

ECOLOGY, CAPITAL, AND THE NATURE OF OUR TIMES: ACCUMULATION & CRISIS IN THE CAPITALIST WORLD-ECOLOGY

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ABSTRACT

*In this essay, I elaborate the possibilities for a unified theory of historical capitalism – one that views the accumulation of capital and the production of nature (humans included!) as dialectically constituted. In this view, the modern world-system is a capitalist world-ecology, a world-historical matrix of human- and extra-human nature premised on endless commodification. The essay is organized in three movements. I begin by arguing for a reading of modernity’s “interdependent master processes” (Tilly) as irreducibly socio-ecological. Capitalism does not develop upon global nature so much as it emerges through the messy and contingent relations of humans with the rest of nature. Second, the paper engages Giovanni Arrighi’s handling of time, space, and accumulation in *The Long Twentieth Century*. I highlight Arrighi’s arguments for a “structurally variant” capitalism, and the theory of organizational revolutions, as fruitful ways to construct a theory of capitalism as world-ecology. I conclude with a theory of accumulation and its crises as world-ecological process, building out from Marx’s “general law” of underproduction. Historically, capitalism has been shaped by a dialectic of underproduction (too few inputs) and overproduction (too many commodities). Today, capitalism is poised for a re-emergence of underproduction crises, characterized by the insufficient flow of cheap food, fuel, labor, and energy to the productive circuit of capital. Far from the straightforward expression of “overshoot” and “peak everything,” the likely resurgence of underproduction crises is an expression of capitalism’s *longue durée* tendency to undermine its conditions of reproduction. The world-ecological limit of capital, in other words, is capital itself.*

INTRODUCTION

“The history of capitalism shows us,” Giovanni Arrighi wrote in the spring of 1972, “that the periodic recurrence of crises is not a function of... ‘mistakes’ in economic management... The tendency towards crisis is indissolubly linked to the existence of capitalism itself” (1978a:3). Today, we find ourselves in a moment of global crisis that overshadows even the turning point of the early 1970s, from whence neoliberalism emerged. It is a moment that has brought forth, from some sections of the left, explanations of crisis premised on the “mistakes” of neoliberal (de)regulation and calls for more effective state management of the world-economy – above all, for a renovated Keynesianism that would discipline finance capital (e.g. Mason 2009). Arrighi’s

approach to historical capitalism offers an indispensable alternative to these explanations and proposed resolutions. From his early formulations of accumulation crisis in the 1970s to his death in 2009, he developed the era's most sophisticated analysis of systemwide accumulation crises over the *longue durée*. (Much of it in collaboration with Beverly Silver.) This essay takes Arrighi's accounts of capitalism over the *longue durée* as a guiding thread to elaborate the next wave of world-historical crisis theory – one that finds its point of departure in the material and symbolic relations of humans with the rest of nature.

Central to Arrighi's thinking is capitalism's remarkable capacity for adaptation. Cautioning against the temptation to engage capitalism as a set of "structurally invariant" processes (2004), he argues powerfully for internalizing spatio-temporal dynamics in the theory of capitalist development. Capitalism does not act upon time and space. *It actively produces these*.¹ Nowhere do we find a more compelling world-historical articulation of this argument than in *The Long Twentieth Century* (Arrighi 1994).

Drawing on this articulation, I focus on the conceptual and methodological possibilities for a unified theory of historical capitalism – one that views the accumulation of capital and the production of *all* nature (humans included!) as dialectically constituted. This argument is closely intertwined with, yet distinct from, narrative construction, which I pursue elsewhere (Moore 2000b, 2002a, 2003b, 2007a, 2007b, 2009, 2010a, 2010b, 2010d, 2010e).

The work of adding "environmental factors" to those of class, capital, empire, and civilization is now largely complete in world-systems analysis, and across the historical social sciences. It is now time to move beyond this grafting of biophysical change onto the body of historical social science. In what follows, I show how Arrighi's relational and contingent construction of capitalism opens the door to a theory of the modern world-system *as* ecological regime. As such, the view that the "*real barrier of capitalist production is capital itself*" (Marx 1967 III:250) – a phrase that Arrighi was fond of quoting – becomes a way of transcending Cartesian reckonings of "capitalism *and* nature" in favor of capitalism-*in*-nature.²

This reconstruction emphasizes the socio-ecological constitution of capitalism's value form – as subjective project no less than objective process. In privileging labor productivity over land productivity, capital reconfigures the relations between humans and the rest of nature (Marx 1967). Value, Marx argues, *internalizes* nature through the alienated elevation of human labor power to primacy. Labor power, as abstract social labor (which might be thought of as the average labor time inscribed in the average commodity), becomes the decisive metric of wealth in capitalism. At the same time, capital *externalizes* nature through the appropriation of extra-human nature as "free gift" (Marx 1967 III:745). Nor are nature's free gifts limited to minerals, soil, and so forth: they also include human labor power (re)produced outside the circuit of capital (Marx 1976:377-378).

Historically, value emerges in and through Braudel's "market economy" (1982). It weaves together the ethereal valences of finance capital and the prosaic routines of everyday life

¹ Yes, there is a "nature" that exists independently of what one thinks of it. Of course, thinking is itself a "natural" process. Nature is knowable only through the conceptual frames and modes of inquiry that humans create and transcend in successive historical eras (Young 1985). Our best guide to the relation between signifier (nature) and signified (the biological, geological, etc.) is historically-grounded theory (Moore 2011a).

² Adapted from Arrighi's important essay on labor-*in*-nature (2009).

in new crystallizations of power and profit, pivoting on the commodity. In this light, the apparently external relations of capitalism *to* nature – captured in the popular concepts of metabolic rift, ecologically unequal exchange, and the ecological footprint – are revealed as inner relations, constitutive of new, and profoundly restless, socio-ecological configurations (Moore 2011a).

As we move from the logic of capital to the history of capitalism, the multiform tension between the internalization and externalization of nature comes to the fore. The logic of capital compels it to ignore nature as historically variant webs of life; the history of the capitalist era reveals the dynamism and degradations inscribed in this logic as it reorganizes human- and extra-human nature, liberating and limiting accumulation in successive eras. Capital's dynamism turns on the exhaustion of the very the webs of life necessary to sustain accumulation; the history of capitalism has been one of recurrent frontier movements to overcome that exhaustion, through the appropriation of nature's free gifts hitherto beyond capital's reach.

The rise of value to the commanding heights of the early modern world-economy was concurrent with the incessant revolutionizing of time and space that we have come to associate with neoliberal globalization. Far from a 20th century invention, "time-space compression" has been central to capitalism from its origins (Harvey 1989; Moore 2003b, 2007a). That these revolutions were fundamentally socio-ecological is easily overlooked. And yet, the universalization of money capital as a storehouse of value is unthinkable except as a part of a world-ecological revolution that enabled European states and capitals to see time as linear, space as flat and homogenous, and "nature" as external to human relations (Cosgrove 1985; Crosby 1997; Moore 2007, 2010a, 2010b; Merchant 1980; Mumford 1934).

It is no coincidence that the most powerful radical theories of capitalist crisis in the neoliberal era have turned on the production of time and space as a unified and differentiated process. We can see the powerful synergies on offer from Arrighi's long dialogue with David Harvey. The demand to accelerate turnover time, so central to Harvey's theory of spatial fix (1982), shapes not only built environments and business organizations, but also the systemwide rhythm of capitalist development. (Every phase of capitalism moves *faster* than the one before it.) The drive to innovate, so central to Arrighi's account of capitalist dynamism, not only produces new markets, new commodities, new statemaking and accumulation capacities, but also recurrent waves of geographical restructuring, global expansion, and the growing spatial compass of the hegemony that lead and coordinate great waves of economic growth. (Every phase of capitalism is *bigger* than the one before it.)

I therefore begin with two premises. The first is Harvey's observation that all social projects are ecological projects and vice-versa (1993). All moments of the spatial fix and its corollaries are irreducibly socio-ecological. The second is Arrighi's inherently open methodological vision of a structurally variant capitalism that is, nevertheless, characterized by definite patterns of recurrence, evolution, and rupture.

I mobilize these insights to engage the great unasked question of the world-historical perspective in the Age of Transition: When it comes to the history of capitalism, what difference does ecology make? What does it mean, for conceptualizing and bounding the systemic phenomena under investigation, to say that all social projects are ecological projects and vice-versa? And if time and space are themselves produced through the agencies of historical capitalism, in what sense is world-systems analysis positioned to transcend the Nature/Society binary?

These questions are especially relevant to the task of interpreting the ongoing crisis of neoliberalism. Is it probable, possible, or unlikely that the world-system's leading territorial and capitalist powers will re-establish the conditions for a new long wave of accumulation? Arrighi's Three Questions provide an indispensable means of exploring, and answering, this question. What are the secular trends within which innovations in the relations between humans and the rest of nature might deliver a new material expansion? What are the cyclical movements of socio-ecological innovation, especially in agriculture and energy, indicating possibility and constraint for such a renewed expansion? In what ways does the recent history of socio-ecological innovation indicate continuity with older patterns, and in what ways have we witnessed a rupture with longstanding cyclical and cumulative movements?

My response to these questions emphasizes the ontological, methodological, and conceptual-historical elements of a theory of capitalism that unifies the accumulation of capital and the production of nature. The argument is organized in three movements. I begin with a consideration of world-systemic investigations of environmental change, pointing to the possibilities offered by transcending the Cartesian binary of "world-system *and* environment." This alternative views the meta-concepts of "social" change as socio-ecological. The ambition is to rethink capitalism as world-ecology... and not capitalism only. My intention is to implicate the widest range of meta-processes in the modern world as socio-ecological, from family formation to racial orders to industrialization, imperialism, and proletarianization. From this perspective, capitalism does not develop *upon* global nature so much as it emerges *through* the messy and contingent relations of humans with the rest of nature.

The second section engages Arrighi's supple handling of time, space, and accumulation in *The Long Twentieth Century*. My reading of Arrighi's history of capitalism in world-ecological perspective highlights its methodological implications. Especially relevant are his arguments for a "structurally variant" capitalism, and the theory of organizational revolution and exhaustion, as fruitful ways to construct a theory of capitalism as ecological regime.

In the final section, I conceptualize accumulation and its crises as world-ecological process.³ The outlines of this crisis theory take shape through Marx's account of *underproduction* crises (1967 III). Historically, I argue, capitalism has been shaped by a dialectic of underproduction (too few inputs) *and* overproduction (too many commodities). Today, capitalism is primed for a re-emergence of *underproduction* crises – early capitalism's dominant crisis tendency – characterized by the insufficient flow of cheap food, fuel, labor, and energy to the productive circuit of capital (M-C-M+) (Moore 2010c, 2011a, 2011b). Far from the straightforward expression of "overshoot" and "peak everything," the likely resurgence of underproduction crises is an expression of capitalism's *longue durée* tendency to undermine its conditions of production.⁴ The ecological limit of capital, it appears, is capital itself.

³ In a companion essay, I place this model of accumulation and crisis in the capitalist world-ecology into dialogue with rise and ongoing signal crisis of neoliberalism (Moore 2011b; also Moore 2009a, 2010c).

⁴ Beyond Marx, the original sources for this perspective include also Polanyi (1957), Worster (1990, 1992), and O'Connor (1998).

THE WORLD-HISTORICAL IMAGINATION: BEYOND HUMAN EXEMPTIONALISM

The Long Twentieth Century coincided with an explosion of world-system interest in the environment. Given this synchronicity, it is something of a puzzle that the world-historical perspective has yet to locate the spatio-temporal coordinates and relations of the system *within* the nature-society relation.⁵

The world-historical perspective has broken two sorts of new ground in environmental studies. First, world-systems analysts have shed light on the ways that biophysical transformations have *enabled* accumulation, and capitalist development as a whole (Foster 1994; Moore 2000a). Perhaps most famous is Bunker's elaboration of staple theory, showing how "modes of extraction" (largely in the South) were intertwined with "modes of production" (largely in the North) (1984, 1985; Bunker and Ciccantell 2005; Ciccantell, Smith, and Seidman 2005). Dutch world hegemony was impossible without timber to build commercial fleets; British hegemony, impossible without coal to fire steam engines. A second group of studies takes up the *consequences* of capitalism upon biophysical nature. This is the "ecological footprint" approach in spirit as well as letter (e.g. York, et al. 2003; Jorgenson 2003; Chew 2001; Amin 2009), overlapping with studies of ecologically unequal exchange (Jorgenson and Clark 2009a, 2009b).

These studies represent a signal contribution to recent world scholarship. They have deepened our understanding of capitalism and environmental change, historically and in the neoliberal conjuncture. They have not, however, moved to rethink the major categories of analysis through the nature-society relation. So far, the "greening" of world-systems analysis has left untouched the core conceptual and methodological premises guiding the investigation and explanation of historical capitalism. The "endless accumulation of capital" has, by and large, remained an irreducibly social process rather than a socio-ecological project. It is a fine example of what Dunlap and Catton once called "human exemptionalism" in their early formulation of environmental sociology (1979). Capitalism, for much of the world-historical perspective, remains a social process that is either enabled by, or imposes terrible degradations upon, external nature. In either case, "nature" is rendered passive, the object of "social" forces, externalized symbolically in many of the same ways that capital seeks to externalize its costs of production.

What would an alternative that transcends such Cartesian binaries look like? I propose that we move from the "environmental history *of*" modernity, to capitalism "*as* environmental history." In the first approach, scholars investigate the environmental consequences *of* social relations. Many of environmental history's classic texts take this approach.⁶ The alternative turns on unthinking social reductionism. This questions the very category of social relations by asking how modernity itself constitutes a socio-ecological project and process. This is capitalism, imperialism, hegemony *as* environmental history. It is the search for a single dynamic inquiry in which nature, social and economic organization, thought and desire are treated as one whole. And this whole changes as nature changes, as people change, forming a dialectic that runs through all of the past down to the present (Worster 1988:293).

⁵ Promising explorations include Quark 2008; O'Hearn 2005; Gellert 2005; Araghi 2009; and Biel 2006.

⁶ For example, Cronon (1991), Merchant (1989), McNeill (2000). An extraordinary exception is Donald Worster (1990, 1992), whose conception of regional modes of production as the crystallization of local environmental conditions and political-economic relations at larger scales prefigures the present argument.

“Environmental history *as*” reorients our line of questioning to the repertoire of modernity’s “interdependent master processes” (Tilly 1984). It opens new questions about how imperialism, commodification, state formation, industrialization, patterns of gender and family relations, and urbanization (*inter alia*) represent distinctive weaves of human and extra-human nature. From such a perspective, we can see Arrighi’s successive hegemonic alliances, and the broader accumulation regimes they pioneered, as constitutive moments in modernity’s recurrent world-ecological revolutions. Systemic cycles of accumulation do not create systemic cycles of environmental transformation so much as they represent differentiated moments of a singular world-historical process – the capitalist world-ecology. Could one write a history of the 17th century Atlantic without reference to the Spanish Empire’s socio-ecological reshaping of the Andes in the service of the silver mining frontier, and the dilapidation of Castile’s agricultural regime (Moore 2010a:46-48; Moore 2010e)? Or of British hegemony in the late 19th century, without an analysis of botanical imperialism, or the Empire’s role in the catastrophic famines that swept through the colonial and semi-colonial world (Davis 2001; Brockway 1979)? Or of American hegemony without considering successive agro-ecological revolutions from the Midwest to California to the Punjab (Friedmann 1978; Walker 2004; Perkins 1997)?

Sure. Such histories are produced all the time. But if environmental history is not merely consequential to, but also constitutive in, the making and unmaking of historical capitalism, new possibilities appear. If Wallerstein (1974) provides insights into the socio-ecological crises and conditions of the transition from feudalism to capitalism (Moore 2003a), Arrighi’s narrative of successive, progressively globalized accumulation regimes points towards an active, dialectical incorporation of nature-society relations since 1450.

Capitalism as *Oikeios*: Conceptual-Linguistic Challenges

Such a dialectical incorporation poses two great challenges, in successive turns conceptual-linguistic and methodological. The first is a problem of conceptual language deployed in global environmental studies. From its origins, conceptual language has been central to world-systems analysis. Scholars often discuss “world-systems *theory*” as if it is primarily a body of theoretical claims about the world. It is too often overlooked that world-historical theorizing emerges through a mode of *analysis*, a “knowledge movement” that seeks to discern the “totality of what has been paraded under the labels of the... human sciences and indeed well beyond” (Wallerstein 2004a; 2004b:62). “We must invent new language,” Wallerstein rightly insists, to transcend the illusions of the “three supposedly distinctive arenas” of society/economy/politics (1991:14). This trinitarian structure of knowledge is grounded in another, even grander, modernist architecture – the alienation of biophysical worlds (including those within bodies) from social ones. “One question, therefore, is whether we will be able to justify something called social science in the twenty-first century as a separate sphere of knowledge” (Wallerstein 1995:855).

We can immediately detect two conceptual-linguistic difficulties in critical environmental studies. The first is a tendency to deploy “ecology,” “environment,” and “nature” (and all manner of cognates) as interchangeable. Not for nothing did Raymond Williams describe nature as “perhaps the most complex word in the language” (1985:219). (In *any* language, one might add.)

There is little question that we “need a much more unified language for the social and biological/physical sciences than we currently possess” (Harvey 1993:38). I am struck by how little progress environmental studies has made in this direction over the past two decades. If new

vernaculars are needed, however, it would be impractical to ignore the old. For the moment, I retain the language of Nature/Society and “socio-ecological,” but emphasize from the outset that these terms represent the *results* of an underlying relation – what I call, following Theophrastus (Hughes 1994:4), the *oikeios*. This signifies the *relation* that produces manifold environments and organisms as irreducibly plural abstractions. To take the Nature/Society binary as a point of departure confuses the origins of a process with its results. The plethora of ways that human and biophysical natures are intertwined at every scale – from the body to the world market – is obscured to the degree that we take nature and society as purified essences rather than tangled bundles of human- and extra-human nature.

Feudalism, capitalism, and other historical systems emerge and develop through this *oikeios*. World-ecologies signify successive configurations of nature-society relations from which no aspect of human experience is exempt. Far more than a simple act of discursive re-branding, the world-ecological perspective seeks to illuminate what is often invisible in environmental studies. In place of a thought-structure that posits the “economic” as independent (or relatively so) from the “environment,” would it not be more fruitful to view financialization, industrialization, imperialism (old and new), and commercialization, among many others, as socio-ecological projects and processes in their own right?

In what follows, the shorthand “ecological” speaks to a holistic perspective on the *society-environment* relation. Each dialectical movement is actively constructed by (and through) the other. If society and environment constitute the parts, *ecology* signifies the whole that emerges through these relations (Levins and Lewontin 1985). In place of environmental crisis, I therefore embrace the language of *ecological* transformation. I do so because a singular object, *the environment*, “does not exist and... because every species, not only the human species, is at every moment constructing and destroying the world it inhabits” (Lewontin and Levins 1997:98).

A second conceptual-linguistic difficulty in global environmental studies implicates the “common sense” of environmental crisis today. The signifier “crisis” is rarely deployed with less historical and conceptual precision than in critical environmental studies. The argument for crisis is too often built out from a catalogue of environmental problems, whose gravity cannot (I agree) be overestimated (e.g. Foster 2009). Unfortunately, such empiricism works against a theory that includes unconventional sites of environmental history – say, financial centers or factories or suburban sprawls *as* environmental history. Nor is it conducive to a world-ecological rethinking modernity’s greatest contradictions – between powerful and weaker states, between capital and the direct producers, between town and country.

Capitalism as World-Ecology: Conceptual-Methodological Visions

We have become accustomed to thinking of capitalism as a social, even economic, system. There is some truth the characterization. But it rests upon a profound falsification. It is impossible to discern, in a non-arbitrary fashion, the boundary between capitalism, the social system, and “the environment.” These realities are so intertwined that it is impossible, as Williams might say, “to draw back and separate either out” (1980:83).

The point is not to do away with distinctions, but to highlight the often-invisible frames within which distinctions are formed. The Cartesian ontology that shapes the distinctions of “economy/society” and “environment” is fast losing its heuristic edge. These abstractions – Nature/Society – are the product of a long history of modern thought, one premised on the search

for “basic units” that could be defined substantially rather than relationally. The basic problem with this is that “all previously proposed undecomposable ‘basic units’ have so far turned out to be decomposable” (Levins and Lewontin 1985:278). And there is an even deeper problem. The *symbolic* enclosure and purification of “nature” (nature without humans) and “society” (humans without nature) is, historically and in the present crisis, instanced in the *material* enclosures of actually existing capitalism.⁷

As Levins and Lewontin underscore, the empirical and conceptual decomposition of basic units – Nature/Society in this instance – entails more than critique. Analytical decomposition, revealing the relations forming basic units, also reconstructs. Such deconstruction necessarily “open[s] up new domains for investigation and practice” (Levins and Lewontin 1985:278). This enables a shift from the privileging of basic units to the relations that form them. This is the methodological core of world-systems analysis (Hopkins 1982; McMichael 1990; Tomich 1990), emphasizing a relational method through which modernity’s “master processes” unfold as a “rich totality of many determinations” (Marx 1973:100).

Our tradition’s longstanding critique of societal development as *the* basic unit of social change – positing that the real relations of national units operate through multilayered local-global dialectics – can now be radically extended. The basic units Nature/Society may now be transcended on the terrain of world history. If capitalism is a matrix of human- and extra-human nature, premised on endless commodification, no domain of human experience is exempt from socio-ecological analysis. Modern world history may then be reimagined, away from the Cartesian basic units – Nature/Society – and towards the socio-ecological constitution of modernity’s strategic relations. This constitutive dialectic extends far beyond *earth-moving*, comprising commodity-centered resource extraction, cash-crop agriculture, energy complexes, pollution, and so forth. The production of nature has been every bit as much about factories as forests, stock exchanges and securitization, shopping centers, slums, and suburban sprawls as soil exhaustion and species extinction.⁸

It has been one thing to argue this theoretically, and another matter entirely to deploy theory in reconstructing these historical master processes *as* nature-society relations. There is no royal road, as Marx would remind us, connecting “green” social theory to a “green” world history. There is little question that we now enjoy a series of extraordinary literatures: on the social theory of the environment, on regional political ecology, on environmental history, on the global political economy of environmental change. For all their groundbreaking contributions, however, the theory of historical capitalism as constituted through a mosaic of socio-ecological projects and processes has made little headway within the world-historical perspective.⁹

⁷ As if it is possible to separate out the material and symbolic. Even Marx likened theory to “a material force” (1926:17).

⁸ “The production of nature is in no way synonymous with a social constructionist vision of nature. While the best constructionist accounts emphasize the combined material and discursive construction of nature, and often invite a discussion of race, gender, sexuality and other forms of social difference in relation to nature, the connection between materiality and discourse often remains vague, the social origins of discourses are underspecified, and the source of change in given social constructions of nature is obscure” (Smith 2006:25).

⁹ The closest we come is the historiography of state formation (Scott 1998; Foucault 2003; Appuhn 2009). But it is one thing to “scale up” from regional political ecology to the nation-state; from one part to another. It is a different enterprise to situate state formation as a world-historical and world-ecological process.

While it is difficult today to learn social theory without engaging “the environment,” the spectrum of “green” social theory has not (yet!) given rise to a “green” history of capitalism. Yes, there is an enormously rich literature on world environmental history. But the master processes remain resolutely social – industrialization colonialism, commercializing imperatives, civilizing projects large and small (e.g. Ponting 1991; McNeill 2000; Richards 2003; Hughes 2001). Instead of colonialism or commercialization or capitalism *as* environmental history, these processes are ceded to the Cartesian binary. They are treated as purified social entities that inflict more or less unsavory impacts on the rest of nature.¹⁰ In much the same manner, the world-systems perspective has offered a remarkable body of work that clarifies capitalism’s manifold forms of environmental degradation (*inter alia*, Clark and York 2005; Goldfrank et al. 1999; Hornborg et al. 2007; Jorgenson and Clark 2009a). As in environmental history, however, there is little attention to the ways that these master processes are themselves products, as well as producers, of far-flung and unruly relations between human and extra-human nature.

Nevertheless, this grafting of “social” and “environmental” change has been enormously productive, and was the environment (if you will) within which my interpretation of capitalism emerged. I arrived at The Johns Hopkins University to study with Arrighi in 1999, already confident that environmental transformation had played a central role in the rise of capitalism (Moore 2000b). The environmental history of the early modern sugar “commodity frontier” indicated not only that staples remade environments (Innis 1956). It also indicated that environmental degradation played a key role in compelling geographical expansion as a recurrent global ecological fix. I was already familiar with *The Long Twentieth Century* (Moore 1997). It was not until I had the chance to rub elbows with Arrighi, however, that I began to come to grips with unusual vitality of his conceptual-methodological approach (Arrighi and Moore 2001). Even then, it took time. Initially, I misunderstood how he deployed the “angles of vision” shaping the spectacular narratives of *Chaos and Governance in the Modern World-System* (Arrighi and Silver 1999). Taking the conflicts of empires, the struggles of classes, the competitions of business enterprises, and the clashes of civilizations as distinctive, partially overlapping optics, Arrighi, Silver, and their colleagues revealed these moments as mutually constituting. This aspect of Arrighi and Silver’s narrative of capitalism is still underappreciated, even within world-systems analysis. My own underappreciation led me to graft two weakly connected intellectual traditions (at the time) – world-systems analysis and environmental history. Drawing on Marx, Foster, and Wallerstein, I argued (2000a) that “systemic cycles of agro-ecological transformation” complemented Arrighi’s systemic cycles of accumulation. It was a useful point of entry. Over the next decade, however, I grew progressively less satisfied with this grafting procedure.

There are plenty of theoretical contributions, even regional empirical studies, arguing that all social projects are ecological projects and vice versa (e.g. Harvey 1993, 1996; Braun and Castree 1998). But it was never clear to me – nor, I should guess, to Left Ecology¹¹ – how relational ontology in theory might translate into world-historical practice. After a certain point,

¹⁰ An extraordinary exception is White (1995).

¹¹ Major points of reference in Left Ecology include Altvater 1993; Benton 1989; Blaikie and Brookfield 1987; Braun and Castree 1998; Bunker 1984, 1985; Burkett 1999, 2006; Enzensberger 1974; Foster 2000; Harvey 1974, 1993, 1996; Levins and Lewontin 1985; Martinez-Alier, 1987; O’Connor, 1998; Peet and Watts, 1996; Peluso, 1992; Peluso and Watts, 2001; Schnaiberg, 1980; Smith 1984; Watts, 1983; Williams 1980, 1985; Worster 1990. Recently, Panitch and Leys 2006, Heynen et al. 2007, and Foster, Clark, and York 2008a, 2008b, bring together important clusters of perspectives within this current.

the Cartesian approach that identifies *social* causes and *environmental* consequences obscures more than it clarifies. Yes, capitalism has done many bad things to living creatures and the environments in which they live. Evidence can be collected and analyzed to document these depredations. There is no question that this has produced a wealth of empirical studies, not least those clustering around the “ecological footprint.” But so long as these studies operate within a Cartesian frame, the active relations of all nature in the making of the modern world remain not just unexplored, but invisible. The impressive documentation of environmental problems in the capitalist era is theoretically disarmed as a consequence, unable to locate the production of nature within the strategic relations of modernity.

We do need an analysis of impacts. The difficulty is that the Cartesian scheme narrows the empirical phenomena under investigation. The Nature/Society binary offers a view of nature that thoroughly exempts humans – “ecological” pressures might include loss of habitat for polar bears but not the loss of habitat for millions of Americans evicted from their homes in the (still-unfolding) “subprime crisis.” It is a view of nature that confuses specific episodes of earth-moving for environmental history as a whole. Farming, mining, and toxification are indeed central to environmental history, but so is the housing question, financialization, state sovereignty, and family policy. If we take the theory of metabolic rift, one of the most dynamic perspectives in critical environmental studies today, topics such as agriculture, global warming, and resource consumption loom large (Foster 2000, 2009). There is nothing inherently problematic about these emphases. But to stop there, and to treat the accumulation of capital and capitalism’s remaking of *human* natures as exogenous, is to miss the greatest promise of the metabolic rift perspective (Moore 2011a) – the transition from environmental histories *of*, to capitalism *as* environmental history.

From the standpoint of world-ecology, we can bring to light what is typically elided by the Cartesian binary. For example, even so perceptive a thinker as Salleh argues recently that “the signs of this [metabolic] rift are deforestation, loss of soil nutrients, poor air quality, water pollution and erosion, toxic wastes, depleted ocean stocks, and so on” (2010:206). But the “so on” does not include home foreclosures, the globalization of industrial production, or the “financialization of daily life” (Martin 2002). A world-ecological reading of the metabolic rift – through which urban-centered capital exhausts the surplus-producing capacities of agrarian spaces – extends the argument to the reconfiguration of human flows as pivotal. Early capitalism appropriated and quickly exhausted African and Amerindian labor power, the proximate agents of New World deforestation and soil exhaustion (Moore 2007, 2010a, 2010e). The mass production capitalism of the long 20th century was built atop the “late Victorian holocausts,” from whose East and South Asian flashpoints flowed millions of workers to the Americas (Davis 2001; Northrup 1995). From the other side of the world, we find tens of millions of immigrants moving towards the same destination, as European peasantries were systematically disorganized by agricultural free trade and cheap American grain (Wolf 1982).

Is it so different today? Yes and no. Successive waves of neoliberal agro-food restructuring have engorged the world’s reserve army of labor, but without the productive dynamism of previous eras. Neoliberalism’s engine of accumulation has depended upon the creation of a “surplus humanity” for whom capitalist civilization has nothing to offer (Davis 2004). Could there be a more foundational socio-ecological category of our times? From the sacrifice zones of American cities to the mega-slums of the Global South, the reconfiguration of human natures in neoliberalism is of a piece with its redistributory impulse, fueled by

financialization and the cannibalization of capital's (re)productive dynamism (Moore 2010c; Soederbergh 2010). I read the theory of metabolic rift to encompass, rather than exclude, the mechanisms of capital's reproduction – mechanisms that are not just quantitatively adjusted, but *qualitatively* remade in successive long centuries (Arrighi 1994). This includes the financial circuit of capital in recent history, from collateralized debt obligations to private equity firms to the “shareholder value” revolution as fundamental moments of capitalism's ordering of human and biophysical natures.

There is a productive tension between the parts and the whole of capitalism and its generative master processes. The key task is to find a means of relating metabolic rift approaches (Foster 2000, 2009), agro-food regime theory (Friedmann 1993; Friedmann and McMichael 1989), energy and resource regime studies (Bunker and Ciccantell 2005; Podobnik 2006), and many more, with *longue durée* movements of recurrence and evolution in the capitalist world-ecology. The greatest virtue of these approaches is, I believe, rarely noted. At their core, they argue that the relation between human and extra-human nature undergoes periodic, revolutionary shifts that are fundamental to the restructuring of power, capital, and empire in the world-system. They are, at once, partial totalities, and expressive of the booms and crises of the whole. Are we dealing with a set of regimes (accumulation, energy, demographic, etc.) that interact in an essentially contingent fashion, or are there specifiable “laws of motion” that influence their movements? My working proposition is that the law of value, privileging labor productivity as the metric of wealth, goes far towards explaining the patterned relations between the realities signified by these and other regime concepts.

There is an “adding up problem” involved here. On the one hand, we construct totalities through successive “tacking” movements between parts and wholes (Moore 2007, 2010b). This necessitates a fluid approach that transcends the Hobson's choice of local particularity and global determination, when the reality is that both constitute world-historical process – the world-*system* is something quite distinct from world-*scale* relations. (How often this is forgotten!) On the other hand, the parts do not “add up” to the whole. For this reason, I part ways with empiricist approaches to ecological regimes that cobble together multiple long-run trends (e.g. Costanza et al. 2007).

Ecology and ecological (as *oikeios*), then, signify the relations of the whole. These are mediated through the partial totalities of capital accumulation and the shifting mosaics of nature-society relations (“master processes”). This poses a different set of questions from the Cartesian model. In place of environmental histories *of* capitalism, in which landscape transformation (earth-moving) moves to center stage, the focus shifts towards an open-ended tacking between earth-moving and broader repertoires of socio-ecological change. These expansive repertoires include the obvious, such as the production of botanical and genetic knowledge, and the less-than-obvious, such the introduction of new financial techniques. This captures the difference between “capitalism *and* nature” and capitalism-*in*-nature, whereby the accumulation of capital and the production of nature become so intertwined that the one is unthinkable without the other. “Nature” is no longer a passive substance upon which humanity leaves its footprint. Rather, it becomes an inclusive and active bundle of relations formed and re-formed through the historically- and geographically-specific movements of humans with the rest of nature.

Capitalism as world-ecology is therefore a protest against, and an alternative to, the Cartesian worldview that puts nature in one box, and society in another. This alternative views the great movements of modern world history – industrial and agricultural revolutions, successive

“new” imperialisms, social revolutions, world markets – as socio-ecological projects and processes. These processes are each aimed at reconstructing the nature-society relations within their respective fields of gravity. At the relational core of this audacious reconstruction, we find the commodity.

If biophysical and human natures are distinctive moments within a dialectical unity, just what are the conceptual frames and methodological premises necessary to illuminate these relations? This will be the focus of our next discussion.

TIME/SPACE/CRISIS: THEORY AND METHOD IN ARRIGHI’S ‘STRUCTURALLY VARIANT’ CAPITALISM

The Long Twentieth Century begins with a set of orienting concepts that would be alien to many scholars working in environmental studies. Arrighi posits capitalism as the shadowy, global zone of money dealing, rather than the sphere of commodity production and exchange. He privileges the relations of global space. He emphasizes long waves in accumulation and world power over the temporalities of region, state, and empire. Further, Arrighi not only has little to say about environmental change, his very meta-theory appears to rule out environmental history as endogenous, or even relevant, to capitalist history. In this respect, *The Long Twentieth Century* replicates Braudel’s disjuncture between capitalism and material life (Moore 2003c). It is difficult to see how Arrighi could guide us towards an understanding of capitalism as world-ecology.

And yet, this is precisely what *The Long Twentieth Century* enables. Arrighi’s theory of successive “organizational revolutions” in the governing structures of capitalist and territorial power is especially important. Arrighi locates the spatio-temporal contradictions of capital *within* the agencies and the hegemonic alliances that propel, reproduce, and eventually undermine successive “material expansions.” In so doing, he opens conceptual space for a theory of crisis that renders nature-society relations endogenous, indeed pivotal, to historical capitalism.

The World-Historical Method: Concept Formation in the Bounding of a Structurally Variant Capitalism

The Long Twentieth Century is a crucial moment of synthesis for the world-historical method. Premised on the selection of relevant “angles of vision” derived from the observation of *longue durée* patterns of recurrence and evolution, and situating time and space internal to capitalist development, Arrighi delivers the elements of an ecohistorical method. His Three Questions – What is cumulative? What is cyclical? What is novel? – combine with a relational and constructivist view of time and space in ways that inform the great methodological question of global environmental studies today: How do we bound biophysical and human natures, and what are we doing when we bound them?

I am proposing that we respond to this question by jettisoning the ideal types Nature/Society, a binary that answers the question through meta-theoretical fiat. Wallerstein’s insistence on *historical* capitalism emerged out a similar objection to ideal type definitions of capitalism, on the left as well as the right (1983). (Let us note that *historical* does not invoke a past/present dichotomy but a way of seeing the emergence of patterned relations.) Such ideal type conceptions were problematic because they short-circuited the very research necessary to

comprehend that messy and evolving web of relations we call capitalism. In much the same fashion, the Nature/Society binary short-circuits research into the cumulatively- and cyclically-evolving configurations of human and extra-human nature over the *longue durée*, including the movements of the present crisis.

The problem with taking history seriously is that it “continually messes up the neat conceptual frameworks and the more or less elegant theoretical speculations” we’ve worked so hard to construct (Arrighi 2000:117). The relation of theory and history is of course at the center of a vast literature in historical sociology, and I will not reprise the debates here.¹² I do wish, however, to place the methodological and theoretical implications of Arrighi’s accounting of historical capitalism into dialogue with the challenges of rethinking modernity as a socio-ecological process and project.

If history has its way of “messaging up” our models, how do we respond? We can begin with a reflexive approach to specificity, in two principal ways. The first involves the conceptual-*historical* task; the second, a *historical*-conceptual challenge. We may consider these in turn.

The conceptual-*historical* task implicates the reflexive interrogation of the relation between theory and history in successive phases of capitalist development. A concept of imperialism appropriate to the analysis of world power in the 17th century is unlikely to be adequate for explaining the “new imperialisms” of subsequent eras.¹³ Arrighi often reminded students that while the signifier, “imperialism,” had remained constant over the 20th century, the bundle of relations that it *signified* had changed substantially.¹⁴ This sensibility informs his first rule for the conceptual mapping of historical capitalism:

The idea still dominant in world-system analysis of a quantitatively expanding but structurally invariant world capitalist system must be abandoned, including and especially the notion of Kondratieff cycles, hegemonic cycles, and logistics as empirical manifestations of such a structural invariance (2004:38).

The temptations of “structural invariance” find traction beyond world-systems analysis. In the closely related field of world environmental history, commercialization often appears as a primary form of structural invariance, through which market forces inflict great damage to landscapes (e.g. Richards 2003; Hughes 2001). But this forgets that world markets are not created equal. The world market of the long 16th century, and the world market today, are not only quantitatively, but also qualitatively variant. Conceptual specificity and empirical specificity are dialectically bound. There is, then, good reason – for environmental historians and world-systems analysts both – to revisit the kind of conceptual-historical sensibility Marx evinced in observing that “every particular historical mode of production has its own special laws of population” (1976:784). Can we not also include, alongside population, specific socio-ecological configurations of market exchange, industry, business enterprise, class structure, imperial power, and urbanization in successive eras of capitalism? This observation poses new questions

¹² Classic texts are Abrams (1982), Burke (1980), and Skocpol (1984).

¹³ This is not to rule out the cross-fertilization of concepts. Consider Chase-Dunn and Hall’s classic work on comparing world-systems over the *longue durée* of civilization (1997).

¹⁴ An argument Arrighi developed throughout his career (1978b, 2007, 2009).

regarding the constitution, reproduction, and eventual crises of capitalism's strategic socio-ecological relations in successive phases of development.

A second issue is the historical-*conceptual* task. A critical historical method goes beyond examining the degree to which our categories appear to explain socio-ecological change. A reflexive and critical method will also interrogate (and with luck, reveal) the uneven and variable correspondences and ruptures between our conceptual frames and contemporary structures of power (Bourdieu and Wacquant 1992).

The uneven development of such a reflexive historical social science is a matter of some consequence, to critical environmental scholarship no less than to politics, and to the relations between them. Within environmental and world history, it is difficult to deny a rough-and-ready correspondence between the meta-theoretical insistence on the primacy of markets (Cronon 1991) and neoliberalism, or between resource constraint approaches (Pomeranz 2000) and neo-Malthusian conceptions of peak oil. In observing this homology, my intention is to direct our focus to the "reflexive" specificity of the concepts deployed, in Bourdieu's sense. This is what I have called the historical-*conceptual* moment, intertwining doxic and heterodoxic moments at once. Viewed in this light, "ecological footprint" approaches (Wackernagel and Rees 1996) – installing human exemptionalism as a mechanical and uni-directional impress upon an externally-constituted and singular "environment" – may be fertile ground for such reflexive examination.

The Theory of Organizational Revolution: Organizational Exhaustion as Ecological Limit

This methodological rethinking may be fruitfully paired with Arrighi's theory of historical capitalism. The general framework runs along these lines. Innovations, centered in and effected by emergent hegemonic complexes, lead to phases of material expansion. These are phases of expansion both in terms of the rising physical output of commodities and the geographical expansion of the system. Characterized by rising returns to capital in the "real" economy, these phases of material expansion mark the beginning of each systemic cycle of accumulation. Over time, the material expansion sets in motion new competitors from outside the hegemonic center, eroding the latter's surplus profits, equalizing profit rates across the core, and exhausting the profit-making opportunities within the productive circuit (M-C-M+). Within the hegemonic center, diminishing returns to capital leads to a rising volume of surplus capital that cannot be (re)invested profitably in material expansion. As profitability falters, capitalists quite sensibly reallocate capital from production to finance (M-M+). It is this reallocation that brings about financial expansions, sustained by the escalating inter-state competition that accompanies the exhaustion of material expansion. These financial expansions set the stage for a new round of innovations, brought about by new alliances of territorial and capitalist agencies in geographically more expansive hegemonic centers.

Two elements of this theory are especially relevant to the present exploration. In both cases, time and space are recast through the dialectic of world power and world accumulation. Arrighi's first contribution brings to the fore the sociology of power and accumulation on a world-scale. This is no "structuralist" account – if by structure we refer to one pole of a structure/agency binary. Those long centuries of capitalist development at the center of *The Long Twentieth Century* did not just happen; *they were made*. Systemic cycles emerge and stabilize through the innovation and generalization of new forms of world leadership and business organization, revolutionized by specific state-capitalist alliances, after which Arrighi names each

systemic cycle (Iberian-Genoese, Dutch, British, and American.) Transitions from one cycle to the next are contingent – “chaotic” – with indeterminate outcomes (Arrighi and Silver 1999). The crises that occasioned these transitions were not provoked by exogenous limits or otherwise caused by exogenous forces. Rather, these systemic crises emerge, cyclically and cumulatively, through the exhaustion of the very “organizational structures” that had initially liberated “material” accumulation (1994:226).

The exhaustion of these organizational structures creates new spaces for the creative responses (“organizational revolutions”) of classes, states, and business organizations to the great crises of their times. We have seen plenty of these creative responses in the neoliberal era, although without the revolution in labor productivity that five centuries of capitalist history leads us to expect (Balakrishnan 2009; Moore 2010c). In directing our attention to successive hegemonic state-capital complexes, Arrighi extends Gramsci’s dialectic of coercion and consent to the world-historical stage (1994:27-84). These hegemonic organizational revolutions possess a dual character. On the one hand they produce a competitive edge in the exercise of politico-military and economic power. On the other hand, they create a development model emulated by rivals. In so doing, these hegemonic revolutions make possible renewed and expanded accumulation over successive long centuries, only to generate renewed and expanded contradictions. As a hegemon reaps the rewards of the regime forged through organizational revolution, its very success leads rival to emulate, then to innovate, with increasingly greater success. The very successes of the initial revolution become an iron cage from which the hegemon cannot escape. Flexibility in youth turns to sclerosis in old age. The decisive moment of systemic crises – from their signal to terminal moments – is driven by the erosion of the declining capacity of the hegemonic center not only to sustain its own power, but to continue to “deliver the goods” to the system. (There are vital ecohistorical implications, which I outline in the next section.)

Arrighi’s second contribution is the internalization of spatio-temporal transformation as central to the making and unmaking of systemic cycles. This brings to light a central *longue durée* contradiction – between the endless accumulation of capital (possible within the logic of capital) and the endless conquest of space (impossible within the nature-society dialectic). The *longue durée* therefore frames an emphasis on middle-run crises to demonstrate that systemic restructuring is at once cumulative and cyclical. Innovation and organizational revolutions unfold within the constraints and possibilities of the system’s cumulative development. New forms of commodification, for instance the early modern sugar plantation or biotech property-rights in neoliberalism, reproduce the secular trend. Each systemic cycle, initiated by variable ensembles of world-historical innovation, differs from the preceding one in two main respects: the greater concentration of organizational capabilities wielded by the hegemonic state in comparison with its successor, and the higher volume and dynamic density of the system that is being reorganized by the hegemonic state (Arrighi and Silver 1999:34).

Thus the qualitative dimension of world-historical innovations does not erase the trend line. *Innovation, in other words, cannot proceed indefinitely.* First, the limits to capital’s self-expansion manifest geographically, and these geographical limits are produced by the accumulation regime itself. Metropolitan rivals “catch up” by emulating the hegemon’s developmental model. Second, declining investment opportunities within the extant divisions of labor signal overaccumulation. Both moments set in play mounting pressures for restructuring through market-deepening and market-widening. To overcome the crises implicated in the

system's always-rising "dynamic density," the organizational revolutions effected by successive hegemonic complexes pioneered a quantum leap forward in the scale of the organizing center – from Genoa to the United Provinces to the United Kingdom to the United States.¹⁵

These organizational revolutions give rise to new accumulation regimes that move through long, and overlapping, systemic cycles of material expansion and financial expansion. Such revolutions achieve their qualitative shifts in response to – and on the basis of – the accumulating (quantitative) contradictions of the previous era. How do we bring a production of nature perspective into this scheme of things? For starters, we might observe that the financial circuit of capital and the commodity-centered transformation of human and extra-human natures are more tightly linked than Arrighi appears to suggest. This hardly undermines the vitality of the argument, however.

In painting capitalism as that zone where money-dealing and world power link up, Arrighi executes a necessary bounding maneuver in *The Long Twentieth Century*. Without it, clearly identifying the alternation of material and financial expansions over the *longue durée* would have been impossible. But I would caution against elevating this provisional conceptualization of capitalism – as that "shadowy zone" in which the "possessor of money meets the possessor, not of labor power, but of political power" (1994:25) – into a general principle. Arrighi's interpretation of recurrent financial expansions allows us to see a cyclically-deepening relation between financialization and material life. Braudel's "Age of the Genoese" (1984), for example, was directly linked to the commodity-centered remaking of Andean life, and closely bound to the world-ecological revolution of the 17th century, which stretched from Brazil to Poland to Southeast Asia (Moore 2010a, 2010b). The financialization of neoliberal capitalism has, likewise, been realized through a revolution in socio-ecological relations unrivaled in scale and scope. The "conversion of the global South into a 'world farm'" (McMichael 2009), the industrialization of the South (Arrighi, Silver, and Brewer 2003), and the radical externalization of biophysical costs, giving rise to everything from cancer epidemics to Global Warming (Davis 2007; Monbiot 2006) – all figure prominently in the unusually expansive character of finance capital's appropriations of the *oikeios* during the neoliberal era.

This observation on the relation between financialization and material life is only a beginning. We might consider a further, ecohistorical, twist on Arrighi's fruitful notion that systemic cycles of accumulation pivot on the vitality of "particular organizational structure[s], the vitality of which [is] progressively undermined by the expansion itself" (1994:226). Once we bring the production of nature into such a world-historical frame, it becomes clear that something more than competition and antisystemic movements cuts into the high rate of profit in the waning moments of material expansion. Indeed, competition, interstate rivalry, and antisystemic struggles are revealed as socio-ecological contests. It is not the absolute exhaustion of an abstract and ahistorical nature that "causes" such crises of profitability, whether through a falling rate of profit owing to overcompetition, or through realization crises owing to overexploitation, to take Arrighi's classic formulation (1978a). Rather, it is the exhaustion of specific complexes of nature-society relations – including the tendencies of overcompetition and overexploitation – that induce transitions from one systemic cycle to the next. Put simply, there is at once an absolute exhaustion of those organizational structures specific to the systemic cycle and a relative

¹⁵ The hypothetical transition to a China-led phase of capitalist development is therefore problematized by the scale issues required for its realization (see Gulick 2011, this issue).

exhaustion of the relations governing the reproduction of biophysical and human natures initiated by the old accumulation regime.

This allows for a theory of accumulation crises as transitions within the specifically capitalist *oikeios*. The world-ecological limits that precipitate these transitions are historical and endogenous. Broadly speaking, crises materialize as a system's capacity to maintain homeostasis breaks down. In critical environmental studies, this moment of breakdown is often framed in language of "natural limits" (e.g. Clark and York 2008). Presumably, this is paired with "social limits," but it is far from clear how we might discern the two in a non-arbitrary way. This is especially true for the history of agriculture, where great revolutions in earth-moving have been bound up with fiercely contested moments of class restructuring and world market formation (Moore 2008; 2010c). The enduring "social" conflict between peasant moral economies and capitalist political economies is in fact a contest over whose valuation of nature – human nature included – will govern socio-biological reproduction and the distribution of surpluses. Is this not at the heart of the global conflict today between advocates of a democratic and polycentric "food sovereignty," and those of a "food security" defined by market participation (McMichael 2005)?

There is an even more problematic aspect to the Cartesian binary of limits. If "natural limits" are often conceptualized as capitalism's tendency to "overshoot" something resembling a global carrying capacity (Catton 1980) – itself a deeply problematic concept (Sayre 2008) – "social limits" are conceptualized as internal. This also strikes me as arbitrary. In world-ecological perspective, all "social" and "natural" limits are irreducibly socio-ecological. These limits assume multiple forms, from state regulation and antisystemic movements to deforestation and climate change. The point – and this is what Marx underscores in arguing that the limit of capital is capital itself¹⁶ – is that all limits are historically constituted through the relations between human- and extra-human natures. The problem is not the "separation" of humans from extra-human nature but rather how the two fit together. These configurations emerge through specific human projects to remake *all* of nature. To say that such projects inevitably encounter limits that emerge through the inner contradictions of these projects is much different from invoking "natural necessity" and "absolute limits" (Foster 2008:125, 129).

Recall that for Arrighi, accumulation crises occur when the organizational structures formed at the onset of a systemic cycle exhaust their capacity to generate rising returns to capital. The question is one of the exhaustion of the relations organized at the beginning of the cycle. While Arrighi's account is resolutely sociological, there is every reason to resituate his favored axes of change – geopolitical rivalry, inter-capitalist competition, and class conflict – as partial totalities within the *oikeios* of historical capitalism. This is a far cry from "adding on" environmental factors. World hegemonies did not merely organize resource and food regimes; the hegemonies of historical capitalism *were* socio-ecological projects. Dutch hegemony emerged through a world-ecological revolution that stretched from Canada to the spice islands of Southeast Asia; British hegemony, through the coal/steampower and plantation revolutions;

¹⁶ Marx does use the language of "natural limits" (1973:399) and "natural barriers" (1976:785). Interestingly enough, Marx often deploys this language in reference to *human* nature. For instance, the self-expansion of capital, in the "infancy" of capitalist production, "came up against a natural barrier in the shape of the exploitable working population; this barrier could only be swept away by the violent means we shall discuss later," that is to say, by primitive accumulation (1976:785). Here, Marx locates this "natural barrier" exogenous to *capital's* self-expansion, and at the same time, endogenous to *capitalism*.

American hegemony, through oil frontiers and the industrialization of agriculture it enabled. In each era, old limits were transcended. A socio-ecological limit for one civilization or phase of capitalism, Benton reminds us, “may *not* constitute a limit for another” (1989:79).

This is the kind of historical thinking that Arrighi’s perspective encourages. I am surprised by the vigor with which “ecological crisis” is so frequently asserted, and so rarely historicized. Arrighi’s Three Questions are strongly relevant here: What is cumulative? What is cyclical? What is new? How does the present conjuncture differ from previous socio-ecological crises? A reluctance to engage this way of thinking has undermined the development of a historically-grounded theory of capitalist crisis within critical environmental studies. Too often, the terrain of socio-ecological crisis theory has been surrendered to neo-Malthusians such as Diamond (2004; e.g. George 2010).

A world-historical alternative identifies the two major types of ecological crisis that we have known since the long 14th century (c. 1290-1450). On the one hand, in late medieval Europe we have an *epochal ecological crisis* – a crisis so serious that it gave way to a fundamentally new way of ordering the relations between humans and the rest of nature. On the other hand, we have seen a succession of world-ecological revolutions in response to accumulation crises since the 16th century. These are *developmental ecological crises* from which new ways of commodifying the *oikeios* have emerged.

Political economists have given considerable attention to comparing the crisis today with the crisis of the 1970s, as well as the crisis of the 1930s (Eichengreen and O’Rourke 2009; McNally 2009; Harman 2009). I am not convinced that these are the most useful comparisons, primarily because they are premised on the notion that we are dealing with an economic crisis that is relatively autonomous from the web of life. A world-ecological perspective directs our attention to the earlier crises of the late 19th century, and of Dutch hegemony in the second half of the 18th century. This latter deserves special attention. At this time, early capitalism, premised on horizontal frontiers, gave way to industrial capitalism’s vertical frontiers, whose most prominent manifestation was the coal seam. Between 1763 and 1815, the progressive exhaustion of the English agricultural revolution threatened the rise of industrial capital. England, the breadbasket of early 18th century Europe, became a major food importer by century’s end. Food prices increased 200 percent, four times faster than the industrial price index (O’Brien 1985:776). England’s agro-ecological woes were, moreover, linked up with a systemwide agrarian depression that reached from the Valley of Mexico to Scandinavia.

This agrarian depression was a crucial moment of developmental ecological crisis; that is, a crisis of the capitalist *oikeios* that could be resolved through more commodification and new commodity strategies. At the time, as today, agricultural productivity growth had slowed or stagnated. It could have been increased, using the best practices of the period, but only through labor intensification. But this was the very shift that could not be tolerated. Such intensification would have reduced labor productivity, and contracted the reserve army of labor, just when each was needed most for industry and empire (Moore 2010c). The solution was ultimately found in two frontiers of appropriation, yielding two sources of windfall profit. The first frontier was vertical, moving *into* the earth to extract coal. The second frontier was horizontal, moving *across* the earth to produce wheat, especially in North America. When another Great Depression rolled around, in the 1870s, the ensuing rapid industrialization was made possible by cheap food delivered by the cooperative labors of both frontiers.

The other major point of comparison to the present crisis is the crisis of late medieval Europe. This was an *epochal* ecological crisis. There are striking parallels between the world-system today and a broadly feudal Europe at the dawn of the 14th century – agriculture, once capable of remarkable productivity gains, stagnated; a growing layer of the population lived in cities; vast trading networks connected far-flung economic centers (and epidemiological flows between them); climate change began to strain an overextended agro-demographic order; resource extraction faced new technical challenges, fettering profitability and investment. After some six centuries of sustained expansion, by the 14th century, it became clear that feudal Europe had reached the limits of its development (Moore 2003b).

Is capitalism today facing a developmental or epochal ecological crisis?

THE PRODUCTION OF UNDERPRODUCTION

My early responses to this question built out from a dual cycle approach, that of capitalism *and* the environment (Moore 2000a). Arrighi's systemic cycles of accumulation were joined to my "systemic cycles of agro-ecological transformation." Eventually, I came to understand these as distinctive angles of vision on a singular, if differentiated, process. Arrighi both helped and hindered this journey towards a unified theory of capital accumulation and the production of nature. On the one hand, Arrighi's meta-theory and method pointed straight towards such a unified theory. On the other hand, his Cartesian understanding of value pointed in the opposite direction. Rejecting Marx's value theory, premised on the active and alienated relation of human- and extra-human natures, Arrighi favored a model of capitalism premised on investment in specific "input-output combinations" (1994:5, 252, 284). It is a value theory that looks suspiciously close to capital's treatment of all nature as mere factors of production. Here was one of Arrighi's rare "doxic" moments, to borrow Bourdieu's language (Bourdieu and Wacquant 1992). It is a theory of value at odds with his ontological insistence that the history of capitalism can be comprehended as a self-forming whole, one emerging through successive analytical optics that illuminate new and mutually constitutive moments in the formation of modernity.¹⁷

Arrighi's break with Marx's value theory limited rather than expanded the explanatory potential of his theory. This is so in two principal respects. First, Marx's theory of value, grounded in socially-necessary labor time, offers a non-arbitrary means of grounding the "commodification of everything" in an active relation between humans and the rest of nature. As such, it offers an *eductive* method, one that draws out and clarifies the complexity of the capitalist *oikeios* without ignoring value relations as its gravitational center.¹⁸ Second, Marx's value theory points towards a specifiable historical proposition concerning the nature of crises in the capitalist world-ecology. This is the world-historical tension between capitalism's dialectical antagonism of overproduction *and* underproduction.

The accumulation of value – the substance of which Marx calls abstract social labor (1976) – is not everything. It is, however, a necessary point of departure for constructing the

¹⁷ In conversation, Arrighi emphasized that the angles of vision he had selected were not the only ones possible and that others might well prove more important.

¹⁸ My approach to global value relations as a methodological proposition is indebted to the groundbreaking work of McMichael (1999) and Aragli (2003).

cumulative and cyclical movements of the capitalist world-ecology. I found it impossible to reach this conclusion, however, by theoretical fiat. Rather, my research on the rise of capitalism led me directly towards the history of commodification, and thence to the production of nature. The production of nature is above all a labor process; this includes knowledge production no less than commodity production directly. As a result, I was unable to see where the “social” moment of the labor process ended, and where its “environmental” moment began.

Modern slavery, for instance, the subject of a great volume of social history, made little sense abstracted from the earth-moving activities of the sugar frontier (Moore 2000b). Indeed, this form of labor mobilization and its attendant labor processes created plantation landscapes. It was through this historical relation that I began to understand a pivotal fact of modernity: the degradation of extra-human nature was the basis for high and low labor productivity, decisive to competitive fitness in the world market. It was not deforestation or soil exhaustion, as historical facts, that caused one great commodity producing region to give way to another – as when Brazilian sugar yielded to the Caribbean in the 17th century. Rather, the decisive relation was labor productivity, *mediated through the production of nature and the accumulation of capital* (Moore 2007: chapter six; 2009; 2010d).

Nor was the sugar frontier exceptional. Human labor and extra-human wealth do not appear to be interchangeable in the history of capitalism. (Even as I recognize land and labor as the “original sources” of wealth [Marx 1976:636-638]). From its origins in the 16th century, the history of capitalism is one of relentless commodification through which labor productivity has been systematically privileged over the well-being of extra-human nature. (A murderous logic that exhausts labor power as well.) For all the green objections to Marx’s value theory, confusing the critique of capitalism’s value form as an endorsement (e.g. Bunker 1984), a centerpiece of green thinking since the 1970s has been the critique of industrial society’s monstrous energy inefficiencies. Nowhere is this more evident than in agriculture. The Green Revolution as world-historical process, from its origins in the U.S. during the 1930s to the Punjab in the 1960s, achieved an epochal leap in labor productivity through the profligate consumption of energy, water, fertilizers, and other inputs (Bairoch 1989; Pimentel et al. 1973, 2008). The “efficiency” of labor and the “inefficiency” of inputs is a staple of environmental critique; because of capitalism’s value relations, they are dialectically bound to each other. From the sugar and timber frontiers of early capitalism to the coal and wheat frontiers of the long 19th century, capitalism’s ecological revolutions were not only acts of enclosing and plundering nature’s “free gifts,” but also of mobilizing these free gifts in the service of maximal labor productivity.

Early capitalism, we have seen, was gripped by a developmental ecological crisis in the later 18th century. And while Arrighi’s notion of overaccumulation and “declining returns to capital” is an accurate description, it says little about the mechanism of this process. This was a crisis of overaccumulation, to be sure, but one driven by *underproduction*. Allow me to explain.

Developmental ecological crises have assumed two major forms in the capitalist era (Moore 2010c, 2011a), overproduction crises and underproduction crises. Since the 1830s, overproduction crises – too few customers for too many commodities – have been the overarching form of accumulation crisis. For Arrighi, these are “overaccumulation” crises (1994:94): too much capital seeking too few investment opportunities. It would be a mistake to link overaccumulation and overproduction too closely, however. In early capitalism, the dominant crisis tendency was *underproduction*. While realization problems (the sale of commodities) did exist, the era’s greatest challenge was found in delivering labor and raw materials to the “factory

gates.” The delivery of heat energy (primarily charcoal), for example, was especially important, and especially difficult. The history of fuel-intensive industries in this era – in particular, sugarmaking and metallurgy, the vanguards of commodity production – is one of unceasing geographical movement in search of cheap energy (Moore 2007, 2010a, 2010b; Williams 2003).

Once the coal-steampower nexus hit critical mass, sometime around 1830, the dominant crisis tendency shifted from underproduction to overproduction. This was definitively illustrated by the Anglo-American depression of 1837-42 (Lloyd-Jones and Lewis 1998; Post 1995). The coal-steampower nexus found creative synthesis with the rationalization and reorientation of British imperial and financial power to effect a double transformation – a quantum leap in labor productivity and a quantum leap in the expanse of *all* nature (humans included) that could now be freely appropriated at minimal cost. Coal and steampower linked up with capital and empire to radically extend frontiers of appropriation, and thereby secure a radically augmented ecological surplus (cheap food, labor, and inputs). There was a significant long-run expansion of consumer markets as a result. Cheap coal made possible “ever increasing levels of consumption” in a manner roughly analogous to cheap oil in post-1945 capitalism (Araghi 2009).

The really remarkable story is how the generalization of the fossil fuel revolution kept the underproduction tendency at bay, right up to the present conjuncture. So successful was “fossil capitalism” in overcoming the earlier problems of underproduction that most Marxists view the transition from underproduction to overproduction as a relic of bygone days, rather than a recurrent tension in the history of capitalism (e.g. Foster 2009; Burkett 2006). Among other things, such an approach cedes the terrain of scarcity to the neo-Malthusianism of “peak everything” (Heinberg 2007).

The General Law of Underproduction and the Capitalization of Nature

Marx’s “general law” of underproduction identifies the circuit of capital *as* a socio-ecological relation, albeit one whose substance (value) is necessarily blind to “natural distinctiveness” (1967 III:111; 1973:141). In this model, “the rate of profit is inversely proportional to the value of the raw materials” (1967 III:111). The cheaper the raw materials and energy, the higher the rate of profit, since constant capital consists of not only fixed capital (machinery that outlasts the production cycle) but also inputs. These inputs, raw materials and energy used up during the production cycle are what Marx calls *circulating* capital. (Not to be confused with the circulation of capital in its monetary forms.) The dynamism of capitalist production leads the “portion of constant capital that consists of fixed capital... [to] run significantly ahead of the portion consisting of organic raw materials, so that the demand for these raw materials grows more rapidly than their supply” (ibid:118-119). Here, the “overproduction” of machinery (fixed capital) enters a dialectical antagonism with the “underproduction” of raw materials (circulating capital) (Marx 1967 III:119). This law, like the falling rate of profit tendency, is a dialectic of tendencies and counter-tendencies. (The counter-tendencies are not exogenous to the law’s operation.) The issue is not overproduction *or* underproduction. It is how the two movements *fit together* in successive eras of accumulation.

Metropolitan capital has been hugely successful in securing cheap inputs since the 19th century. This has an awful lot to do with the productive and transport efficiencies enabled by cheap fossil fuels. Nevertheless, for all their undeniable contributions to the appropriation of nature’s free gifts, fossil capitalism eased, but did not resolve, the basic contradiction. Marx’s

theory of underproduction basically says two things. First, capital seeks to drive down the value composition of raw materials (circulating capital) relative to machinery and buildings (fixed capital),¹⁹ even as it geometrically expands the material mass of commodity production. Second, capital's inner dynamism undermines the conditions of reproduction that allow it to deliver cheap inputs. This is why new frontiers of appropriation have been central to launching, and sustaining, long waves of accumulation.

With some help from Arrighi, Marx's theory of underproduction can be situated within the shifting configurations of the capitalist *oikeios*. Arrighi is at his most persuasive in revealing how new long centuries of accumulation take shape on the basis of qualitative innovations in business organization and territorial power. Just as the imperialism and great firms of the 17th century are not equivalent to the imperialism and great firms of the 21st century, neither are we dealing with a structurally invariant nature. There *is* a quantitative moment that merits careful scrutiny: the exponential growth curves of 20th century resource use are a powerful illustration (e.g. McNeill 2000; Costanza et al. 2007). In sum: not only has capital sustained itself on the basis on cheap inputs (the quantitative moment); it has also revolutionized the socio-ecological relations of production (the qualitative moment). In this fashion, hegemonic alliances have mobilized a succession of "great leaps forward" in the relative ecological surplus. The point I wish to underscore is that the *cumulative* moment of geometrically rising material throughput is embedded in a *cyclical* moment of producing new configurations of the *oikeios*. "Nature" is a historically variant category. Industrial capitalism gave us Darwin and the Kew Gardens; neoliberal capitalism, Gould and biotechnology firms.

World-ecological revolutions deliver a relative ecological surplus. The "surplus" represents the gap between appropriated and capitalized natures. This surplus becomes "revolutionary" to the degree that accumulation by appropriation issues a significant middle-run (40-60 years) reduction in the value composition of food, labor, and inputs. Just as capital benefits from employing workers located in semi-proletarian households, where a decisive share of income is located outside the wage relation (Wallerstein 1983), so does capital prefer to mobilize extra-human natures capable of reproducing themselves relatively autonomously from the circuit of capital. A large ecological surplus is found whenever a relatively modest amount of capital sets in motion a very large mass of use-values. When the volume of appropriated natures is sufficiently large, it reduces the share of the systemwide *oikeios* that depends on the circuit of capital for its daily and inter-generational reproduction. An ecological revolution occurs when capital's share of reproducing the *oikeios* within its field declines significantly and quickly. This creates a "golden age" of cheap food, energy, and inputs. These always involve technological innovations in earth-moving, but depend on system-making organizational revolutions for the full effect.

We can see these revolutions in the ecological surplus at work in modernity's great energy transitions: from peat and charcoal to coal (1750s-1850s), and from coal to oil (1900-1950). The revolutionary increase in the ecological surplus realized through these transitions was not primarily one of "energy returned on energy invested," but rather "energy returned on *capital* invested" (Moore 2011a). In securing cheap energy, capital can increase labor productivity without a corresponding increase in capital intensity, what Marx calls the rising organic

¹⁹ Falling input prices usually reduce the value composition of fixed capital too.

composition of capital (1967). Cheap energy, in other words, powerfully checks the falling rate of profit.

Before turning to the falling rate of profit as a world-ecological dynamic, let us take a moment to consider the capitalization and appropriation of nature. Capitalized nature depends on the circuit of capital – crudely, either $M-C-M^+$ or $M-M^+$ – for its daily and inter-generational reproduction. For these natures, including humans, the circuit of capital directly determines the rules of reproduction. A good example is the capital-intensive family farm that first developed in the U.S. after 1865, and which was progressively globalized as the Green Revolution model after World War II. An Iowa corn farm producing for ethanol refineries is highly capitalized biophysical nature. As for highly capitalized human natures, these can be found in the proletarianized households of metropolitan accumulation – households that depend on wages for most income.

Accumulation by appropriation signifies a range of processes through which capital appropriates the *oikeios* to maximize labor productivity, without however capitalizing the relations of reproduction for those webs of life. At its core, appropriation is less about the mechanism of extraction – neoliberal privatizations, colonial taxation, enclosures old and new – and more about how capitalism reduces its basic costs of production: food, energy and raw materials, labor. Appropriation and capitalization, then, are not directly implicated in the share of machinery relative to labor power in production (Marx's *technical* composition of capital). The capital-intensive farming of the American Midwest developed through the epoch-making appropriations of cheap water, cheap soil, and cheap oil. These appropriations are now coming to an end (Weis 2010), as the cost of securing these vital inputs moves closer to the systemic average. Costs rise because appropriation imposes a peculiar temporal logic on nature. This temporal discipline, tightly linked to the spatial remaking of nature into a storehouse of interchangeable parts, undermines the daily and inter-generational reproductive conditions by enforcing the systemic disciplines of "*socially-necessary turnover time*" (Harvey 2001:327). The spatio-temporal compulsions of the law of value drive capital to accelerate the extraction of use-values, but at the cost of destabilizing the webs of relations necessary to sustain such value production in the first place. This temporal revolution was present from the origins of capitalism, revealing itself in rapid and large-scale landscape changes – such as deforestation – that moved in decades, not centuries, as was the case for feudalism (Moore 2007, 2010b). Interestingly enough, as Marx recognizes in his treatment of the working day (1976:377-378), these frontiers of appropriation have been as necessary for labor power as they have been for energy, food, and raw materials.

By driving down the capitalized share of world nature and increasing the share that can be freely appropriated, ecological revolutions have worked in two major ways. First, they expanded the relative ecological surplus specific to the ongoing transformation of production (e.g. coal for steam engines). Second, they produced new configurations of global nature, as in the "massive taxonomical exercise[s]" of early capitalism that culminated with Linnaeus (Richards 2003:19). These taxonomical and other symbolic revolutions were crucial to successive reimaginings of global nature as a warehouse of free gifts. Identifying and quantifying new sources of extra-human wealth, these successive scientific, cartographic, and metrical revolutions enabled that crucial achievement of world-ecological revolutions: an increase in the share of appropriated relative to capitalized nature (the capitalized composition of global nature). By reducing the systemwide capitalization of production through global appropriations, allowing a

rising volume of nature's bounty to attach to a given unit of capital, these revolutions directly and indirectly checked the tendency towards the rising organic composition of capital. This happened directly through the cheapening of raw materials (circulating capital), and indirectly through the effects of cheap inputs on fixed capital (e.g. cheaper steel meant cheaper fixed capital). In so doing, these revolutions created the conditions for new long waves of accumulation.

This dialectic of appropriation and capitalization may give us pause to turn inside-out our usual thinking of capitalism's long waves. The great problem of capitalism, in effect, has not been too little capitalization, but *too much*. The socio-technical innovations associated with capitalism's long history of industrial and agricultural revolutions were so successful because they dramatically expanded the opportunities for the appropriation of human and extra-human nature. It is true that one finds concentrations of highly-capitalized production in each of these revolutions, from Amsterdam to Manchester to Detroit. These technological revolutions, however, became epoch-making only when joined to imperial projects that revolutionized world-ecological space. This is an important implication of Arrighi's emphasis on organizational revolutions. If technological dynamism alone was decisive, it is likely that Germany would have won out over Britain *and* the U.S. in the late 19th century. Instead, the American vertically-integrated firm with its continental geography, and British commercial and financial supremacy, combined to make Germany the odd man out.

The essential logic of capitalism's ecological revolutions therefore combines capitalization and appropriation so as to reduce the share of the *oikeios* that directly depends on the circuit of capital. One of the most spectacular examples of this logic is the global railroad and steamship revolution of the "second" 19th century (c. 1846-1914), the apogee and *belle époque* of British hegemony (Headrick 1988; Arrighi 1994). Its crowning achievement was a great leap forward in accumulation by appropriation, as capital's steel tentacles grabbed hold of far-flung peasant formations from South Asia to Eastern Europe, shaking loose vast rivers of cheap labor (Northrup 1995; Wolf 1982). Within North America, railroads made the antebellum revolution in property relations a continental reality (Page and Walker 1991; Post 1995; Moore 2002b). The capital-intensive family farm, integrated into international markets, was of a piece with railroadization – the latter making possible the former's world-historical appropriation of soil and water, formed over millennia (Friedmann 1978, 2000). The epoch-making character of railroadization consequently turned on its capacity to radically extend the appropriation of world nature – it created the conditions for cheap food and resources. Cheap food disorganized European peasantries and sent millions to North America and beyond. Once arrived, they worked in factories that were competitive on the basis of cheap (highly appropriated) energy and resources mobilized through railroadization. Here was the *appropriation* of space by time that was central to American hegemonic ascent.

Re-reading Marx in this fashion extends Wallerstein's longstanding argument about rising costs and systemic crisis (2004c). For Wallerstein, three movements in the history of capitalism have propelled a secular rise in the costs of production: 1) the rising costs of labor power apace with proletarianization, as a growing share of world households come to depend on wages; 2) the rising costs of taxation, as democratization compels rising expenditures on education, health care, and other social programs; and 3) the rising costs of input procurement and waste disposal, as capital exhausts the possibilities for appropriating nature. How have these tendencies been constrained, even at times reversed, in the history of capitalism? We can identify a series of interlinked responses in the neoliberal era – the reassertion of coercive-intensive

income redistribution from poor to rich (Klein 2007; Harvey 2005), the industrialization of the Global South (Arrighi, Silver and Brewer 2003), the temporal deferments of financialization.

These responses directly implicate the dialectic of overproduction and underproduction. On the one hand, competition drives capital to expand geographically, to zones where commodification is low, and the opportunities for appropriation high. To the degree that capital can “jump scale,” it can, in one fell swoop, drive down the cost of inputs and increase the rate of profit. On the other hand, competition compels individual capitals to innovate through rising capital intensity, such that relatively less labor (human nature) and relatively more extra-human nature is embedded in every commodity. This accelerates the uptake of external natures into a geometrically expansive production process, which intensifies the drive towards geographical expansion as input and labor costs rise in established zones of production. In this way, capitalism’s ever-accelerating transformation of biophysical and geological natures (the conquest of time) is joined to its voracious appetite for new frontiers of appropriation (the conquest of space).

Rising capital intensity – Marx’s rising organic composition of capital – places downward pressure on the general rate of profit.²⁰ If expansion across space (appropriation) represents one fix to the falling rate of profit; innovation through time (capitalization) represents the second. The first moment extends the net of resource consumption ever more widely, driving down the costs of circulating capital (inputs); the second enables fewer workers to produce more commodities in less time, driving down the costs of variable capital (labor power). Neither can be amplified endlessly.

What are the conditions for a revival of accumulation after a long downturn? Marxists usually respond by emphasizing the role of crises in propelling creative destruction. In these accounts there are three big themes. One is the devaluation of fixed capital, as when factories close. Another is the introduction of productivity-maximizing technical innovations that increase the rate of exploitation. A third is the implementation of coercive-intensive policies that redistribute wealth from the direct producers to the accumulators of capital, Harvey’s accumulation by dispossession (Harvey 1982, 2003; Mandel 1975; McNally 2009; Walker 2000).

To these three moments, I would add a fourth. This turns on circulating capital (inputs), but with important implications for variable capital (labor power) as well. What I wish to underscore is that Marx’s “most important law” (1973:748) can be more fully grasped – and its explanatory power radically extended – by taking *as a whole* the contradictions between “second” and “first” nature (machinery relative to inputs) as well as those within second nature (constant relative to variable capital). I am tempted to say that the crucial weakness in falling rate of profit arguments has been the overemphasis on one moment of constant capital – on fixed rather than circulating capital.²¹

There is, of course, enormous debate over the relation between accumulation crisis and the falling rate of profit. For the purposes at hand, I wish to bracket these, and simply point to the

²⁰ “Why [do] profit rates fall? The argument is simple. It is because the numerator in the profit equation, surplus value, is outrun by the denominator, capital stock (both measured in annual terms)... That is, too much capital stock builds up in factories and equipment around the world, pitting companies against each other in an ever-fiercer competitive brawl for markets. This holds prices down, leads commodity output to outrun demand at prevailing prices, and/or lowers capacity utilization rates – thereby lowering profit margins, leaving goods unsold, and running equipment at less efficient levels” (Walker 1998).

²¹ We are, naturally, dealing with shifting configurations among the three elements of capital.

possibilities of recasting the inner contradictions of capital accumulation as dynamic socio-ecological forces (Burkett 1999). These possibilities can be realized by treating Marx's "progressive tendency" towards a "*gradual fall in the general rate of profit*" (1981:318-319) as a historical proposition on the long-run relation between the overproduction of machinery and the underproduction of inputs. This illuminates a decisive point of fracture in the *longue durée* of historical capitalism, locating biophysical disequilibria *within* the circuits of capital. In so doing, it provides a basis for a much broader conceptualization of cyclical and cumulative crises in the modern world-ecology than hitherto possible.

Could it be that since the 1830s, capitalism's technological dynamism has forged agro-extractive complexes capable of outrunning the tendency towards the underproduction of inputs? If a sufficient mass of cheap energy and raw materials can be mobilized, the rising organic composition can be attenuated; especially if "capital saving" innovations run strongly alongside labor saving movements.²² This not only checks, but (for a time) reverses, the tendency towards a falling rate of profit.

A similar argument can be made for variable capital (human nature.) If a sufficient volume of cheap food can be supplied to workers the rate of surplus value may be augmented in a manner roughly analogous to wage freezes and technical innovations. The most spectacular booms in the capitalist era have combined cheap labor and cheap inputs – think of English industrialization with its heavy reliance on cheap energy (coal) and cheap calories (sugar) (Wrigley 1988; Mintz 1985).

I have argued that underproduction and overproduction are dialectically bound, and that our investigations ought to focus on their shifting configurations. The late 19th century's long depression offers a promising illustration of the possibilities. World prices for raw materials imported by Britain began to rise sharply during the 1860s and '70s, at the very moment of its peak industrial supremacy (Hobsbawm 1975; Rostow 1938; Mandel 1975). This inflationary moment was quickly turned inside-out, as prices in general declined quite sharply (Landes 1969). At the same time, an inflationary undercurrent was at play. The era was punctuated by successive (if partial) moments of underproduction in such key raw materials sectors as cotton, indigo, rubber, palm oil, copper, nickel, lead, tin, jute, and sisal (Headrick 1996; Mandel 1975; Brockway 1979; Bukharin 1929; Magdoff 1969:30-40). These inflationary undercurrents were set in motion by the rise of new industrial powers, Germany and the United States above all. They were amplified further still by the qualitative shifts of the "second" industrial revolution, premised on the auto, steel, petrochemical, and electrical industries (Barraclough 167:45-63; Landes 1969).

The underproductionist tendency was consequently checked, but not abolished, by the second industrial revolution. Insofar as we restrict our attention to the new industrializers, the inner contradiction between value accumulation and the production of inputs was intensified. The contradiction was resolved through the dialectic of plunder and productivity characteristic of capitalism's successive global ecological fixes: 1) the radical enlargement of the geographical arena, with the rapid acceleration of colonial and white settler expansion; and 2) the "massive penetration of capital into the production of raw materials," especially in the newly-incorporated zones (Mandel 1975:61). There is no question that steam power augmented the capacities of capitalist agencies to transform space. A modest amount of capital mobilized a relatively vast

²² Between 1980 and 2005, for example, the "relative price of capital goods" declined 25-40 percent in the U.S. and Japan (BIS 2006:24).

energy surplus. This enabled capital to appropriate new frontiers faster than its productive dynamism could exhaust extant reserves of resources and labor power. At the dawn of the long 20th century, Malaysian rubber and tin, Chilean nitrates, Australian copper and gold, Canadian nickel, all entered the world-historical stage as key moments in an ecological revolution that was “far quicker, far more prodigious in its results, far more revolutionary in its effects on people’s lives and outlooks” than anything previously known (Barraclough 1967:44). What I wish to underscore is that the delivery of crucial ecological surpluses was achieved through the combined movement of capital-intensive and labor-intensive processes, productivity and plunder. State-of-the-art Canadian nickel smelters were of a piece with Malaysia’s tin sector, where nearly a quarter-million Chinese miners “equipped with little more than shovels and simple pumps” fed the growing appetites of the new industrializers (Huff 2007:i131.). One needn’t take a resource-determinist view of the 19th century’s “new imperialism” to understand that the reorganization of world-ecology – at times coercive-intensive, at times capital-intensive – was central to the trajectory of power and progress in the long century that followed.

Capital’s world-historical challenge has been to strike the right balance between regularizing supply (which is always rising) and making those supplies cheap enough to permit expanded accumulation. Rising capital intensity tends to regularize supply but does so by accelerating the place-specific exhaustion of profitability. Capitalism has been remarkably adept at finding ways to overcome the basic tendency. Through capital intensification and socio-technical innovation, capitalist agencies have found ways to make more out of less. More out of less, however, is not something for nothing. The counter-movement to input underproduction has therefore been a frontier movement. From the 16th century, the appropriation of biophysically rich frontiers, combined with cheap labor and sufficiently mobile capital, has periodically resolved the underlying contradiction.

These periodic resolutions, underpinning successive waves of world accumulation, have been realized through varying combinations of the global ecological fix, with its constitutive dialectic of productivity and plunder. If one part of this twin-process falters, the whole edifice erodes, calling forth the need for additional stimuli. Does there exist today a field of appropriation sufficiently large to revive world accumulation?

The history of neoliberalism suggests rocky terrain ahead. Neoliberal capitalism was built by returning to the “scenes of the crime,” ruthlessly appropriating wealth from the long-plundered zones of the Global South, with eastern Europe thrown into the mix after 1989. These extractions did not, as previously, revive labor productivity growth, the real basis of accumulation (Gordon 2010). Is not this failure to revive productivity growth closely linked to an accumulation regime notable more for its enclosures than for its productive dynamism? The Fordist “compromise” of postwar North Atlantic capitalism, through which rising productivity gains were partially shared with workers, was impossible after 1971, precisely because those gains have been so slight. Thus neoliberalism’s “class project” has been one of accumulation by dispossession (which is usual) without a revolution in productivity (which is not) (Harvey 2005; Moore 2010c, 2011b). As a result, neoliberalism has been about *taking* first, and *making* second. This is rooted in a specific world-historical contradiction: relative to capital as a whole, the opportunities for appropriation have never been fewer, while the demand for such appropriations has never been greater. This is a precious clue to understanding the ongoing transformation of capitalism as it confronts the *longue durée* exhaustion of frontiers.

BY WAY OF CONCLUSION: ECOLOGY AND THE WORLD-HISTORICAL IMAGINATION:

We need now to go further, along paths hitherto little explored, to see the successive synchronous patterns of historical social systems within the ecological whole that is the earth – Wallerstein (1980:159).

I have argued three propositions, in turn ontological, methodological, and historical-analytical. First, ecology as *oikeios* stands as a signifier of the whole and not the parts. This *oikeios* is the relation that gives rise to the mythic categories Nature/Society. This peculiarly modern ontology says, in effect, that some things humans do are social, and can be analyzed as such, abstracting from biophysical process. I avoid the term “hybrid” for this very reason, since hybridization rests on a purity of essence that does not exist. If there is something resembling a fundamental ontological relation, it is between humans and the rest of nature – the *oikeios*. No domain of human experience is off limits. Capitalism as world-ecology, unifying the production of nature and the accumulation of capital, becomes a means of re-reading the diversity of human experience in the modern world-system as unavoidably socio-ecological. This stems from a paradigmatic contention that: 1) capitalism as a whole is most effectively interpreted through the totality of its conditions of reproduction and not merely commodity production and exchange; and 2) the most fruitful entry into such holistic considerations is to move from the logic of capital to the history of capitalism and back again (and vice versa).

The upshot is that “nature” (however one defines it), like capitalism, is not an invariant structure. It is a *historical* structure – although I am not sure that “structure” is the right word for it. World-systems analysis has produced a remarkable body of scholarship in environmental studies. But little attention has been given to “incorporating” nature into the mode and method of analysis. There has been too little investigation into how nature-society relations constitute modernity’s patterns of recurrence, evolution, and rupture. The impression is that modernity makes environmental history. Yet, a more nuanced proposition is more tenable: modernity *as* environmental history. For many, nature remains, as in the old days of state-centric social science, a neat and tidy container within which one can identify all manner of unsavory footprints (e.g. Clark and Jorgenson 2009a).

There are still too few studies that tell us how that container undergoes qualitative transformation. This speaks to my second, methodological, proposition, which turns on the bounding of socio-ecological relations. Once we acknowledge that the old containers (Nature/Society) may need to be radically refashioned, we can read modernity’s world-historical patterns – soil exhaustion and deforestation, unemployment and financial crashes – as expressions of an underlying bundle of relations (the *oikeios*). Some of these expressions operate at ground level, others at the scales of accumulation, and of course many more work in-between. Many of these expressions do not appear to be socio-ecological – financialization, the creation of cultural distinction, the prison-industrial complex. And this is precisely the point of world-ecology as educative method. A methodological choice that begins by *narrowing* the field of vision may not be the most fruitful choice in an era when an elusive logic of financial calculability rules the roost of global capitalism, and shapes, as never before, the structures of everyday life – *including* the “everyday lives” of birds and bees and bugs, alongside human beings.

The alternative is a part-whole approach through which *concrete totalities* emerge. This approach “says to keep moving out by successive determinations, bringing successive parts – themselves abstract processes – in continuous juxtaposition and in this way form the whole which you need for interpreting and explaining the... historical changes or conditions under examination” (Hopkins 1982:147; also Marx 1973; Tomich 1990; McMichael 1990). For example, one might take the metabolic rift (Foster 2000) as a historically concrete relation that emerges through the “continuous juxtaposition” of various parts (e.g. episodes of resource exhaustion and urbanization), stabilized provisionally in “successive determinations” over the *longue durée* (Moore 2000a). Deforestation and resource depletion become meaningful only through such historically concrete relations. In other words, *historical* nature merits incorporation into the emergence of successive world capitalisms in the spirit of McMichael’s contention that “neither whole nor parts are permanent categories or units of analysis” (1990:386).

If historical nature and historical capitalism form a dialectical unity, we can investigate the modern world-system as a matrix of commodity-centered relations that transforms and reforms through the *oikeios*. Note that the logic of commodification is a gravitational field that owes its success as much to the extension of appropriation as it does to the penetration of capital into production – this, the dialectic of plunder and productivity (Moore 2008, 2010c). The generalization of the commodity form is a project that instanciates a specifiable, yet contingent, bundle of human and extra-human relations. The (non-arbitrary) contingency of the world-ecological conjuncture is important here, for so much of the discourse on ecological crisis presents this as an external limit. It asserts the very question that merits investigation, the adaptability and evolution of the relation between humans and the rest of nature. My view is therefore one that extends to the *oikeios* Arrighi’s emphasis on capitalism’s essential flexibility: “One of the major problems of the left, but also on the right, is to think there is only one kind of capitalism that reproduces itself historically; whereas capitalism has transformed itself substantively – particularly on a global basis – in unexpected ways” (2009:92).

Can we not say the same thing about nature-society relations in the modern world-system? (My third, historical-analytical proposition.) The nature produced through early capitalism and its scientific revolution was not the same nature produced through American-led monopoly capitalism and the scientific management revolution (Merchant 1980; Foster 1994).²³ And the nature of the post-World War II “golden age” differs from the nature produced through neoliberalism and its project to create, in Cooper’s delicious phrase, “life as surplus” (2008).

²³ This is no call for idealist constructivism. Yes, there are geological and evolutionary processes that have shaped the contours of the earth and the species who live here. These processes long outstrip the lifespan of capitalism. *And*, there is a relation through which humans move to comprehend all natures, including their own: “Dialectical enquiry is not itself outside of its own form of argumentation but subject to it. *Dialectical enquiry is a process that produces things in the form of concepts, abstractions, theories and all manner of institutionalized forms of knowledge which stand in their own right only to be supported or undermined by the continuing processes of enquiry.* There is, furthermore, a certain relationship implied between the researcher and the researched, a relationship which is not construed in terms of an ‘outsider’ (the researcher) looking in on the researched as an object, but one between two subjects each of which necessarily internalises something from the other by virtue of the processes that operate. Observation of the world is, Heisenberg argued, inevitably intervention in the world, in much the same way that deconstructionists will argue that the reading of a text is fundamental to its production” (Harvey 1993:36, emphasis added).

Here is a way to engage the popular and scholarly debate over socio-ecological limits without invoking neo-Malthusian or millenarian notions – a discourse that has recently enjoyed a renaissance around peak oil and climate change. (This is hardly to deny the evidence for both!) To be perfectly clear: There *are* limits. But just what is the best way to identify, to narrate, and to explain the emergence of these limits, historically and in the present conjuncture?

It is not my intention to chart any single “best way,” but rather to argue for the internalization of nature-as-*oikeios* into the fundamental methodological and conceptual frames of world-historical studies. I am doubtful that either the world-systems perspective or Left Ecology can effectively engage the present global crisis without engaging in a creative dialogue over the most productive ways to move from red-green theory to red-green histories of capitalism that transcend the Cartesian divide. Now that a metabolic rift has been discovered on the land, Left Ecology and the world-historical tradition can proceed to transcending its own, deeply-rooted, “epistemic rifts” (Schneider and McMichael 2010; Moore 2011a).

Arrighi’s conceptualization of time and space as active and endogenous moments in the theory of capitalism opens the possibility for such a transition. Arrighi’s world-historical imagination pivots on the tensions between time and history, space and geography – between the theory of capital and the history of capitalism. Incorporating such tensions is crucial to incorporating nature as not only empirically consequential to, but as relationally constitutive of, modernity’s master processes. Grounding time, space, and power in the theory of organizational revolutions and the accumulation regimes they construct, Arrighi clears a path to integrating Braudel’s three socio-historical layers of capitalism, market exchange, and material life. The spatio-temporal configurations of geopolitics and finance are “only relatively autonomous from the logics of the lower layers and can be understood only in relation to these other logics” (Arrighi 1994:26). The tension can be resolved – “if that is possible” – only by returning to these “lower layers of market economy and material life with the knowledge and questions brought back from the journey and into the top layer [of capitalism]” (ibid).

Is such an endeavor possible? The possibility of integrating Braudel’s capitalism, market economy, and material life is the premise of much work in critical environmental studies, taking seriously the interplay between political economy and environmental change. The challenge is to revise without simply adding more. Arrighi is emphatically correct: “[W]e cannot do everything at once” (1994:25).

My prescription for cutting through this Gordian Knot turns on value theory as educative method. By this, I emphasize a method that draws out, and clarifies, the complexities of the *oikeios* within a relational rather than Cartesian frame. This allows for three ways of seeing modernity as world-ecology. First, capital is “value in motion” deriving from human labor on the ground and the sale of the resulting commodities in a multi-layered world market. This offers a non-arbitrary way of synthesizing earth-moving (necessarily local) with more expansive repertoires of producing nature, incorporating financial transactions, resource legislation, agricultural science, geopolitical arrangements such as the Westphalia system, and so on. The inner connections between earth-moving and the rest of the world-ecology do not need to be established in *a priori* fashion. Rather, they can be allowed to emerge through the analysis of the *oikeios* as a “self-forming whole” (McMichael 1990:386). There are many ways to do this. I have found useful a “tacking” approach, moving between pivotal changes and conflicts at multiple geographical scales, from the body to forests to factories to financial centers *and back again* (e.g. Moore 2000a, 2002b, 2007a).

Second, a historical value relation approach privileges the irremediable tension between the “economic equivalence” and the “natural distinctiveness” of the commodity (Marx 1973:141). It bears repeating that these are not Cartesian categories but distinct vantage points on a singular process. It allows a complementary form of “tacking” to the geographical argument above. If we take value as a guide to the decisive “stakes of the game” in modernity (Bourdieu 1990:110), then a conscious tacking back and forth between the superficially “social” (bourgeois property relations, new credit mechanisms) and the apparently “ecological” (soil exhaustion, pollution, deforestation) becomes a means of revealing their inner connections.

Finally, the perspective of global value relations opens a new way of comprehending what is arguably the decisive middle-run contradiction of capitalism as it moves into the 21st century – the “end” of cheap food, energy, water, metals, and (it seems) everything else. This turns crucially on the resurgence of the underproduction tendency that we explored in the last section.

The events of 2008 – the inflationary crescendo of the commodity boom and the near-meltdown of world’s financial system – marked the *signal crisis* of the neoliberal era. By signal crisis, with Arrighi (1994), I refer to the moment when a phase of capitalism reaches its tipping point in the delivery of “cheap” food, energy, raw materials, and not least, labor power. These four “cheaps” are essential to establishing the conditions for any great wave of accumulation (Moore 2010c). They are *cheap* to the degree that these vital commodities – decisive forms of the ecological surplus – are delivered in sufficient volumes and sufficiently cheaply that they reduce systemwide production costs.

There is a good reason why such relative cheapening has been a recurrent condition for the renewal of world accumulation. All things being equal, a decline in these costs of production favors a higher rate of profit, because labor costs fall (cheap food is crucial to determining the costs of reproducing labor power), because the costs of machinery and inputs fall, or both. Historically, new socio-technical innovations in production, and new innovations in the appropriation of nature’s free gifts, have generated revolutions in labor productivity. This was the foundation for successive long centuries of accumulation, from the factories in the field of early capitalism’s plantation revolutions, to the rise of large-scale industry in the 19th century, to the mass production systems of the 20th century. The neoliberal era marks a historic rupture with this *longue durée* pattern of revolutions in labor productivity.

Here I distinguish between *neoliberalism* as a phase of capitalism and *neoliberalization* as a set of policy orientations and institutional practices (Moore 2010c). The institutional practices and policy initiatives of neoliberalization – from structural adjustment to the shifting governance of finance to privatization – represent an often unconscious response to the progressive slowdown of labor productivity since the 1970s. After three decades of seemingly breakneck technological innovation, there remains little prospect of a revival of labor productivity growth compared to the first part of the long 20th century – in agriculture and the wider economy (Ruttan 2002; Gordon 2010). The upshot? The cheapness of these vital commodities (energy, food, etc.) in the neoliberal era has relied less on rising efficiencies in production, and more on the coercive dispositions of the state-finance nexus, driving the interlinked processes of “accumulation by dispossession” (Harvey 2003) and “forced *underconsumption*” (Araghi 2009).

The erosion of these four “cheaps” invariably signals a cascading collapse of investment opportunities. This is why overaccumulation may coexist with overproduction *or* underproduction as the dominant crisis tendency. Hence, financial expansions typically coincide

with new and ruthless initiatives to appropriate extra-human nature (resources), which entail new and ruthless initiatives to exploit human nature (labor power). Historically, this establishes new conditions for a revival of profitability in the productive circuit, a material expansion in Arrighi's language. This was true for the "Age of the Genoese" in the century after 1557 (Moore 2010a, 2010b), and it has been true for the neoliberal era. The instructive contrast with the Age of the Genoese and its successors is the non-appearance of a productivity revolution in the neoliberal era (Balakrishnan 2009; Moore 2010c).

The signal crisis of neoliberalism, punctuated by the near-meltdown of North Atlantic finance in 2008 and rippling outwards still (as the Eurozone periphery's financial woes in 2010 indicated), speaks to the ongoing resurgence of underproductionist tendencies. Overproduction retains the crown from the time being, although for how long is uncertain. The ongoing transition in favor of underproduction is suggested by three major developments (Moore 2010c, 2011b):

- 1) *The arrival of peak appropriation.* The capitalization of nature has reached a *longue durée* tipping point, signaling the irreversible contraction of opportunities to appropriate nature's free gifts, especially in energy, metals, and water;
- 2) *The rise of the superweed.* Capital's reworking of biophysical natures through new forms genetic-chemical manipulation is producing a cascading series of unpredictable biological responses (superweeds) in the most capitalized zones of world agriculture;
- 3) *The financialization of nature-as-oikeios.* The rules of reproduction for biophysical and human natures are increasingly determined by the financial rather than productive circuit of capital. This favors the interlinked phenomena of high commodity prices and the progressive stagnation of labor productivity, especially in world agriculture.

This prospect for seeing capitalism as "world-ecology" is one of many possibilities for navigating the transition from a red-green synthesis in social theory to red-green narratives of historical capitalism and its crises. If this argument merits any traction, we can thank Giovanni Arrighi for opening our eyes to the dialectics of time and space in actually existing capitalism, and in the possible futures we make.

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