinguish between different kinds of agency, I do not agree that agency should be granted to 'anything and everything [which] could affect us'.
8. The symbolic or social aspects of these particular phenomena include, for instance, the food preferences deciding the choice of crops, the categories of economics, and the fashions generating tastes for specific commodities.
9. If the framework of distinctions presented here is to be classified as 'naturalism' (Descola, 2013), the category must be widened to include more variation than specified in the definition provided by Descola. In rejecting all possible distinctions between nature and society, the posthumanist urge to relativize and dismiss 'Cartesian' dualisms has tended to throw out the baby with the bathwater.
10. This insight is strikingly similar to the perspectivist variety of animism identified among some indigenous peoples of Amazonia (Viveiros de Castro, 1998), but it does not necessarily imply that different species literally live in different worlds, as is the conclusion of ontological relativists regarding the radical alterity of non-modern peoples (Goldman, 2009; Blaser, 2013; Law, 2015).
11. And vice versa, of course. This is to say that the material and semiotic aspects of ecosystems are recursively interdependent, rather than one being ontologically prior to the other.
12. For a profound defense of human exceptionalism, see Soper (2012).
13. John Law (2015: 127) has expressed this position with admirable clarity:

Are we simply saying that white people believe one thing, for instance about what we code up as 'nature', whereas Aboriginal people believe something different? Or is something different going on? The new post-colonial response is that the differences are not simply matters of belief. They are also a matter of reals.
14. Apparently, the alternative for environmental humanities contemplating the Anthropocene, explicitly endorsed by posthumanist Donna Haraway (2015: 161), is 'dithering'. For superb illuminations of the contradictions and analytical lapses of ANT, grounded in critical realism, see Elder-Vass (2008, 2015).
15. A recent exception is the amorphous and analytically incoherent approach of Jason W. Moore (2015), who has attempted to integrate classical Marxist theory not only with ecology but also with the 'post-Cartesian' rhetoric of posthumanism.

References

- Bessire L and Bond D (2014) Ontological anthropology and the deferral of critique. *American Ethnologist* 41(3): 440–56.
- Bhaskar R (1975) *A Realist Theory of Science*. Leeds: Leeds Books.
- Blaser M (2013) Ontological conflicts and the stories of peoples in spite of Europe: toward a conversation on political ontology. *Current Anthropology* 54(5): 547–68.
- Burkett P and Foster JB (2006) Metabolism, energy, and entropy in Marx's critique of political economy: beyond the Podolsky myth. *Theory and Society* 35: 109–56.
- Chakrabarty D (2009) The climate of history: four theses. *Critical Inquiry* 35: 197–222.
- Chakrabarty D (2014) Video presentation at the conference *Os mil nomes de Gaia*, Rio de Janeiro, 15–19 September 2014.
- Chakrabarty D (2015) The human significance of the Anthropocene. Unpublished manuscript.

- Chase-Dunn C and Hall TD (1997) *Rise and Demise: Comparing World-systems*. Boulder, CO: Westview.
- Cronon W (1995) The trouble with wilderness; or, getting back to the wrong nature. In: Cronon W (ed.) *Uncommon Ground: Rethinking the Human Place in Nature*. New York: WW Norton, pp. 69–90.
- De la Cadena M (2010) Indigenous cosmopolitics in the Andes: conceptual reflections beyond ‘politics’. *Cultural Anthropology* 25(2): 334–70.
- Descola P (2013) *Beyond Nature and Culture*. Chicago: University of Chicago Press.
- Elder-Vass D (2008) Searching for realism, structure and agency in Actor Network Theory. *The British Journal of Sociology* 59(3): 455–73.
- Elder-Vass D (2015) Disassembling Actor-network Theory. *Philosophy of the Social Sciences* 45(1): 100–21.
- Ellen RF (1996) The cognitive geometry of nature: a contextual approach. In: Descola P and Pálsson G (eds) *Nature and Society: Anthropological Perspectives*. London: Routledge, pp. 103–23.
- Foster JB, Clark B and York R (2010) *The Ecological Rift: Capitalism’s War on the Earth*. New York: Monthly Review Press.
- Foster JB and Holleman H (2014) The theory of unequal ecological exchange: a Marx-Odum dialectic. *The Journal of Peasant Studies* 41(2): 199–233.
- Georgescu-Roegen N (1971) *The Entropy Law and the Economic Process*. Cambridge, MA: Harvard University Press.
- Goldman M (2009) An Afro-Brazilian theory of the creative process: an essay in anthropological symmetrization. *Social Analysis* 53(2): 108–29.
- Gregory C (2014) On religiosity and commercial life: toward a critique of cultural economy and posthumanist value theory. *HAU: Journal of Ethnographic Theory* 4(3): 45–68.
- Hall CAS and Klitgaard K (2012) *Energy and the Wealth of Nations: Understanding the Biophysical Economy*. New York: Springer.
- Hamilton C (2015) Towards a philosophy of history for the Anthropocene. Paper presented at the conference *Comment penser l’anthropocene?* Collège de France, Paris, 5–6 November 2015.
- Haraway D (1988) Situated knowledges: the science question in feminism and the privilege of partial perspective. *Feminist Studies* 14(3): 575–99.
- Haraway D (2007) *When Species Meet*. Minneapolis: University of Minnesota Press.
- Haraway D (2015) Anthropocene, Capitalocene, Plantationocene, Chthulucene: making kin. *Environmental Humanities* 6: 159–65.
- Hornborg A (2001a) *The Power of the Machine: Global Inequalities of Economy, Technology, and Environment*. Walnut Creek, CA: AltaMira.
- Hornborg A (2001b) Vital signs: an ecosemiotic perspective on the human ecology of Amazonia. *Sign Systems Studies* 29(1): 121–52.
- Hornborg A (2010) Toward a truly global environmental history: a review article. *Review* 33(4): 295–323.
- Hornborg A (2014a) Technology as fetish: Marx, Latour, and the cultural foundations of capitalism. *Theory, Culture, & Society* 31(4): 119–40.
- Hornborg A (2014b) Ecological economics, Marxism, and technological progress: some explorations of the conceptual foundations of theories of ecologically unequal exchange. *Ecological Economics* 105: 11–18.

- Hornborg A (2015a) The political economy of technofetishism: agency, Amazonian ontologies, and global magic. *HAU: Journal of Ethnographic Theory* 5(1): 35–57.
- Hornborg A (2015b) The political ecology of the Technocene: uncovering ecologically unequal exchange in the world-system. In: Hamilton C, Bonneuil C and Gemenne F (eds) *The Anthropocene and the Global Environmental Crisis: Rethinking Modernity in a New Epoch*. London: Routledge, pp. 57–69.
- Hornborg A (2015c) Why economics needs to be distinguished from physics, and why economists need to talk to physicists: a response to Foster and Holleman. *Journal of Peasant Studies* 42(1): 187–92.
- Hornborg A (2016) *Global Magic: Technologies of Appropriation from Ancient Rome to Wall Street*. Houndmills: Palgrave Macmillan.
- Hornborg A (in press) How to turn an ocean liner: a proposal for voluntary degrowth by redesigning money for sustainability, justice, and resilience. *Journal of Political Ecology*.
- Kipnis AB (2015) Agency between humanism and posthumanism: Latour and his opponents. *HAU: Journal of Ethnographic Theory* 5(2): 43–58.
- Kohn E (2013) *How Forests Think: Toward an Anthropology Beyond the Human*. Berkeley: University of California Press.
- Latour B (1993) *We Have Never Been Modern*. Cambridge, MA: Harvard University Press.
- Latour B (1996) *Aramis or the Love of Technology*. Cambridge, MA: Harvard University Press.
- Latour B (2004) *Politics of Nature: How to Bring the Sciences into Democracy*. Cambridge, MA: Harvard University Press.
- Latour B (2005) *Reassembling the Social: An Introduction to Actor-Network-Theory*. Oxford: Oxford University Press.
- Latour B (2010) *On the Modern Cult of the Factish Gods*. Durham, NC: Duke University Press.
- Latour B (2013) *Facing Gaia: six lectures on the political theology of nature*. The Gifford Lectures on Natural Religion, Edinburgh.
- Latour B and Woolgar S (1979) *Laboratory Life: The Construction of Scientific Facts*. Beverly Hills, CA: Sage.
- Law J (2015) What's wrong with a one-world world? *Distinktion: Journal of Social Theory* 16(1): 126–39.
- Malm A and Hornborg A (2014) The geology of mankind? A critique of the Anthropocene narrative. *The Anthropocene Review* 1: 62–9.
- Martin K (2014) Afterword: knot-work not networks, or anti-anti-antifetishism and the ANTIPolitics machine. *HAU: Journal of Ethnographic Theory* 4(3): 99–115.
- Moore JW (2015) *Capitalism in the Web of Life: Ecology and the Accumulation of Capital*. London: Verso.
- O'Connor J (1998) *Natural Causes: Essays in Ecological Marxism*. New York: The Guilford Press.
- O'Connor M (ed.) (1994) *Is Capitalism Sustainable? Political Economy and the Politics of Ecology*. New York: The Guilford Press.
- Soper K (2012) The humanism in posthumanism. *Comparative Critical Studies* 9(3): 365–78.
- Steffen W, Broadgate W, Deutsch L, Gaffney O and Ludwig C (2015) The trajectory of the Anthropocene: the Great Acceleration. *The Anthropocene Review* 2(1): 81–98.

- Strum S and Latour B (1987) Redefining the social link: from baboons to humans. *Social Science Information* 26: 783–802.
- Tainter JA (1988) *The Collapse of Complex Societies*. Cambridge: Cambridge University Press.
- Viveiros de Castro E (1998) Cosmological deixis and Amerindian perspectivism. *Journal of the Royal Anthropological Institute (N.S.)* 4(3): 469–88.
- Von Uexküll J (1940 [1982]) The theory of meaning. *Semiotica* 42: 25–82.
- Wallerstein I (1974) *The Modern World-System: Capitalist Agriculture and the Origins of the European World-Economy in the Sixteenth Century*. San Diego: The Academic Press.

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