

*Nature and the Transition from Feudalism to Capitalism**

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The transition to capitalism was a major theoretical question with widespread political implications for the world's left throughout the golden age of American hegemony, between the end of the Second World War and the long global stagnation that began in the 1970's. Intimately tied to such pressing political questions as the possibility of "socialism in one country" and the nature of imperialism, the transition debate (as it became known) was a major part of the radical critique of capitalism among intellectuals and activists alike. Several decades later, the transition debate—and along with it, the critique of capitalism—has lost much of its salience for the world left. Of course there are many reasons for this, not least neoliberalism's successful ideological campaign trumpeting the notion of capitalism as the "end of history." I wish to suggest, however, that the task of historicizing capitalism—that is, of comprehending capitalism not only as a system of political economy but also as a historical system that was born in a specific time and place and will one day pass from the scene—is quite possibly even more important for today's left than it was for yesterday's.

Perhaps nowhere is this task more relevant than for the world's environmental movements. Local and national movements confront not only the forces of global capitalism, but equally the threat of impending global ecological crisis.¹ The idea of eco-

* I am grateful to Diana Carol Moore Gildea and Brett Clark, who read and commented upon successive drafts of this article. For discussion and comments, thanks also to Giovanni Arrighi, Ben Brewer, Edmund Burke III, Barbara Epstein, John Bellamy Foster, David Harvey, Ho-fung Hung, Michael Johns, Jordan Leonard, Peter Grimes, Nari Rhee, Sky Spehar, Ann Strahm, Dale Tomich, and Richard A. Walker.

¹ This much is clear. The twenty-first century world faces deepening ecological *problems*, conceptualized as "a condition of the environment which prevents pleasant or

logical crisis is a powerful one. It is also a difficult concept to pin down. Competing explanations of ecological crisis tend to be muddled and confused, or too simplistic. Often hidden from view, at times even from their proponents, are a variety of historical and geographical assumptions about how societies have interacted with nature. These assumptions, sometimes explicit but usually not, are important because they inform political strategy—some identify industrialization as the culprit, and urge forward moment into “postindustrial” society (or backward to preindustrial times); others see urbanization as the problem, and argue for a return to agrarian society, a move “back to the land.” For others the problem is overpopulation, and relatedly, some even posit human civilization as the problem; and some argue that today’s mammoth transnational firms and unregulated markets are the main source of the problem and contend that the solution is global movement towards the democratic regulation of markets and firms. Often, we find some combination of these varied interpretations, further obscuring the historical origins of ecological crisis.

A small but growing number of environmentalists see capitalism as the prime mover behind today’s global ecological crisis. This group identifies the solution as a socialist project in which Marx and Engels’ vision is realized, whereby a society of associated producers governs the metabolism of nature and society in a sustainable and egalitarian manner (Burkett, 1999; Foster, 1999;

preferable activities and is threatening either human health and well-being or the productive potential of nature” (Haila & Levins, 1992: 226). In contrast, the idea of an impending global ecological *crisis* is certainly a speculative one, if by the term we mean an impending, dramatic reduction in the capacity of the planet to sustain human life. However speculative, this “strong” conception of ecological crisis is nonetheless grounded in a considerable body of scientific research. Among the central themes of this research is the idea that “gradual changes” in ecosystems, climate, and so forth can give way to “sudden drastic switches” (Scheffer et al., 2001: 591). But we may also find useful a “weak” conception in which ecological crisis is

viewed as a metaphoric expression for a multitude of specific environmental problems accumulation all over the world, some of them extremely serious. . . . Deterioration of ecosystems all over the world threatens the life-supporting potential of nature. *The threat is real—although we do not know how actual—even on the global scale.* The conditions making life possible on the earth were produced by life itself, and there are no transcendental guarantees that those conditions cannot change (Haila & Levins, 1992: 211, emphasis added).

2000; Harvey, 1996; O'Connor 1998).² Yet, even within these circles, there has been little sustained examination of the historical origins of capitalism's peculiar relation with nature.

What I would like to sketch, in broad strokes, is the importance of such an examination, which we might call the world environmental history of the transition to capitalism. I advance two propositions in this formulation. First, in the capitalist era, environmental history is fundamentally world-historical, in the way that Marx and Engels understood the term (1970: 56; *passim*). Environmental problems prior to capitalism were local and regional. With the transition to capitalism, however, they became progressively globalized. Local environmental transformations were no longer localized—at once they necessitated, and were predicated upon, changes in other locales and the world-economy as a whole.

Secondly, the environmental history of early modern Europe supports the idea that there was one and not many transitions to capitalism. (Even as we acknowledge that capitalism has become more "capitalist" over time in the sense that social life and its material substrate has become progressively commodified.) Capitalism emerged over the course of the "long" sixteenth century (1450–1640) as a "vast but weak" world-economy that stretched from Poland to the Americas (Braudel, 1961: 260; Wallerstein, 1974). The subsequent history of global conquest bore witness not only to the ascendancy of capital to the commanding heights of this vast but weak world-economy, but equally to the new system's explosive socioecological contradictions.

The emergence of capitalism signaled a quantum leap forward in the scale, scope, and speed of ecological degradation. Constructing new relations between town and country, which burst asunder the largely sustainable nutrient cycling of earlier city-hinterland complexes, capitalism gave rise to what Marx calls an "irreparable rift" in the metabolism of nature and society (1981: 949). Capitalism established, on a progressively globalized basis, a "metabolic rift" whereby nutrients flowed out the countryside and

² There are, it should be said, significant differences within this camp, chief among them the centrality of ecological thinking in Marx's political economy and historical materialism (Foster and Burkett against O'Connor); and the threat of global ecological crisis to the survival of capitalism (Foster against Harvey).

into the cities at a geometrically increasing volume and pace (Foster, 2000: ch. 5; Foster & Magdoff, 1998). Nutrient cycling was increasingly disrupted, precipitating one after another “local” ecological crisis—such as soil exhaustion or deforestation—whose global impacts manifested in recurrent waves of geographical expansion, as capital was compelled to seek out new supplies of land, as well as the labor to work it (Moore, 2000a). In this way, early capitalism’s ecological contradictions were powerful forces behind the system’s global expansion. Above all in the New World, early capitalism rapidly degraded the land and required successive “spatial fixes” in order to procure the land and labor necessary for ever more globally expansive regimes of capital accumulation (Harvey, 1999).

This line of reasoning runs contrary to received wisdom. Especially but not only within the left, the origins of environmental crisis are typically chalked up to the Industrial Revolution. Even so important an ecological theorist as James O’Connor has developed a theory of capitalism-nature relations whose relevance is essentially limited to the nineteenth and twentieth centuries (1998). A theory of capitalism’s ecological contradictions that rests upon the rise of industrial capitalism tells us little about the origins of that momentous development—namely, as Marx argues so persuasively, the domination of the land by capital.

Silence on the era of capitalist development prior to the nineteenth century serves only to shore up what we might call the industrialization thesis—a perspective that effectively renders capitalism synonymous with, or a subset of, industrialization. The result: capitalism disappears from view. While nineteenth-century industrialization surely accelerated the degradation of nature, this line of reasoning attaches undue weight to technological process narrowly conceived. In this scheme of things, social relations express the abstract logic of technological imperative. But if instead technological innovations express social relations, then perhaps an alternative reading of modern environmental history is in order. However significant the Industrial Revolution, if it can be shown that a new era of historically unprecedented ecological degradation began not in the long nineteenth century (1789–1914) but in the “long” sixteenth century (1450–1640), then we have good reason to question the prevailing orthodoxy concerning the origins of today’s global ecological crisis.

It also gives us good reason to suspect capitalism, not industrialization alone, as the real culprit.

When environmental critics speak of industrialization, they are usually talking about world history since the Industrial Revolution. But the Industrial Revolution was by no means the world's first "industrial revolution." Even within Europe, there were several waves of industrialization prior to the later eighteenth century, not all of which proceeded according to a strictly capitalist logic (Carus-Wilson, 1941; Gimpel, 1976; Nef, 1964). "Medieval man was surrounded by machines," writes historian Jean Gimpel. Machines "were not something foreign or remote to the townsman or to the peasant in his fields" (1976: 1). Indeed, trade-induced manufacturing expansions were an essential feature of "tributary" systems in general, ranging from feudal Europe to imperial China. The great Eurasian-wide trade expansion of the twelfth and thirteenth centuries was precisely one such expansion (Abu-Lughod, 1989). As Robert Brenner has argued so effectively (1985a; 1985b), such expansions were inevitably constrained by the class relations prevailing on the land. Agrarian ruling classes had good reason to fear the revolutionary changes promised by a regime of ceaseless capital accumulation, so marvelously equipped to sweep away "all feudal, patriarchal, idyllic relations" (Marx & Engels, 1972: 337; Wallerstein, 1992: 612-15).

Closely related to the industrialization thesis is the idea that cities are the loci of environmental degradation. In this scheme of things, the urban industrial form, sometimes associated with capitalism, sometimes not, is demonized. The countryside is seen as cooperating with nature, the city, as destroying it. The great social theorist Raymond Williams, however, reminds us that

Since the dramatic physical transformations of the Industrial Revolution we have found it easy to forget how profoundly ... agriculture altered the land. Some of the earliest and most remarkable environmental effects ... followed from agricultural practice: making land fertile but also, in places, overgrazing it to a desert; clearing good land but also, in places, with the felling of trees, destroying it or creating erosion. Some of these uses preceded any capitalist order, but the capitalist mode of production is still, in world history, the most effective and powerful agency for all these kinds of

physical and social transformation. The city is only one if now conventional way of seeing this kind of change; and the country . . . is undoubtedly another (Williams, 1973: 293).

Neither industrialization nor urbanization has an internal logic of its own. This logic is supplied by the system of production—in the case of capitalism, a system of generalizing and globalizing commodity production. This is not to say that the rise of what Marx calls “modern industry” in the nineteenth century was unimportant. Quite the contrary. But to identify this era as capitalism’s starting point—or worse, to identify this epoch as witnessing not the birth of capitalism but the advent of industrial society—is to miss the decisive eco-social transformations that occurred over the previous three centuries (e.g., Turner et al., 1990). The prime mover of these transformations was capital, which ascended to the commanding heights of the emergent European world-system in the sixteenth century, and in alliance with states and landowners began to reshape the land as the first major step in the long march towards the “commodification of everything” (Wallerstein, 1983).

Precisely how capital ascended to world power, and in what ways this was conditioned by the natural environment and in turn transformed it, is a thorny problem indeed. In this article, I approach this problem by attempting to answer four major questions. In what sense was the crisis of feudalism an ecohistorical crisis? How did feudalism’s socio-ecological contradictions, and Europe’s eco-geographical specificities, shape the outcome of feudal crisis in favor of capitalism? Why and how did Europe’s transformation of world ecology in the centuries following 1450 help to resolve the economic crisis driven by the disintegration of feudalism? And finally, relative to feudalism and other precapitalist systems, how were capitalism’s environmental transformations historically distinctive?

HISTORICAL FEUDALISM?

“Feudalism” means many things to many people. One camp limits the concept to “the hierarchical relationship between a lord and his vassals” (Lefebvre, 1976: 122). In this tradition, “[h]istory was not just written *from* the perspective of the top but was also

limited to studies *of the top*" (Kaye, 1984: 73; e.g., Ganshof, 1964). The critique of this narrow conception of feudalism was spearheaded by, among others, Rodney Hilton (1949; 1973; 1985) and Marc Bloch (1961). While recognizing that "feudal Europe was not all feudalized in the same degree or according to the same rhythm and, above all, that it was nowhere feudalized completely" (Bloch, 1961, II: 445), these historians deployed a broader conception that sought "to describe a whole social order whose principal feature was the domination of the rest of society, mainly peasants, by a military landowning aristocracy" (Hilton, 1976: 30).³

It is this broader conception of feudalism that most strongly influenced the world-historical perspective since the 1970's (esp. Wallerstein, 1974). The major exception to this generalization is Giovanni Arrighi (1994; 1998), who in key respects returns to the earlier, narrower conception of feudalism. In Arrighi's scheme of things, feudalism is limited to rural social relations in medieval Europe. While feudal relations are

no doubt very relevant to an **understanding** of English, French, Polish, Swedish and many other "national" histories of the European world[,] [t]hey nonetheless are largely if not entirely irrelevant to an understanding of the origins of world capitalism for the simple reason that world capitalism did not originate within the economic activities and social relations [of territorial Europe]. Rather, [capitalism] originated in the *interstices* [the city-states] that connected those territorial organizations to one another (1998: 126).

Thus, following Postan's famous statement that "[m]edieval towns were . . . non-feudal islands in the feudal seas" (1972: 239), Arrighi narrows the conception of feudalism to exclude urban centers in order to designate them prime movers in the transition to capitalism. In so doing, Arrighi runs the risk of tautological reasoning: the origins of capitalism are explained in terms of capitalist city-states (see also Mielants, 2000).

³ We can certainly identify a number of regions, such as the Low Countries, where the peasantry enjoyed relative freedom from seigneurial power (Vries, 1973; Vries & Woude, 1997). Nevertheless, even these peasantries were embedded in a broader system of power in which tributary relations predominated over enclaves of both protocapitalism and peasant natural economy.

Tautology aside, this line of argument tends to reproduce a sterile dualism, pitting the capitalist city against the feudal natural economy. But if the broader conception of feudalism is deployed, city and countryside, market and production, are viewed not in isolation but rather dialectically. From this perspective, production and exchange are “points of departure” for the investigation of large-scale “social economies” (Tomich, 1997: 299). From this standpoint,

production and exchange are no longer conceived as discrete entities divorced from their broader contexts, separated from and opposed to each other as external object; nor are they treated as identical. Rather, production and exchange are understood as relations that presuppose, condition, and are formative of one another as distinct parts of a whole. If we conceive of the social economy in this way, the relevant unit of analysis is defined by the extent of the *inter-related* processes of production, distribution, exchange, and consumption (Tomich, 1997: 300; also Merrington, 1976; Marx, 1973: 83–100).⁴

Feudalism’s historical geography was shaped by the agrarian class relations that enveloped the mass of the population. As

⁴ This approach seems consonant with the spirit (and often the letter) of Marx and Engels’s (1972; 1979; Marx, 1973) broad conception of feudalism. Marx and Engels emphasize the system’s historically- and geographically-specific class relations and its town-country division of labor, which determined specific forms of wealth production and accumulation. Some degree of confusion typically arises over the term “mode of production” (e.g., Chase-Dunn & Hall, 1997; Mielants, 2000), which Marx used in at least three different ways: 1) to refer to “the actual methods and techniques used in the production of a particular kind of use value”; 2) to refer to “the characteristic form of the labor process under the class relations of capitalism,” whereby the capital-labor relation constitutes “an abstract representation of a reasonably narrowly defined set of relationships”; and 3) to refer,

holistically and for comparative purposes . . . to the whole gamut of production, exchange, distribution and consumption relations as well as to the institutional, juridical and administrative arrangements, political organization and state apparatus, ideology and characteristic forms of social (class) reproduction. This all-embracing but highly abstract concept is in some ways the most interesting, but it also creates the greatest difficulties (Harvey, 1999: 25–26).

It is this third meaning of the concept mode of production that I deploy in comparing capitalism and feudalism.

Hilton argues, the “struggle for rent” was the “‘prime mover’ in feudal society” (1976: 115). The struggle between landlords and peasants for shares of the agricultural surplus tended to generate modest (but always constrained rather than ceaseless) pressures for increased productivity and simple commodity production. The expansion of

medieval market centres and towns from the 10th or eleventh century was based fundamentally on the expansion of simple commodity production. The spectacular developments in international trade, the industrialisation of Flanders . . . , the growth of big commercial centers like Venice . . . are chronologically secondary to the development of the forces of production in agriculture, stimulated in the process of the struggle for feudal rent (Hilton, 116; also Lewis, 1958).

With this basic framework in mind, we may now investigate feudalism’s socio-ecological crisis tendencies in some depth.

EXPANSION AND CRISIS: FEUDALISM’S SOCIO-ECOLOGICAL CONTRADICTIONS

Our story begins with the golden age of European feudalism. Between the eleventh and fourteenth centuries medieval Europe experienced rapid population growth, leading to new settlement throughout central and eastern Europe. Successful military campaigns (“Crusades”) were waged against non-Christians in the Baltic, Iberia, and Palestine. Cities grew. There was significant growth of manufacturing output and cash-crop agriculture, part and parcel of a generalized wave of commercial expansion throughout Afro-Eurasia. The states consolidated their power against feudal lords.⁵ Social and technological innovations—

⁵ The language of “states” must be used very carefully here. I am sympathetic to Strayer’s line of argument (1970), which dates the origins of the modern state to 1100. But this approach is most useful as a heuristic guide, not a statement of historical-geographical fact. Prior to the twelfth century, “parcellized sovereignty” (Anderson, 1974b: 15) held sway to such an extent that “by the year 1000 it would have been difficult to find anything like a state anywhere on the continent of Europe” (Strayer, 1970: 15). Even after 1100,

especially in sea transport, financial mechanisms, and business organization—encouraged new divisions of labor between previously distant regions.

But sometime around 1300, things started to go wrong. Terribly wrong. Seigneurial revenues began to contract. Peasants started to revolt. Famine proliferated. And famines paved the way for even more deadly epidemics. The inroads made by the states against the landlords were reversed. Merchants and financiers in the city-states began to lose money. And the states went to war. Feudalism, as a social system no less than a system of production, was in crisis.

The origins of this crisis are found in feudalism's relation to the land. Organized on the political extraction of surplus, yet (in most cases) recognizing the peasantry's customary rights to the land,⁶ feudalism provided neither the coercion nor the incentive necessary to ensure rising productivity. On the one hand, the peasant proprietor could only rarely be displaced from the land—even more rarely could market forces displace him. He was therefore compelled to *produce* to survive, rather than *sell* to survive. It is in this narrow sense that “the crucial feature of feudalism . . . [is] *production for use*” (Sweezy, 1976: 35). On the other hand, productivity gains, such as they were, tended to be undermined by feudal exactions (Dobb, 1963: 42–44). Rising peasant surpluses were subject to appropriation by the seigneurs and the states—indeed, the appropriation of surplus through rent, levies, and taxes were the primary means of increasing ruling class revenues. (This of course dampened the seigneurs' incentive to increase produc-

the states were never strong in Europe. . . . But they were stronger at some times than at others. The expansion of the economy in Europe between 1000–1250 which created new revenue bases for the states and new needs for internal order, on the one hand, and the outward expansion of “Europe” (the Crusades, colonization in the east and far north) which called for some military unification, on the other, combined to create a new life for nascent state-machineries (Wallerstein, 1992: 603–04).

⁶ While the seigneurs legally “owned” the land, the peasants “possessed” it (Milonakis, 1993–94). On the one hand, peasant customary possession placed limits on the degree to which the direct producer could be compelled to pay higher rents, whether labor, in-kind, or monetary. On the other, the relative (if still very limited) autonomy of the direct producers under feudalism constituted a real productive advance over slave systems of production. Feudalism limited but did not remove incentives for increased productivity.

tivity, since rent and levies were not directly tied to agricultural improvement.) Within certain limits, then, feudal income could increase even if the surplus stagnated or contracted. And this is what seems to have occurred by the early fourteenth century (Hilton, 1985: 129–30).

Feudalism consequently limited the surplus available for investment in agricultural improvement, which tended to undermine soil fertility (Postan, 1972; Duby, 1972; Anderson, 1974a: 197–99). Put simply, the lord-peasant relation was fundamentally antagonistic to long-run ecological sustainability. Feudalism's ecological cycle was a vicious circle indeed: "Few animals had provided little manure; little manure had meant low [grain] yields; with low corn yields per acre, every possible scrap of land had to be ploughed for corn; so there was little winter feed for animals, and few animals . . ." (Davis, 1973: 113).

Even as the feudal system limited the possibilities for reinvesting surpluses in the agricultural improvement, it favored population growth as a means of generating surpluses.⁷ For the mass of the population, population growth under feudal class relations tended to fragment smallholdings through partible inheritance. Peasant households therefore faced contracting living standards—although of course a few did well—and tended to compensate, much like peasant families today, by opting for larger families, which over time fragmented holdings still further (Brenner, 1985b: 230; Dobb, 1963: 47). Over time, the fragmentation of holdings itself began to fetter productivity (Milonakis, 1993–94). Consequently the peasantry's position tended to deteriorate over the course of the Middle Ages, even in the absence of rising seigneurial demands. But the seigneurs' demands did tend to rise. The development of feudalism favored not only a rising population for the masses, but also an enlarged ruling class:

[T]here was a tendency . . . for the number of vassals to be multiplied, by a process known as sub-infeudation, in order to strengthen the military resources of the greater lords. This, combined with the natural growth of noble families

⁷ "The long-term tendency, therefore, appears to have been towards over-population, leading to increasing demand for land, creating the *possibility* of extracting growing rents, *without* direct resort to extra-economic pressures or controls" (Brenner, 1985b: 230).

and an increase in the number of retainers, swelled the size of the parasitic class that had to be supported from the surplus labour of the serf population (Dobb, 1963: 45).

So it was that the feudal system of production exhausted the soil, which led to malnutrition, which prepared the ground for epidemic disease, and in short order, a terminal systemic crisis.

There were three main solutions to this contradiction within the feudal mode of production. All were self-limiting.

One solution was to increase land productivity. Following the eighth century, western European peasants began to shift from a two-field to a three-field rotation. In principle, this allowed cultivated acreage to grow by as much as 50 percent. But the three-field rotation did not work well in Mediterranean and northern European climes. Even in western Europe its diffusion was highly uneven. And it demanded relatively more fertilizer than its predecessor. At the same time, the three-field system reduced the land available for pasture by as much as a third, thereby reducing the livestock necessary to replenish the soil's nutrients at the very moment when its nutrient demands were rising (Miskimmin, 1975: 18–19, 24–25; Dobb, 1963: 43–44; Postan, 1972: 63–67; Duby, 1972: 196; Braudel, 1981: 109; Bowlus, 1980: 89; White, 1962: 69–76).⁸ (Even if these problems could be overcome, feudal class relations, as we have seen, discouraged sustained productivity gains.)

The reduction of pasturage implied in the shift to the three-field system only intensified feudalism's expansionary impulse. Thus efforts to increase productivity were typically bound up with a second solution, which found its expression in various movements of internal and external expansion. Among the chief moments of internal expansion was the conversion of forests to pasture.⁹ For a time offsetting the contraction of pasture in favor

⁸ "Everything leads us to suppose that the food needs of the ever-increasing population had necessitated an abusive exploitation of the land, and that the land was nearing exhaustion. The continual exhausting of undermanured, overworked, and under-rested arable land seems to have been an *inherent feature of the agrarian system of medieval Europe*" (Duby, 1972: 198, emphasis added).

⁹ We would also include polderization in the Low Countries, reclaiming land from the sea, and various efforts to drain marshland, in Italy and elsewhere (Vries & Woude, 1997; Bloch, 1966; Braudel, 1972).

of arable, forest clearance proved increasingly self-limiting. New pasture could be reclaimed from the forest, but under feudal conditions of steady population growth, pasture tended to be quickly converted to arable land, and thence to more forest clearance (Ponting, 1991: 121–22; Bloch, 1966: 7–8). The resulting deforestation compounded rather than attenuated feudalism's tendency towards soil exhaustion. Altering local hydrologies through forest clearance, this mode of internal expansion increased the frequency and severity of flooding—and consequently increasingly serious episodes of soil erosion, above and beyond deepening soil exhaustion (Hoffmann, 1996; Lopez, 1967: 397). These problems were likely intensified with the arrival of colder and wetter weather in the fourteenth century.

These inner frontiers were complemented by outward territorial expansion. While the Crusades served to integrate northern and southern Europe, and to draw this “competitive alliance” into the broader network of Eurasian commerce (Abu-Lughod, 1989: 46–47), settler colonialism was far more important to feudalism's survival. Because the feudal system generally restrained productivity, after a certain point economic growth hinged on geographical expansion. Although the balance of class forces might favor peasants or landlords at different times and places, the general rule was that seigneurial revenues increased as long as the population continued to grow. This meant that settlement tended to expand, all other things being equal. And this was precisely the case between the eleventh and mid-thirteenth centuries, an era of “classical frontier development” (Lewis, 1958: 475). Successive waves of colonial settlers occupied eastern Europe, large sections of reconquered Iberia, and Wales, Scotland, and Ireland.

A third solution was urbanization. The countryside's surplus population could be absorbed by the cities, even out of all proportion to urban growth, given the latter's notoriously high death rates.¹⁰ The cities grew as long as rising revenues—made possible by modestly rising agrarian productivity and geographical expansion—fueled demand for urban manufactures. At the same time,

¹⁰ “[T]he cities had a lower marriage rate and birth rate than the country villages. Since all together produced at best only a very gradual increase, it is obvious that the cities did not replace their population and thus were dependent on the countryside” (Russell, 1972: 64).

the growth of the nonagricultural workforce increased demand for agricultural produce. This brought further pressure to bear upon the land, and greater pressure for territorial expansion.

By 1300, these solutions were no longer working. “Two centuries of uncontrolled expansion had been purchased on credit using as collateral Europe’s natural resources, which were being rapidly depleted” (Bowlus, 1980: 94; also Lewis, 1958: 480). Agricultural innovation (such as it was) and geographical expansion were unable to keep pace with population growth and the rising demands of the states and seigneurs. The central problem was the very soil exhaustion engendered by feudalism’s class contradictions, which at once encouraged population growth and discouraged the agricultural investment necessary to sustain the demographic expansion. By the early fourteenth century, feudal agriculture had significantly degraded the land within western and central Europe’s fertile core areas. In England, yields per acre may have declined by as much as one-third between the thirteenth and fifteenth centuries (Dobb, 1963: 44, n. 1). As we have seen, in this settlement core, new land was reclaimed from the forests, whose soils were quickly exhausted.¹¹ And on the frontiers, especially but not only in eastern Europe,¹² colonization brought more and more people onto less and less productive land at the geographical margins of the system. In both areas, yields—and revenues with them—stagnated or declined (Bowlus, 1980: 96; Ponting, 1991: 123).

Because virtually all of medieval Europe’s surplus product flowed from the countryside, declining seigneurial revenues were a serious problem indeed. The agrarian recession that spread throughout early fourteenth-century Europe, then, threatened not only the landlords, but also the states who faced contracting tax revenues, and the city-state capitalists who faced contracting markets. But agrarian recession is one thing. Crisis, another.

What turned this contraction from recession to crisis had everything to do with environmental history. In the first instance,

¹¹ “By about 1200 most of the best soils of western Europe had been cleared of forest and new settlements were increasingly forced into the more marginal areas of heavy clays or thin sandy soils on the higher ground and the heathlands” (Ponting, 1991: 122).

¹² Medieval settler expansion was particularly vigorous along the southeastern Baltic, whose sandy soils were especially prone to exhaustion (Anderson, 1974a: 247).

the weather got colder.¹³ The margin of survival for the European peasant had always been razor thin, and overpopulation and overexploitation in the heartland and overextension at the margins rendered fourteenth century agriculture highly “dependent upon favorable weather” (Utterstrom, 1955: 5). Crop failures became more common, and with them general famines, which had been quite rare in the twelfth and thirteenth centuries (Bowls, 1980: 95–96; Hughes, 1996: 66). Above all, the great famine of 1315–17 cut a swathe through rural and urban populations from France to Russia. Far from an isolated occurrence, this was simply the worst of a series of devastating famines throughout the fourteenth and fifteenth centuries (Braudel, 1981: 74; North & Thomas, 1973: 72–73). So severe was the agrarian crisis that by 1300 “almost every child born in Western Europe faced the probability of extreme hunger at least **once** or twice during his 30 to 35 years of life” (Miskimmin, 1975: 26–27; also Braudel, 1981: 73; Montanari, 1994: 68–70).

The conjuncture of unfavorable weather and agrarian recession produced more than increasingly severe and widespread famine. Through famine, it undermined the population’s capacity to resist disease. Thus feudalism’s ecological contradictions gave rise not only to soil degradation but equally to a dietary regime that virtually guaranteed epidemic disease (Montanari, 1994: 70–71; Slicher van Bath, 1964: 84, 88–90; Dobb, 1963: 48–49; Braudel, 1981: 78).¹⁴ It is almost certainly no coincidence that those regional populations—such as the Low Countries—marked by the greatest agricultural productivity, and the greatest freedom from seigneurial oppression, were among those most resistant to the new disease vectors (Vries, 1973; Slicher van Bath, 1963; DuPlessis, 1997: 25–27).

¹³ “By 1500 European summers were about seven degrees Celsius cooler than they had been during the Medieval Warm Period [ca. 800–1300]” (Fagan, 1999: 194).

¹⁴ The repeated incidents of nutritional stress suffered by the European population in the first half of the fourteenth century engendered a state of widespread malnutrition and physiological weakness which prepared the way for the plague epidemic. . . . Clearly there is not a *direct* causal link between the two phenomena: each has its own life and history. . . . It is equally clear, however that the standard of living of a population . . . plays an important role in favouring or blocking individual defences to infection (Montanari, 1994: 70–71).

To make matters worse, the great trade expansion of the eleventh and twelfth centuries knitted together not only Europe, but also much of Eurasia, more tightly than ever before. A new “disease pool”—to borrow a phrase from William McNeill (1976)—unprecedented in its geographical scope, had come into existence. Chinese peasants, central Asian pastoralists, and European artisans were increasingly breathing the same air, epidemiologically speaking.

Agrarian recession, bad weather, and a new disease pool proved a fertile conjuncture for the bacillus that carried the Plague from Southeast Asia to Europe in 1348. Within three years, one-third of Europe’s population, some 25 million people, perished. Other epidemics followed. The enormity of the loss boggles the mind.

Feudalism’s fate may already have been sealed prior to 1348. Less certain, however, was the nature of the social system that would succeed it. More than any other event, the Black Death at once signed feudalism’s death warrant and favored a capitalist rather than tributary solution to Europe’s crisis. This had a lot to do with feudalism’s class contradictions. On the one hand, feudal class structure rested upon rising population densities, whose agro-ecological contradictions were attenuated through geographical expansion. A relatively high labor-land ratio reinforced seigneurial power by tending to reduce labor costs, increase aggregate value appropriated in the form of feudal rent, and as a result, augment revenues. Conversely, a relatively low labor to high land ratio tended to reduce the value derived from the land, raise real wages, and depress feudal revenues (Duby, 1972: 213; Dobb, 1963: 49).¹⁵ By the mid-fifteenth century, rents in England, Germany, and Italy were 40% lower than a century earlier; wages for laborers were as much as 400% higher (DuPlessis, 1997: 21–22; Anderson, 1974a: 204; Hodggett, 1972: 208–09; Bloch, 1966: 116). By dramatically shifting labor-land ratios in favor of the direct producers, the

¹⁵ “[T]he smallholders and landless men profited perhaps more than any other group [from the consequences of the Black Death], for those with under 2.5 hectares . . . were in a position to acquire more and the landless benefited from the high wages and were often able to obtain some land” (Hodgett, 1972: 208–09).

Black Death at once empowered the peasantry and weakened the seigneurs.¹⁶

On the other hand, the very processes most reflective of feudalism's success—commercialization, urbanization, and state formation—also enhanced the peasantry's potential class power, even after (especially after) the states, the seigneurs, and the capitalists fell into crisis. As Perry Anderson observes, "the penetration of the countryside by commodity exchange had weakened customary relationships, and the advent of royal taxation now often overlaid traditional noble exactions in the villages; *both tended to centralize popular reactions to seigneurial extortion or repression, into major collective movements*" (1974a: 202, emphasis added). From the early fourteenth century, once-local peasant revolts began to appear on a regional, even national, scale (Hilton, 1973). The class power of the western European peasantry had developed to such an extent that the reestablishment of serfdom became exceedingly unlikely, particularly if less costly alternatives were available.

Before considering those less costly alternatives, however, we might turn our attention momentarily to the somewhat different situation in eastern Europe.

In eastern Europe, Poland above all, the crisis was delayed, and on first glance looks quite similar to the situation in western Europe. Wages for day-laborers increased, and peasants benefited from the declining value of money rents. This favorable situation for the direct producers would persist into the mid-sixteenth century (Malowist, 1959: 182–83). In contrast to the West, however, the peasantry was weaker, and feudal relations were maintained or reimposed in what has become known as the "second serfdom."

¹⁶ The troubles of [the fourteenth century] . . . forced the landlords to be less exacting towards their tenants and bondmen, even though they themselves were affected by the calamities and perhaps more in need of money than ever before. Their problem was to persuade the peasants to stay on their lands, to repopulate them when they were deserted, and to put them back in order. . . . Some landlords attempted to tighten the bonds of servitude and tie the workers [peasants] closer to the soil; they failed: it was too easy to abscond; and this emigration contributed towards the total disappearance of bondage in most of western Europe. . . . The only way to keep or attract tenants . . . was to give in to their demands and lighten their dues. Peasant families were much less numerous; they handed over an ever decreasing share of their working profits: hence the period saw a considerable fall in seigneurial income (Duby, 1972: 213).

This is an important part of the story, and one also that has quite a bit to do with feudalism's agro-ecological contradictions, as well as the transition to capitalism. Eastern European feudalism took shape out of the great demographic expansion of the eleventh and twelfth centuries, a movement driven by rising population densities and environmental pressure in west-central Europe. Relative to western Europe, three decisive features of stand out. First, peasant village solidarity was weaker in the East, reflecting the region's development as a "colonial society" (Brenner, 1985a: 42). Colonization in the East was led by landlords. As a result, village self-government was limited. This seems to have been the political expression of the underlying agricultural geography. In contrast to the West, common lands were typically absent. Settler colonization produced consolidated rather than fragmented holdings, which reinforced tendencies towards "individualistic farming" (Brenner, 1985a: 42). Secondly, the towns were weaker in the East, and they suffered more from the agrarian recession.¹⁷ Although towns may not have uniformly supported peasant revolts, there does seem to be a strong correlation between urbanization and the possibilities for effective peasant resistance to serfdom. In both the East and West, peasant revolts clustered around the towns—the main difference being that there were many more powerful, relatively autonomous towns in the West (Anderson, 1974a: 253; Brenner, 1985b)! And thirdly, the weakness of the East's towns meant that there was a minimal woolens industry, which had come to the rescue of "hard-pressed lords in England and Castile" (Anderson, 1974a: 252). Consequently, Eastern landlords could not shift so easily from arable to pasturage as a means of responding to rising labor costs and a (temporarily) stagnating cereals market. The first two contrasts minimized the possibilities for effective resistance by the peasantry; the third contrast maximized the likelihood that the seigneurs would opt for a reimposition of serfdom.

If the seigneurs ultimately succeeded in reimposing serfdom in the east, they failed in the west. But not for lack of trying. Throughout western Europe, the nobility's "immediate reaction

¹⁷ Not only were eastern Europe's towns weaker, but their control over their respective hinterlands was considerably more restricted than their northwestern and southern European counterparts (Anderson, 1974a: 252).

was to try to recuperate its surplus by riveting the peasantry to the manor or battering down wages in both towns and countryside” (Anderson, 1974a: 201). The seigneurs, in concert with the states, waged an all-out campaign to intensify feudal control of the peasantry—issuing repressive legislation in England in 1349–51, France and Castile in 1351, Germany in 1352, Portugal in 1375. Only now, as never before, these measures provoked explosive peasant revolts on a much larger scale (Hilton, 1973; Anderson, 1974a: 201–02). Indeed, by turning to the state, the very measures the seigneurs hoped would increase feudal exactions tended to unify discontent, “because the target of the discontent was no longer the individual lord alone, but also the local officials of the government” (Hilton, 1949: 132; also Duby, 1972: 214).

If the producing classes were rarely successful in political terms—only in Switzerland did the peasantry bring the seigneurs to their knees—they made it crystal clear that a feudal solution to western Europe’s agrarian crisis was impossible. This clarity was reinforced by developments in the cities—those autonomous urban enclaves that were perhaps feudalism’s crowning achievement. In western Europe’s most heavily urbanized areas, Flanders and Italy, artisans and even wage-workers staged revolts that toppled the urban patriciate—most notably in Ghent (1309) and Florence (1378). The strength of the cities had three major effects on the peasantry’s class power. First, the urban semiproletariat lent support to peasant revolts, as occurred in London during the 1381 uprising or in Paris during the 1358 Grand Jacquerie (Anderson, 1974a: 202–04). Secondly, the cities provided a means of escape from feudal bonds themselves. And finally, the commercialization of the countryside, in addition to its role in centralizing resistance as we noted above, also profoundly threatened subsistence-oriented peasant society. It appears that in the fourteenth century no less than in the twentieth, those areas most prone to revolt were neither fully commercialized (prior to capitalism no area could be) nor entirely subsistence-oriented, but rather those areas that lay somewhere in between.

OVERSEAS EXPANSION: A SPATIAL FIX TO THE CRISIS OF FEUDALISM

All of which meant that an “internal fix” to feudalism’s problems was infinitely more costly than an “external fix,” provided one could be found. In terms of the class struggle, then, trans-Atlantic expansion was the path of least resistance, given the reality of overlapping crises. Previously at odds, the feudal crisis pushed together the interests of the states, the seigneurs, and the city-state capitalists in favor of overseas expansion. “The only solution,” argues Wallerstein, “that would extract western Europe from decimation and stagnation would be one that would expand the economic pie to be shared, a solution which required, given the technology of the time, an expansion of the land area and population base to exploit” (1974: 24). It is this process of geographical expansion—made possible by the converging interests between the states, the seigneurs, and the city-state capitalists—that made possible the transition to capitalism. The outline of this convergence in favor of geographical expansion runs as follows.

First, the states, which had made great strides between the eleventh and fourteenth centuries—owing to increased revenues from internal expansion and the politico-military unification which resulted from the Crusades—now suffered greatly from the economic contraction, which began even before the Black Death (Strayer, 1970; Wallerstein, 1992). Beginning in the fourteenth century, the states faced a deepening “liquidity crisis” (Wallerstein, 1974: 21), as they struggled to exact higher taxes from the peasants in the interests of waging war. The big states tried to conquer smaller states, but given the widespread diffusion of advanced military technology and techniques, alongside the equally widespread access to the money capital needed to wage war,¹⁸ the possibilities for conquest were continually frustrated from the mid-fourteenth century on. England could not conquer France; France could not conquer Italy; Castile could conquer neither Portugal nor England (indeed, it could barely hold together its own rickety “nation” within Iberia); and perhaps most significantly, the Austro-

¹⁸ Indeed, capital was *more* widely available for warfare because profitable investment opportunities had dried up as a result of the agrarian and demographic crises (see Arrighi, 1994).

Iberian Hapsburgs could not conquer Europe. Moreover, the rising costs of war meant increased borrowing, which strengthened urban capital against the states, and at the same time sapped the latter's strength relative to the seigneurs, whose support they also needed to wage war.

Secondly, the seigneurs faced a deepening crisis in the wake of the Black Death. As we have seen, the downward readjustment of labor-land ratios effected several crucial changes in the balance of class forces, particularly in western Europe. Internal efforts to restore seigneurial revenues were ultimately self-defeating. Political measures to reimpose serfdom sparked peasant revolts. Efforts to convert arable land to pasturage allowed some landlords to shift from labor-intensive cereals production—whose profitability declined precipitously in the wake of the Black Death—to the more profitable, land-extensive stock raising.¹⁹ Sheep (and cattle) not only required fewer hands relative to agriculture, it yoked the seigneurs to the world market, who were as a consequence inclined to support measures that favored the further expansion of that market.

The resulting widespread displacement of cereal agriculture by animal husbandry not only entailed a more specialized world-scale division of labor (Helleiner, 1967: 68–69). As we shall see, it also biased the European world-economy in favor of further expansion because of the geographically expansive character of the European livestock economy. (It is no coincidence that Europe's greatest overseas empires were forged by those very states—England and Castile—most involved in sheep farming.) Moreover, the shift from arable to pasturage militated against a rapid population recovery by reducing grain acreages, and therefore limited the very demographic expansion that might have shifted the balance of class power back in favor of the seigneurs. Finally, the livestock economy was not only expansive but *expansionist*, by virtue of its strong tendency towards land degradation and consequent demand for new land (Clough, 1959: 146; Klein, 1919). Thus, the seigneurs were triply motivated to expand geographically, by virtue of the peasantry's continued class power, diminishing returns

¹⁹ For instance, the ranks of Castile's wool-producing sheep grew from 1.5 million to 2.7 million between 1350 and 1450 (Mielants, 2000: 266, n. 81).

on cereal production, and the ecological contradictions of ranching.

At the same time, the peasantry's newfound power led the seigneurs to turn their attention to the states,²⁰ who were forced to recognize the former's voice in policy making.²¹ The seigneurs' political turn meant they could expand their revenues only so far as "their" states prospered. But the very nature of feudal crisis limited such prosperity to the extent that intra-European warfare was privileged over geographical expansion. Thus an uneasy compromise prevailed between the states and seigneurs in favor of statism and overseas expansion.

Finally, the city-states were equally beset by contradictions that favored geographical expansion. Economically, urban capitalists were doubly squeezed. On the demand side they faced the contraction of the domestic European market owing to declining seigneurial revenues. On the supply side, they suffered from the contraction of Eurasia's great commercial networks. The port of Genoa's tax receipts, to cite but one example, dropped nearly 50% between 1293 and 1334 (Lopez, 1967: 399).

Socially, the city-states faced increasingly serious threats to internal order from the producing classes (Wallerstein, 1974: 52). In Florence, where one out of three people depended on the city's woolen industry, the economic crisis curtailed the latter's output by more than two-thirds in the four decades after 1338. The social unrest that followed "culminated in the so-called revolt of the *Ciompi* [1378] ... when impoverished clothworkers seized state power and put a woolcomber ... at the head of the republic's gov-

²⁰ Hilton sees a direct link between the economic crisis and rising seigneurial interest in the state:

[D]emesne profits ... [were] disappearing very rapidly, especially after the 1370s. No wonder that in the second half of the fourteenth century we see not only the economic aspect of the crisis but its political consequences. These, taking the form of intensified factional struggles among the landed aristocracy, largely over the control of the state and its fund of patronage, connected with declining landed income (Hilton, 1985: 132-33).

²¹ The opportunities of the seigneurs within western Europe were at once limited and augmented by the formation of powerful territorial states. State fiscal policies of debasement and increasingly effective taxation systems undermined feudal arrangements in the countryside by devaluing fixed rents and extracting surplus from the peasantry. But by creating various assemblies and selling state offices, new opportunities were opened for the seigneurs to advance their interests through the state.

ernment" (Arrighi, 1994: 101; also Miskimmin, 1975: 98–99). Florence's crisis was overdetermined by a deepening agro-ecological crisis in the 1330's, which among other things saw the price of wheat jump by 300–500%; no small matter for a city that relied on grain imports for seven months of the year (Hughes, 1996: 66–67).

The generalized contradictions of the city-states generated specific antagonisms that favored overseas expansion. By the later fourteenth century, Venice proved militarily strong enough to pursue an internal fix to this contraction, driving Genoese capital from the eastern Mediterranean and monopolizing what remained of profitable trade opportunities with the East (Arrighi, 1994: 114–15).²² By the middle of the next century, however, Genoa was able to turn an apparent position of weakness into a position of strength. As Genoese capitalists turned west, looking to replace the investment outlets they had lost in the economic contraction and conflict with Venice, they became the bankers to the Portuguese and Castilian crowns. In so doing, they hitched their collective wagon to the very powers that would expand the geographical arena necessary not only for renewed commercial expansion, but also for the emergence of a world-system predicated on the endless accumulation of capital. What Genoa had lost in the East could be won back (and then some) in the newly "discovered" West of the emergent Atlantic economy.

ENVIRONMENTAL DETERMINANTS OF EUROPEAN EXPANSION

If there were strong social forces pushing medieval Europe towards an external rather than internal fix to feudal crisis, there were also powerful geographical factors favoring such an outcome. But rather than succumb to environmental determinism,

²² Genoese capital was also deprived of investment opportunities in its *contado*, relative to its rivals, Venice above all. In an era when Italy's urban capitalists aggressively colonized the surrounding countryside (Braudel, 1972), Genoese capital encountered a powerful rural aristocracy, who posed "an insurmountable social barrier to the domestic expansion of [the urban merchant classes'] wealth and power" (Arrighi, 1994: 111). In sum, the intersection of Genoa's town-country division of labor and class structure further biased Genoese capital towards global expansion.

which has experienced something of a renaissance in recent years (Diamond, 1997; Fagan, 1999; Landes, 1998; Jones, 1987), we should remember that geographies are as much made as they are given.

The first of these factors was Europe's political geography. In contrast to China, Europe contained not one but many states. As the fourteenth-century crisis deepened, these states went to war, seeking to recoup through battle what they had lost in the agrarian recession.²³ As competition between the states intensified, so did the search for sources of power that would give one state a competitive edge. This was true no less for city-state capitalists than for states—it was the great Venetian-Genoese rivalry that pushed the latter into an alliance with the Iberian states and encouraged the search for an alternative route to the Indies. In a social system where revolutionary increases in productivity were not (yet) feasible, this search for power necessarily entailed geographical expansion—at first to the Atlantic islands, subsequently to the Indian Ocean and the New World. Not only *did* this political geography provide incentive for expansion, it removed a significant barrier to it. China's great overseas voyages began in the early 1400's but were called to a halt by the Empire by the 1430's. But Europe was a region of multiple states, and no central authority could restrain the expansionary impulses of, first and foremost, the Iberian powers.

While much of this is widely recognized, less obvious is the relationship between this unusual political geography and Europe's physical geography. Europe's geographical position was in sharp contrast to that of China, whose civilization took shape around the two major river valleys (the Yellow and Yangzi) and was consequently vulnerable to recurrent waves of Central Asian invaders. In western Europe there were multiple fertile "core" areas separated from each other by mountains or other natural barriers (Pounds & Ball, 1964)—Portugal from Spain; Spain from France; England from everyone; Italy from Germany; Sweden from Norway (both protected by sea); the northern Netherlands

²³ "In an age when the economy was stagnant, if not regressive, the easiest way for a ruler to increase his income and power was to try to gain control of new territories, even if those territories lay within the boundaries of an already established state" (Strayer, 1970: 59–60).

by riverine marshes; and so forth. (Eastern Europe is another story, and this partly explains, among other things, Poland's sorry history.) The effect of this physical geography was to raise the costs of continental empire-building, and in corresponding degree, to reduce the costs of overseas empire-building. So the matter of Europe's physical geography in providing a certain bias to geographical expansion should not be discounted.

I don't think we should make too much of this, as does Eric Jones (1987) and other environmental determinists. At the same time, I don't think we should make too little of this, as does the great critic of Eurocentric historiography, James Blaut. While the environment determined nothing—the outcome of Europe's fourteenth century crisis was not discernible until well into the sixteenth century—neither was Europe part of a Eurasian-wide “landscape of even development,” as Blaut would have it (1992: 22). Environment matters, but where many look for deterministic answers, we would do better to look for how classes make history (and geography), but not in eco-geographical situations of their own choosing. We are dealing here with environmental determinations, not determinisms.

A second major bias to overseas expansion is found in Europe's agronomy. Medieval Europe was a society of wheat,²⁴ medieval China, a society based on wet-rice farming. Partly as a consequence, China's agronomy leant itself much more easily to internal fixes. (I think this is the very small but important kernel of truth in the otherwise problematic theory of hydraulic societies [Wittfogel, 1957].²⁵) Wet rice yields were vastly higher, typically

²⁴ “[A]s soon as one looks at the question of grain, one realizes what a complicated phenomenon it is. It would be better to put it in the plural—*los panes*, as so many Spanish texts say. . . . [W]heat was never grown by itself. Despite its great age, even older cereals grew alongside it” (Braudel, 1981: 109). Rye, a poor man's crop, was especially important. On balance, there are not sharp ecological differences between the various cereal grains. Yield ratios between European grains did not strongly vary (Braudel, 1981: 121–22). At the same time, relative to rye, wheat tended to be more vulnerable to climatic shifts, for instance to the cooler, wetter weather that arrived in the early fourteenth century, and it tended to demand more fertilizer (Fagan, 1998; Bloch, 1966: 25).

²⁵ Chaudhuri compares wheat- and rice-growing zones in medieval and early modern Asia:

Wheat land, the making of bread, and the caravan trade were connected together by an invisible net, woven by climatic, social, economic, and even political relationships. Centralised governments in the wheat- and millet-growing

five times greater than European cereals (Braudel, 1981: 151). Moreover, the revolution in wet rice farming, based on early maturing rice varieties and allowing multiple cropping (Braudel, 1981: 154–55; Ho, 1956), seems to have occurred right around the same time as the introduction of the three-field rotation, iron mouldboard, and horse-drawn ploughs in Europe. Given the relatively smaller and more tightly-knit wet rice zone in the south, agricultural innovations likely diffused much faster in China (Elvin, 1973, ch. 9). Wet rice farming does not face wheat's problems of soil exhaustion. As long as river ecologies are regulated adequately and not unduly disrupted, the nutrients are replenished. Climate permitting, multiple cropping is possible on the same land for centuries on end. There also seems to have been a much more sustainable metabolic relation between town and country in China, whereby urban wastes were returned to the soil (Braudel, 1981: 155, 486). During periods of crisis, the state could focus on maintaining or restoring the hydraulic infrastructure—above all, the canal system linking the two great river valleys—as an internal fix. In Europe, no such internal fix was possible, given the necessarily fragmented character of its wheat-livestock agronomic complex. Given this agronomic variation, it comes as little surprise that China recovered from the Black Death much faster than Europe.

Rice's great advantage was its tremendous productivity on minimal land. Its great disadvantage was its high labor requirements.²⁶ Wheat's advantage, such as it was, ran in the opposite

areas faced a perpetual struggle to bring the lesser chiefs of the independent-minded agricultural communities under a single authority. In the rice-growing lands, the control or destruction of the water channels, the dykes, or even the nursery beds of young seedling rice placed the terrible weapon of mass starvation in the hands of the war lords. The collective effort needed to plant and harvest rice and its favourable land:yield ratio forced centralized Asian government to consider the welfare of cultivating villages much more than was the case with the extensive farming techniques associated with wheat and millet (1985: 29).

²⁶ Palat takes this line of reasoning even further. In a sort of agronomic variation of the Brenner thesis, wet rice not only demanded more labor than rain-fed grain, its labor process impeded capitalist development:

[F]undamental differences in agricultural techniques [were] dictated by the dominant crops and the specific conditions of production in [China and Europe]. . . . Whereas the substitution of labor-power by animal and mechanical

direction—it was highly consumptive of land but not labor. “Wheat’s unpardonable fault was its low yield,” observes Braudel (1981: 120). It “devours the soil and forces it to rest regularly” (Braudel, 1977: 11).²⁷

These distinct agronomic complexes implied different kinds of livestock economies, with different kinds of spatial logics. While China’s wet-rice cultivation maintained high yields without animals, used primarily for draught purposes (Grigg, 1974: 75–83), wheat’s ecology required livestock to maintain its fertility. While in principle livestock replenished fertility and therefore encouraged sustainability, the fourteenth-century crisis turned this logic inside-out. As we have seen, western Europe’s landlords responded to the agrarian crisis by enclosing common lands and shifting from arable to animal husbandry, especially sheep-raising. At the same time, the renewal of economic expansion in the mid-fifteenth century relied heavily on horses for haulage and transport. More “horses meant a greater demand for fodder . . . [and land] used to grow fodder is obviously no longer available for crops to feed men; therefore, if the cultivated areas remains the same, an increase in the number of horses reduces the quantity of cereals for human consumption” (Slicher van Bath, 1963: 195). At the

power represented technological progress in societies with low densities of population [as was the case in Europe], the technical conditions of wet-rice cultivation dictated the substitution of simple tools for more complex instruments. This implies that, rather than moving toward large-scale consolidated farming operations, the dynamics of change in societies based on irrigated rizicultures increasingly privileged small-scale operations. Or, as Thomas Smith [1980: 105] puts it so well, “To speak metaphorically, rather than impelling farming forward to a manufacturing stage of production, [operations associated with wet-rice agriculture] served to strengthen its handicraft character.”

Once emphasis was placed on the skill of the cultivators rather than on increasingly complex instruments of production, as was the case in early modern Europe, there was a tendential decline in the intervention of landlords in the production process. This implied that though producers may remain formally subordinate, no attempt was made by landowners to revolutionize and transform constantly the labor process. These conditions imposed severe impediments to a ceaseless accumulation of capital since landlords were unable to realize an increase in relative surplus value by constantly reducing production costs. At the same time, the increasing premium placed on skilled labor even constrained their ability to realize an increase in absolute surplus value. There was hence no tendency toward an increasing real subsumption of labor to capital (Palat, 1995: 56–57, 70).

²⁷ “Wheat cannot be cultivated on the same land for two years running without serious harmful effects. It has to be rotated” (Braudel, 1981: 114).

onset of the “long” sixteenth century, then, Europe’s livestock economy reinforced wheat’s spatially expansionary ecology.

This expansionary logic was reinforced further by a marked shift in the social division of labor. If cereal agriculture and livestock evolved in close quarters during the long medieval expansion, what develops over the course of the feudal crisis is a wheat-livestock complex in which cereal agriculture and stock raising become geographically specialized. These were economically interdependent but not ecologically articulated. There was a widening and increasingly “irreparable rift” in the metabolism of nature and society (Marx, 1981: 949). As animal husbandry was ecologically hived off from arable, local nutrient cycling was significantly disrupted. Cereal and sugar monocultures would take root in Poland and Brazil while sheep farming would predominate in Castile, England, and Mexico. By the sixteenth and seventeenth centuries, there was widespread soil erosion, soil exhaustion, and deforestation in all these regions (Wallerstein, 1980: 132–33; Klein, 1919; Melville, 1990; Moore, 2000b; Westoby, 1989). Thus did new divisions of labor within the countryside undermine the conditions for ecological sustainability, even as population pressure on the land was greatly reduced.

The landlords’ widespread shift from arable to pasturage reduced the land available for grain cultivation in western Europe. The Black Death reduced labor-land ratios, and thereby allowed more land per capita, which should have allowed for a fairly rapid demographic recovery. “[A]lthough fewer men should have meant more food since the landmass remained the same,” the shift to pasturage led to “a reduction of caloric output” (Wallerstein, 1974: 35–36). Fifteenth-century Europe was partially “decerealized,” as stock raising occupied a landmass five to six times greater than did cereal agriculture for the same caloric output (Helleiner, 1967: 69). Western European wool production may have increased between three- and five-fold in the fourteenth and fifteenth centuries (Anderson, 1974a: 208). By the sixteenth century, then, pasturage not only became “regionally specialized”; this regional specialization was linked to deepening land degradation on the one

hand, and deteriorating peasant diets on the other (Wallerstein, 1974: 109, 44).²⁸

In sum, wheat's low yields and soil-exhausting properties conditioned Europe's reliance on cattle, sheep, and horses—who "ate" men nearly as often as men ate them.²⁹ The upshot: Europe's agromomic complex encouraged extensive development (Wallerstein, 1974: 56–63). It was this bias that "condemn[ed] the great Mediterranean area to the conquest of the Earth" (Chaunu, 1969: 338–39 quoted in Wallerstein, 1974: 57). Between 1535 and 1680, the European world-economy more than doubled in size, expanding from three to seven million square kilometers (Wallerstein, 1974: 68). The labor-land ratio declined even more sharply, falling some 80% between 1500 and 1650 (Webb, 1964: 17–18).

A final decisive geographical bias concerns what we might call "locational" advantage. It is certainly not the case that European seafaring technology was superior (Chaudhuri, 1985: 138–59; Abu-Lughod, 1989: 326–27, 353–54). Europe's crucial seafaring advantage was locational. In the first place, Europe was closer to the New World than any other maritime civilization. Once Portugal and Spain had colonized the Atlantic islands, whose sugar plantations worked by African slaves prefigured later developments, the Americas were even closer. But that would not have mattered much if the Atlantic Ocean's currents carried European vessels in the wrong direction. Fortunately for Columbus and those who followed, these ocean currents would not only carry European vessels to the Caribbean, Brazil, and North America, but carry them back home as well. From the experience of sailing to the Atlantic islands, and fishing voyages probably as distant as Newfoundland, Columbus and others

knew that the trade winds (or easterlies) would assist him outbound and had good reason to believe that the westerlies

²⁸ "The most important thing to note about pasturage in the 16th century, especially livestock, was that it was becoming increasingly a regionally specialized activity. *More cattle here, an advantage to large landowners, also meant less cattle elsewhere, which often meant a reduction in peasant consumption of meat and dairy products, a deterioration in the diet*" (Wallerstein, 1974: 109, emphasis added).

²⁹ Europe's wheat-livestock complex—especially stock raising—proved especially well-suited for the conquest of the New World (Crosby, 1972: 98–99; Parry, 1963: 244–47; Wolf, 1959: 197–99; Melville, 1990).

would assist the return voyage. The point here is a matter of strong probabilities. Overall, it is vastly more probable that an Iberian ship would effect a . . . round trip to America than would an African or Asian ship in the late 15th century (Blaut, 1993: 181–82; see also the maps in Landes, 1998: 80–85).

Making matters even more favorable, Europe's only possible seafaring rival was West Africa. But West Africa's political and economic geography was unfavorable to overseas expansion. Like China, West Africa was a zone of wet rice cultivation (Carney, 2001). Its leading urban centers were oriented to land, not sea. Where Africa's coastal trade was an extension of inland trade, Europe's inland trade was an extension of seaborne trade. West and Central Africa's great empires were located inland, and the primary trade routes lay northward to the Maghreb and Mediterranean and eastward to the Nile and the Middle East. The Maghreb's great trading cities possessed a strong maritime tradition, but faced serious military threats from the Ottomans and Iberians (Blaut, 1993: 183; 1993: 373, n. 16; Thornton, 1992: 13–21).

FIXING EUROPE'S ECONOMIC CRISIS: GEOGRAPHICAL EXPANSION AND THE "DISCOVERY" OF SILVER AND SUGAR

Let us review. The fourteenth-century crisis strengthened the western European peasantry and weakened the states, the seigneurs, and the city-state capitalists. Feudal relations were severely weakened in western Europe, and try as they might, the ruling classes could not reimpose the status quo ante. Geographical expansion was therefore a more attractive option than fighting the class war at home; or even waging war against one's territorial rivals. But geographical expansion was also an attractive option because of Europe's physico-political geography, its wheat-live-stock agronomy and division of labor, and its comparatively advantageous location, close to the Americas and the ocean currents that would carry vessels to and fro.

But the question remains. How did geographical expansion resolve the crisis of feudalism in a way favorable to the development of capitalism?

Geographical expansion resolved the feudal crisis—whose most dramatic expression was a precipitous drop in seigneurial revenues—by expanding the economic surplus, without a direct *and above all costly* confrontation with the peasantry, or otherwise requiring the ruling strata to share the bigger pie with its class enemies. As we have seen, one seigneurial response was to convert arable land to pasturage, but this met with some measure of success only in a few regions, such as Castile and England. The best way to expand the economic pie without sharing it was through geographical expansion. This expanded pie came in two flavors, silver and sugar. Silver's greatest significance lay in helping to consolidate a new trans-Atlantic division of labor between town and country, as well as the emergent "global rift" (Stavrianos, 1981) between core and peripheral regions. The sugar plantation played a much more direct role in forging a new globalizing relation between capital, land, and labor—above all because it was the agent of modern slavery and monoculture, the twin processes that would shape New World history perhaps more than any other.

New World silver of course had a lot of economic effects whose significance is still widely debated. Still, it is difficult to argue that the flow of silver from the New World—more than tripling European reserves between 1500 and 1650 (Galeano, 1973: 33)—did not shape the era of transition in important ways. Besides its profoundly destructive environmental impacts at the point of production (about which more presently), American bullion had two major effects on the socio-spatial division of labor of lasting importance, precisely because the "long" sixteenth century was an era of transition in which the final outcome—capitalism? feudalism? an agrarian world-empire?—was still in question.

In the first place, American silver monetized the European world-economy sufficiently that the new peripheries in eastern Europe and the New World could not easily withdraw into regional autarchy. In Poland, "the influx of precious metal ... caused the price of agricultural products to soar," relative to the rest of central and eastern Europe (de Maddalena, 1974: 308; also Anderson, 1974b: 285). While this might have benefited Eastern landlords, Western (especially German and Dutch) access to bullion flows and mastery of credit mechanisms helped create an uneven division of labor. The crowning achievement of this Western strategy of uneven development was an "system of interna-

tional debt peonage” (Wallerstein, 1974: 121–22) that not only subordinated Polish landlords to the world market, but gave these landlords some incentive to stay in the game. Any significant demonetization of the world-economy would likely have removed that incentive. (We can say the same about American planters.) It is important to remember that sixteenth-century inequalities between western and eastern Europe were at this point still quite small. If delinking was increasingly unlikely, it was not inconceivable. One needed only to look farther east if there was any doubt that silver’s gravitational pull had its limits, for Russia remained outside this emergent capitalist world-economy until Peter the Great.

When viewed from the perspective of the emergent “core,” the West’s strategy of uneven development enabled by American bullion was if anything more significant. It may be objected that the international grain trade—leaving aside the pressing question of what precisely was “international” and what was “local” in this tumultuous era—was not so important because it fed only 1–2% of Europe’s population in the sixteenth century (Glamann, 1974; Braudel, 1981). Is that a lot?³⁰ Consider that only one out of ten Europeans, at most, lived in cities. (And this includes mostly cities of only regional importance.) Which cities were the major grain importers? Antwerp, Amsterdam, Lisbon, Genoa, and so forth. So what we have is the Baltic grain trade providing a significant share of the nutritional needs of urbanites in those very places where capital was being rapidly accumulated. Baltic grain gave capitalists a hedge against local famine, which, along with ensuing food riots in these major cities, could very well have brought to an end the original accumulation of capital. American bullion at once served to lock the peripheral monocultural regimes—in eastern Europe (wheat), the Atlantic islands (sugar), the Americas (silver, sugar)—into the new division of labor, *and* ensured the stability of the major urban centers through which virtually all of the world-economy’s money capital flowed. (Then as now.) From this vantage point, we can see the creation of a new and deeply antagonis-

³⁰ “If there is any factor to be singled out as the fundamental limiting factor upon the pace of development, then I suggest it is this *marketable surplus* of agriculture: this rather than the total product, or the productivity, of agriculture in general” (Dobb, 1951: 45).

tic relation between the city and the country—and also mutually reinforcing divisions *within* the countryside. Poland, for example, was locked into a low-value-added agricultural sector (grain) which allowed the Dutch to concentrate on high-value-added agriculture such as garden crops and dairy.³¹ (Not to mention the Low Countries' concentration of high-value-added urban activities such as transport, shipbuilding, and finance.)

If American silver was a means of consolidating emergent global inequalities, the sugar plantation was perhaps the chief means of pioneering them outside Europe. Around sugar, first in the Atlantic islands and later in Brazil and the Caribbean, would develop a “plantation complex” (Curtin, 1990), whose great innovation was to combine a new means of organizing labor (modern slavery) with a new means of organizing the land (monoculture). Far from accidental, the modern plantation's combination of a brutal labor regime with an ecologically destructive agricultural regime reflected the logic of the new capitalist system. Slavery and monoculture were not somehow incidental to each other. Quite the contrary, they were two sides of the same (world-historical) coin.

These two innovations had two things in common. First, slavery and monoculture reflected capital's tendency to radically simplify land and labor. Although slaves performed skilled labor, by and large the slave system functioned best when slaves were assigned to relatively simple tasks. In the case of the plantation system, the labor process could be simplified largely to the extent that the land was simplified. Diversified agriculture tended to require more complex tasks and therefore posed a greater labor control problem relative to monoculture. Secondly, slavery and monoculture embodied an alienated relation between the direct producers and the land. While not fully proletarian, modern slavery, like the modern working class, presupposed the domination of the land by capital and its intermediaries. Capital's increasing

³¹ If the amount of grain exported from eastern Europe in the mid-sixteenth century “was small in proportion to total consumption, . . . it relieved pressure at vital points, notably where the Low Countries industry and Andalusian [Spanish] viniculture were producing for European markets *on a scale that could only be maintained by importing food for their own people*” (Davis, 1973: 19, emphasis added; see also Tilly, 1975: 416; Hofmann, 2001).

domination of the earth—“severing . . . any direct connection between the mass of the population and the earth” (Foster, 2000: 170)—was the necessary precondition for capital’s exploitation of wage-labor in a system of (progressively) generalized commodity production. The production of monocultural regimes in fifteenth-century Madeira is the flip side of this process. The original settlers, who had grown wheat, were displaced by the sugar planters, who then purchased foodstuffs from abroad. This dual expropriation of the direct producers from the land—the laborer (the slave) and the displaced settlers—tended to reproduce such alienated relations by stimulating cash-crop production abroad. (Madeira, once sufficient in grain, switched to sugar and began importing wheat from the Azores—a pattern that would repeat itself, on a vastly larger scale, in the Americas.)

Marx helps us understand how this simplification of land and labor in the sugar plantation, which emerged by the later fifteenth century in the Atlantic islands, was related to the most basic aspects of capital accumulation. For Marx, the substance of capital is value, measured by abstract social labor; a particular commodity’s value is found in its objectification of socially necessary labor time. Capital is self-expanding value. It is value in motion.

While seemingly abstract from questions of environmental history, Marx’s value theory illuminates the underlying logic of capitalism’s historical tendency towards the radical simplification of land and labor. By distinguishing “the original sources of wealth,” such as land and labor, from capitalism’s definition of “value,” the labor theory of value reveals the contradiction between the accumulation of value as abstract social labor (its social form) and the accumulation of value as material process (its spatial form). Under capitalism, money becomes the general equivalent of value, which presupposes abstract labor, which in turn presupposes the separation of the direct producers from the land. (Hence, the domination of the land by capital and its intermediaries.) The function of money is to mediate the contradiction between value’s “social generality” and its “material particularity.” Money “solves” (albeit temporarily) this contradiction by “abstracting from the qualitative differentiation of useful labor as conditioned by the material diversity of human and extra-human nature—the true sources of wealth” (Burkett, 1999: 84).

But monetary capital accumulation not only abstracts from the material diversity of human and extra-human nature, it seeks to reduce that diversity to general and simplified forms. Here we can extend to environmental history Braverman's great insight, that capital seeks to dissolve concrete forms of labor into "general types of work motions" (1974). As a broad historical tendency, capital seeks to transform concrete human labor into general human labor.³² Plantation agriculture, to return to the story at hand, was possible only to the extent that the complex, concrete labors and knowledge systems involved in feudal and premodern agricultural systems were broken down into simple components, even within a complex technical division of labor, as sugar cultivation surely was. Planters could accomplish this labor process transformation, however, only to the extent that the agro-ecological landscapes themselves were transformed. Through the plantation, capitalism brings together slavery (simplified labor) and monoculture (simplified land) as a dialectical unity.

Such a unity was possible in large part because ongoing transformations of Europe's division of labor stimulated growing demand for sugar. Sugar, like wood, was one of early capitalism's few continuing "growth crops" (Wallerstein, 1980: 161), relatively unaffected by economic contractions. Far from merely responding to market demand, however, the plantation regime at once extended capitalism's geographical reach and through its contribution to trans-Atlantic commodity flows—including various incarnations of the so-called "triangular trade"—contributed mightily to the accumulation of capital. Indeed, along with silver, sugar was probably the "the largest single generator of value" in the early modern world-economy (Blaut, 1993: 198; also Blackburn, 1997: 173).

³² It is precisely [the capitalist's] effort and *metier* to visualize labor not as a total human endeavor, but to abstract from all its concrete qualities in order to comprehend it as universal and endlessly repeated motions. . . . Labor in the form of standardized motion patterns is labor used as an interchangeable part, and in this form comes ever closer to corresponding, in life, to the abstraction employed by Marx in analysis [sic] of the capitalist mode of production (Braverman, 1974: 181–82).

PRIMITIVE ACCUMULATION & WORLD ECOLOGY:
SILVER, SUGAR, AND THE ECOHISTORICAL
SPECIFICITY OF CAPITALISM'S UNSUSTAINABILITY

Silver and sugar not only rescued Europe's ruling classes from the crisis of feudalism. These commodity frontiers signaled a historical rupture with the feudal mode of environmental transformation.³³ Feudalism, it will be recalled, degraded the environment in significant ways. Although it was primarily a system of production for use, which would seem to favor sustainable development, the

³³ The idea of the commodity frontier derives from the world-systems concept of the commodity chain, which "refers to a network of labor and production processes whose end result is a finished commodity" (Hopkins & Wallerstein, 1986: 159). Although the usual approach to the study of commodity chains is to *begin* with the finished product, the task of tracking frontier expansion requires a focus on relatively unfinished, "raw" materials; a full analysis would require a subsequent backtracking, which is outside the scope of this article. The point of commodity chain analysis is two-fold: 1) to determine the boundaries and shifting configuration of the world-economy's interdependent division of labor; and 2) to analyze shifts between core, periphery, and semiperiphery over time according to each zone's retention of surplus value. While state actors attempt to shape the system's division of labor to their advantage, the primary organizing mechanisms are commodity chains, whose operations are by definition transnational. This approach permits an end-run around traditional conceptions of frontier expansion, which accept the nation-state or imperial sphere as the primary unit of analysis rather than the world-economy as a whole.

The existence of multiple *commodity frontiers* in the Americas—sugar, silver, timber, cattle, foodstuffs, cotton, tobacco, furs and deerskins, fisheries, etc.—allows us, first, to track not only capitalist expansion but also the unevenness of that expansion. This helps correct the impression of many critics of the world-systems perspective, who rightly argue that the transition to capitalism has assumed radically different forms in different places, but wrongly contend that world-systems analysis is incapable of theorizing this diversity. Secondly, it provides a way to link up relatively abstract processes such as long waves with relatively specific processes such as commodity production and labor relations in particular places. The concept of the commodity frontier, moreover, sheds light on the ways in which place-specific commodity production shapes and is shaped by the socio-spatial expansion of the law of value—ongoing primitive accumulation—under which people are forced to "sell to survive." This approach permits a deeper examination of how the world-economy and local ecosystems interact to determine the *rate* of capitalist expansion. Thirdly, because commodity frontiers, especially sugar, required numerous capital inputs unavailable at the immediate point of production, the concept provides a more specific theorization of the simultaneous deepening and widening of the system's social division of labor. In short, the commodity frontier gives meaning to the concept of the "multiplier effect" in terms of spatial expansion and the global reach of the law of value. And fourthly, because the most significant commodity frontiers were based on the exploitation of the environment—sugar, silver and gold mining, tobacco, grain, among others—the concept allows an exploration of the interrelationships between production in one *place*, and the expansion of capitalist *space* in general (see Moore, 2000b).

lord-peasant relation limited the possibilities for reinvestment in the land. As a consequence, European feudalism tended to exhaust the soil from which it derived revenues. The feudal system's best response to this socio-ecological contradiction was an anemic spatial fix, which took the form of internal and external colonization, such as land reclamation in the Low Countries, or colonial expansion in the East. Capitalism, however, was an entirely different animal. Where earlier ecological crises had been local, capitalism globalized them. And it did so at a pace that outstripped all previously existing historical systems. (Here, David Harvey's oft-cited "time-space compression" [1989] appears to have relevance for "early" as well as "late" capitalism.)

At the root of this ecohistorical difference between capitalism and feudalism is the role of commodity production in the two systems. To be sure, there was commodity production under feudalism, and there were important antecedents of the modern plantation system in the medieval Mediterranean. But however widespread this commodity production may have been, there was no ineluctable tendency towards its generalization. Why? Because a society organized around the progressive generalization of commodity production undermines relations of domination based on tribute. All things beings equal, social strata that benefit from this system are likely to oppose any change that might favor generalized commodity production. But as we have seen, all things were not equal. The crisis of feudalism led to a convergence of interest among Europe's ruling strata in favor of a significant expansion of commodity production, most dramatically in the New World.

Now commodity production may be generalized in two ways. Goods and services may be transformed within an established zone of production. Alternatively, the zone of production itself may be extended, allowing the commodification of goods and services previously unknown or available only through trade with external areas. Given the social power of the western European peasantry—which opposed not only a second serfdom but also unrestricted commercialization, with its promise of dispossession and pauperization—geographical expansion became the preferred option. This generalization of commodity production through geographical expansion entailed two major kinds of ecological transformation—the degradation of the soil, and the degradation of the worker. These transformations were especially destructive

because they tended to effect two major kinds of change detrimental to the well-being of human and extrahuman nature alike. In the first instance, capital sought radically to simplify land and labor through monocultures and in the second, new specialized labor processes sought to transform the worker to “a mere fragment of his own body” (Marx, 1977: 482).

These twin processes of radical simplification were accompanied by unremitting pressure to increase the productivity of the increasingly simplified land and labor. Both land and labor were subjected to the “speed-up.” Capitalism is therefore doubly antagonistic to ecological sustainability, conceived as the health of the worker and the land together. The consequences of this speed-up were to set in motion all manner of transformations in the technical and social divisions of labor that would give rise to a new and progressively antagonistic town-country dialectic. Thus these were local transformations in one sense, but profoundly global in another—suggesting that the interpenetration of local and global social relations, heralded by many as a defining feature of contemporary globalization (Swyngedouw, 1997), has a much longer history than is commonly acknowledged.

We will explore this dual environmental history, of the worker and the soil, with special reference to the two great commodity frontiers of early capitalism, silver and sugar.

Silver Mining

While mining is an industrial activity that dates back to antiquity, its revival in the mid-fifteenth century reflected and reinforced broader changes in Europe’s political economy. Driven largely by war demand, which made profitable technological innovations designed to extract greater use-values from the land, iron and copper production increased sharply. Wars were waged not only by the force of arms but equally by the power of credit, and Europe’s financial system depended on silver. The great silver mining centers of central Europe expanded their annual output fivefold between 1460 and 1530. By the 1520’s, Europe’s silver output reached a level that would not be exceeded until the mid-nineteenth century. Mobilizing huge concentrations of capital and labor, these mining enterprises were probably the largest capitalist operations anywhere at this time (Nef, 1964: 42, and 31–75 pas-

sim).³⁴ Where states owned shipyards, such as Venice's famous Arsenal, private enterprise was the motive force in this renaissance of large-scale mining.

Mining's ecological transformations were evident from the very beginning. With the emergence of central Europe's gigantic ironworks in the mid-fifteenth century, "the air was filled with such a stench and smoke as to trouble travelers as well as inhabitants" (Nef, 1964: 44). Effluents from forge and furnace polluted streams and killed fish (Agricola, 1950 [1565]: 8). From the perspective of capital, however, the biggest problem was the exhaustion of the forests. Wood fuel (charcoal) was enormously expensive and constituted the largest item in smelters' account books. And it was not only silver that consumed central Europe's thick forests. Far more destructive was iron. If mining in general was "perhaps the major source of worldwide deforestation" in the early modern era, the iron industry proved "the greatest waster of timber" (Burke, forthcoming).

The upshot was that silver faced a situation of rising costs for wood, both from relative exhaustion and competition from iron producers. A proliferation of state regulations by the later fifteenth century, designed to limit private capital's overexploitation of the forests, further restricted fuel supply and pushed costs upward (Darby, 1956). The political pressures from above were complemented by political pressures from below. Peasants resisted regalian and seigneurial enclosures of the forest commons. This was one of the major issues in the German peasant war of 1525 (Blickle, 1981: 19-21, 120-22), and an important issue in peasant struggles throughout our period (Westoby, 1989: 54-58, 60-61). Moreover, mining's boomtown geography tended to concentrate large number of potentially restive workers (Mols, 1974: 40; Kellenbenz, 1974; Braudel, 1982: 323-25). Thus there were a number of good reasons for all types of mining to move elsewhere. It was "small wonder then that the European economy as a whole applied to Sweden for iron and copper; to Norway for copper;

³⁴ With the revival of mining in late-fifteenth century Central Europe, "we have already passed from the realm of domestic industry to that of modern manufacture" (Mandel, 1968: 113). Braudel concurs. In the early decades of the "long" sixteenth century, "capitalism entered upon a new and decisive stage. For here the merchant system took control of production and reorganized it" (Braudel, 1982: 323).

before long to distant Russia for iron; to America for gold and silver" (Braudel, 1982: 325; also Cameron, 1993: 118–19).³⁵ The transition to capitalism, in other words, led directly to the globalization of extractive industries.

In the Americas, silver mining encountered enormously favorable ecological conditions. Even better, mining operations were relatively unfettered by custom and law. These ecological and social conditions allowed mineowners to exploit land and labor to the fullest. It could achieve in the New World what was impossible in the Old: "a fundamental spatial and social reorganisation of the continent" (Dore, 2000: 6). In every case, the sparsely wooded territory around the new mining centers, above all in the Andes (Potosi) and the arid Mexican plateau (Zacatecas and Guanajuato), was stripped of trees. Thereafter, "timber then had to be brought in at high cost over great distances" (Bakewell, 1987: 217–18). In sixteenth-century Zacatecas "it took scarcely more than 40 years to destroy the forests over a radius of almost 50 kilometres round the mining and smelting district" (Kellenbenz, 1974: 257; also Bakewell, 1971: 146–47; Semo, 1993: 76). In west central Mexico's mining districts, Taxco and Sultepec, deforestation was equally rapid. In 1550, Viceroy Antonio de Mendoza

warned his successor . . . regarding depletion of the forests: "In just a few years a large area of forest has been destroyed [near the mines], and it appears that the wood supply will be depleted sooner than the ore." . . . The problem of vegetation depletion around mines dependent on charcoal for the smelters continued through the colonial period (West, 1997: 68–69).

The introduction of the *patio* process in the 1550's, which used mercury to extract silver from the ore, reduced some pressure on local forests (Kellenbenz, 1974: 257). But even here, relief was limited. A century later, half the silver at Zacatecas and all of it at nearby Sombrerete derived from smelting rather than amal-

³⁵ By the later sixteenth century, the central European silver mining boom went bust, as American silver "so depressed prices that many European mines were forced to shut down" (Cameron, 1993: 119; also DuPlessis, 1997: 102). By 1618, European silver production was one-third to one-quarter of its 1530's peak (Slicher van Bath, 1963: 107; Brading & Cross, 1972: 545).

gamation (Brading & Cross, 1972: 556, 574; Assadourian, 1992: 59).³⁶

But it was in Potosi, the greatest silver-producing center of the early modern era,³⁷ that capitalism's ecological destructiveness showed its true colors. Almost overnight, Potosi became one of the European world-economy's largest cities—with a population of 120,000 in 1573 it was larger than Madrid, Rome, or Paris (Galeano, 1973: 31). This boomtown was replete with all the accoutrements of Europe's greatest cities, including dance academies, opera houses, and "magnificently decorated churches" (Galeano, 1973: 32). But unlike Amsterdam or Lisbon, Potosi was a center of neither economic nor political power. It produced value but did not control it.

The greatest boomtown of early modern capitalism, Potosi embodied Marx's observation, that where the societies of antiquity represented the "ruralisation of the city," and feudalism was marked by the opposition of town and country, capitalism effects the "urbanisation of countryside" (1973: 479; also Marx & Engels, 1970; 1972: 339). Nowhere was this new spatial pattern more evident than in early modern Latin America, where the Iberian conquerors "established, from the start, the supremacy of the city over the countryside" (Portes, 1977: 60).³⁸ And nowhere was the

³⁶ Moreover, the extraction of mercury from ore required charcoal fuel. The regions surrounding Spain's Almaden mercury mines—the principal supplier of New Spain's silver frontier—were deforested, beginning in the sixteenth century (Parsons, 1962: 200–01).

³⁷ In the later sixteenth century, Potosi was producing seven times as much silver as Zacatecas, its closest rival (Garner, 1988: 911).

³⁸ [The Iberians' urban-centered] colonization, the direct opposite of the British gradualistic model, permitted Spain to conquer and control an entire continent in a few years with a very small occupying force. It was, it is true, a tenuous and fragile control at first, but it covered the entire territory and tended to solidify as the years passed. Gradually, cities abandoned the role of military enclaves for imposing European authority and became integrated as the administrative, economic, and cultural centers of vast regions. This urban-centered strategy of colonization had two immediate consequences: First, it restricted the emergence of a "frontier" in the North American sense. Especially in the case of Spanish America, the major part of the territory was immediately, albeit tenuously, controlled. Subsequent colonization was directed at filling in and solidifying juridically existing holdings, seldom at creating new ones via expansion from initial coastal settlements.

Second . . . the foundation of cities did not . . . arise to serve, but to subdue. From the city the Spaniards moved out to a hostile environment to con-

“predatory nature” of the new settlements more forceful than in Potosi and its hinterland (Portes, 1977: 63; Zimmerer, 2000).

Potosi was the “hub of Latin American colonial life; around it . . . revolved the Chilean economy, which sent it wheat, dried meat, hides, and wines” (Galeano, 1973: 43; also Assadourian, et al., 1980; Burkholder & Johnson, 1994: 152–54). At the same time, Potosi’s appetite for human labor led to various labor drafts that profoundly dislocated village agriculture. Some 50,000 Indians flowed in and out of Potosi every year in the seventeenth century (Bakewell, 1987: 231). The Potosi mines, said contemporaries, were “devourers of mitayos.” Perhaps as many as a quarter of these workers—especially those who handled mercury—were consumed by the mines (Barber, 1932: 105; Brown, 2001). This gruesome form of labor turnover led the Spaniards to “scour the countryside for hundred of miles for labor” (Galeano, 1973: 51; also Rowe, 1957). Mine owner Luis Capoche observed that “the roads were so covered with people that the whole kingdom seemed on the move” (quoted in Galeano, 1973: 51).

The town-country division of labor that took shape with the rise of Potosi not only expressed relations of economic and political power. It equally expressed the emergent system’s metabolic contradictions. This was doubly unfortunate because mountain ecosystems are especially vulnerable to the kind of unremitting exploitation that characterizes capitalist development (Dunaway, 1996). Forest clearance encouraged soil erosion and flooding, as everywhere else, but in mountain ecosystems these effects were intensified and accelerated. Once green landscapes turned brown. As in Mexico, there was rapid deforestation around Potosi. Forests were cleared to provide construction materials and fuel. The surrounding area was quickly stripped of trees, and timber for stamp

quer, control, and indoctrinate the surrounding populations. Conquerors lived, by and large, in the city, while the conquered remained in the countryside. . . .

Spanish and Portuguese urban foundations in the New World were, by and large, of a thoroughly exploitative nature. Some were superimposed on previously existing indigenous cities; others grew with the frenzied search for mineral wealth. Cities with an agricultural hinterland differed from similar settlements in other parts of the world in that they were established *prior* to organized agricultural production with the explicit purpose of subduing and appropriating the labor of the surrounding populations (Portes, 1977: 61, 63, emphasis added).

mills was sometimes trucked in from as far as 200 miles away (Bakewell, 1984: 24; 1987: 218; Sauer, 1981: 50). Transport was typically by mule and llama, and once-thick forests became pastures for these beasts of burden (Dore, 2000: 8–9; Cobb, 1949). (Farther away, Spain, having thoroughly deforested its homeland, turned to the forests of Central America and the Caribbean for its silver-driven shipbuilding needs [Moore & Gildea, 2000; Özveren, 2000: 23, 30, 35; Radell & Parsons, 1971].) By the mid-seventeenth century, after 100 years of silver mining around Potosi, a Spanish observer commented that:

Even today there is no sign the mt. of Potosi had ever had a forest, when it was first discovered it was fully covered of trees . . . Today, not even weeds grown on the mt., not even in the most fertile soils where trees could have grown. The barrenness is most alarming because the mt. is now merely a conglomerate of loose gravel with little or no fertile land, pockmarked with sterile mineralized outcroppings (quoted in Burke, forthcoming; also Sauer, 1981: 353).

Some of the worst damage occurred at the point of production. While mercury amalgamation reduced the high fuel demands of silver smelting, it presented a far more serious threat to regional ecology. "One gram of mercury poured into eighty million liters of water would be cause for concern under [U.S.] human health standards for drinking water, enough to contaminate a typical mid-western lake" (Project Underground, n.d.). The volume of mercury "lost" in Peruvian silver production was measured not in thousands but rather *hundreds of millions* of grams—some 300 tons *annually* between 1580 and 1640 (Nriagu, 1993: 174). Here was a radical extension of capitalism's metabolic rift, not only disrupting nutrient cycling, but poisoning the nutrient cycle itself. Dumped into the rivers,³⁹ mercury poisoned the entire food chain—the fish, the animals who fed on them, and the humans

³⁹ It is impossible to know precisely how much mercury flowed into local hydrosystems. My figures rely on Nriagu's estimates of overall "mercury loss" in Latin American silver mining: over 400 *tons* a year between 1580 and 1640 (Nriagu, 1994: 174). Peru's share amounted to over 300 tons annually in this period. Recent studies of mercury contamination suggest that some 55–60% of this mercury loss "was released to the atmosphere," while the rest poured into aquatic ecosystems (1993: 179; also Frery et al., 2001).

who ate them. The bioaccumulation and consequent magnification of mercury toxicity—“concentrations of mercury in predatory fish can be a *million times* higher than in the surrounding water” (Stephens, 2001: 20)—are not highly durable over time, but highly “mobile, moving through the environment in the water and in the atmosphere, to locations quite remote [in time and space] from the mining districts” (Schoenberger & Silbergeld, n.d.; also Dore, 2000; Nriagu, 1994, 1996).

Mercury poisoned the workers through consumption, and even more quickly through work itself. Surveying working conditions in the early seventeenth century, Governor Juan de Solorzano reported that “the poison penetrated to the very marrow, debilitating all the members and causing a constant shaking, and the workers usually died within four years” (quoted in Galeano, 1973: 50). Pedro Muniz, dean of the cathedral church at Lima, observed that mining, especially mercury mining, was “totally contrary to the heath” of the workers (1603, reproduced in Fox, 1962: 76). In the 1580’s Luis Capoché decried the mines as a “harsh executioner of Indians, for each day it consumes and destroys them, and their lives are made misery by the fear of death” (quoted in Bakewell, 1984: 145). Over time, conditions worsened. As shaft depths increased in the early 1600’s, “the proprietors decided they were losing time changing shifts, so they started keeping the workmen underground continuously from Monday evening to Saturday” (Rowe, 1957: 174).

Working the stamping mills, *ingenios*, responsible for crushing the ore, was even deadlier, if slower acting. The workers who inhaled dust particles suffered from silicosis, rendering them vulnerable to a wide range of respiratory diseases (Bakewell, 1984: 149). It probably helped little that the standard work shift was twelve hours, day and night, giving way to round-the-clock shifts during the wet season,⁴⁰ “when advantage had be taken of every hour of adequate water flow” to power the hydraulic stamping mills

⁴⁰ Although few social researchers consider it, the kind of “shift work” that capitalism imposes on workers may be a form of ecological degradation in itself, rendering workers more vulnerable to disease and disability. “Shift work often goes against the rhythms governing many bodily functions. . . . It has [a negative] impact on the metabolism (the bodily processing) of various chemicals and toxins to which individuals are exposed in the course of their work” (Freund & McGuire, 1999: 94).

(Bakewell, 1984: 152). The wet season also put pressure on the elaborate system of water control (Brading & Cross, 1972: 554), rendered exponentially more difficult in the wake of widespread deforestation and the attendant disruption of the region's hydrology. This of course led to disastrous consequences. Four thousand died when one of Potosi's larger dams collapsed in the early seventeenth century (McCully, 1996: 14). Finally, smoke from the smelters rendered both agriculture and ranching impossible within a radius of twenty miles, "and the fumes attacked the men's bodies no less relentlessly" (Galeano, 1973: 52).

Probably the most severe socio-ecological consequence of the mining frontier's expansion was its large scale disruption of indigenous agricultural systems. Andean societies were especially vulnerable. The close proximity of distinct regional environments—"the coast, the piedmont, the altiplano highlands, and the tundra steppe (puna)" (Wolf, 1982: 59)—encouraged highly interdependent agro-pastoral linkages. Potato cultivation in the highlands, for instance, was supported by fertilizer (guano) supplied by coastal communities, which in turn consumed highland foodstuffs (Wolf, 1982: 59; Larson, 1998: 19–20; Murra, 1984). "Any dislocation of these systems," writes Eric Wolf (1982: 134), "threatened the survival of the remaining population. The disruption of hydraulic works and the interruption of exchanges between zones promised famine and social collapse. The mining frontier disrupted these systems across all zones, "upset[ting] the synchronized ecological relationships between coast, piedmont, highland, and puma," and "disrupting a finely calibrated system of food transfers" (Wolf, 1982: 134–35; also Zimmerer, 2000).

The sources of disruption were several. As we have seen, they stemmed partly from the mining frontier's immense labor demands. Partly, they were driven by the reorganization of agriculture along capitalist lines, producing cash crops for export, especially to mining regions (Martinez-Alier, 1991: 632; Mannion, 1991: 129). The mita's demand for labor tended to weigh more heavily as population declined, as it would until the early eighteenth century. Indigenous local rulers, *kurakas*, attempted to compensate for the rising burden of taxation and labor drafts by turning to cash-cropping (wheat and barley especially) as a means of "substitut[ing] cash for labor in paying tributes" (Godoy, 1991: 406; also Spalding, 1975: 111). Among other things, this tended to

reproduce Europe's expansionary agricultural model, land-extensive rather than labor-intensive (Wolf, 1959: 198).⁴¹

The disruption of indigenous agriculture also owed much to the extension of European stock raising, especially cattle, pigs, horses, and sheep. Large-scale mining was inconceivable without this. Extractive centers relied on European livestock for food, transportation, as power sources for mine hoists; sometimes they were even used in milling and the *patio* amalgamation process. Cattle offered not only meat but hides, made into sacks and pouches for carrying ore and mercury. They also supplied tallow for candles. Underground mining was impossible without these. Consumption of tallow in 1730's Zacatecas—considerably smaller than Potosi—was over 80 tons *a year* (Semo, 1993: 12; Crosby, 1972: 86; Sluyter, 1996: 172).

The invasion of European livestock proved a particularly effective means of conquering space for the advancing capitalist world-economy. There were in effect two waves of invasion. The first was epidemiological. The largely unintentional spread of European fauna created huge new breeding grounds for European diseases. Pigs proved especially deadly, their foreign microbes infecting local wildlife and humans alike (Mann, 2002). A second wave proved competitive in an entirely different way. The “spectacular rise” in the number of the biggest European livestock in these zones of conquest “was accompanied by an equally spectacular decline in the Indian population; *and disease and exploitation do not*

⁴¹ Where the Indians had farmed land with a dibble, the Spaniards introduced a light plow drawn by oxen. . . . With this new instrument, men were probably able to farm land which they had not farmed before: the plow with a metal tip is a much better tool for loosening deep sod and breaking up the tangle of roots and rhizomes than the hoe. Undoubtedly, therefore the conquerors took under cultivation land which the Indian had not utilized. . . . *But in its net effect, the plow also upset the balance of Indian life on the land.* The plow is efficient only where land is plentiful but labor is scarce. Plow agriculture does not produce as much as hoe cultivation on any given unit of land. . . . Also, plow agriculture means that oxen must be fed, and some land must be devoted to their care. . . . [E]very unit of land withdrawn from Indian agriculture meant a halving of the food supply on that land [assuming that hoe yield ratios were twice that of plow ratios], and thus a halving of the population dependent on that food supply. And when that land was planted to wheat to feed the Spanish conquerors [or non-agricultural workers in the mines] rather than the Indian inhabitants of that land, the growing imbalance between man and land was intensified (Wolf, 1959: 198–99).

entirely explain that decline. The Indians were losing out in the biological competition with the newly exported livestock” (Crosby, 1972: 98–99, emphasis added). Cattle, sheep, and pigs trampled and fed upon Indian fields in Peru and New Spain, where “huge herds” of cattle had “completely depopulated” some regions (Chevalier, 1963: 93; Sluyter, 1996: 173).

Indian cultivators saw their crops “repeatedly destroyed” by European livestock (Parry, 1963: 246). This left them with two options: move to marginal lands, or seek employment in the cities and mining camps. In either event, the impact on the indigenous population was negative. Marginal lands, with their low yield ratios, were unfavorable to demographic recovery. On the other hand, the cities were hotbeds of disease, especially smallpox (Parry, 1963: 246). So great was the devastation that the Viceroy Antonio de Mendoza reported in 1550 that “if cattle are allowed, the Indians will be destroyed” (quoted in Chevalier, 1963: 94). Even where cattle did not compete directly with Indian cultivation, they often “engulfed land which the Indians did not farm during any given year but which constituted the indispensable reserve in their system of field-to-forest rotation” (Wolf, 1959: 198; also Simpson, 1952). Cattle thus came into competition with the overall *system* of indigenous cultivation, dramatically undermining these societies’ socio-biological reproduction.

Sugar

If silver mining was indispensable to the rise of the modern world-economy as a system of capital accumulation, the sugar plantation remade the divisions of labor necessary for this early accumulation to be not only “original” but ceaseless. Silver mining reflected capitalism’s tendency to accelerate environmental degradation, intensify exploitation of labor and land (that is, human and extrahuman nature), and to globalize these exploitative and transformative production systems. Yet, once extended to the Americas, the number of locations in which silver mining could occur was quite limited. However advanced, the mining enterprise could not be generalized throughout the capitalist world. Not so with the plantation, which could take root almost anywhere in the tropics, and whose concentration and organization of labor and capital prefigured the rise of modern industry in the later eighteenth

century. While the plantation organized multiple cash crops in the early modern era, there is no mistaking its agronomic origins in sugar. Sugar was the original cash crop of European expansion.

The economic success of the sugar plantation flowed from its reorganization of land and labor. Imposed on fertile tropical landscapes, modern slavery and monoculture ensured that sugar was one of the very few growth crops of early capitalism. At the same time, the very reorganization of land and labor that ensured sugar's profitability degraded and exhausted the soil and the workers who made it possible. In essence, the land was progressively mined, until its relative exhaustion fettered profitability, whereupon capital was forced to seek out more fertile lands, which typically were found outside the established boundaries of the capitalist system. Successive "local" ecological crises became a driving force of capitalism's global expansion.

Before considering the early history of the sugar plantation, a word or two about the socio-ecology of sugar cultivation and processing. One reason sugar and slavery fit together with such gruesome perfection concerns sugar's labor requirements. In contrast to wheat but similar to cotton, sugar cane requires labor throughout the year, which discouraged free labor even if it could be obtained cheaply, which was rarely the case on any early frontier. (Lands where labor was plentiful tended to also contain powerful states.) In contrast to cotton, however, the sugar plantation was highly industrial, involving not only a high degree of fixed capital and processing facilities on-site, but also a degree of labor process coordination and capital intensity that was rare in this era. The sugar plantation was the original "factory in the field." This has everything to do with sugar's ecology, which requires that cutting, milling, and boiling occur within 48 hours; sugar cane desiccates rapidly once it is cut. During the harvest, slaves worked the sugar mills and boilers around the clock (John, 1988: 163). The resulting labor process was highly rationalized. Cultivation and processing required both skilled and unskilled labor, providing an early glimpse into the capitalist labor process, including such dynamics as deskilling.

The specialization by skill and jobs, and the division of labor by age, gender, and condition into crews, shifts, and "gangs"

... are features associated more with industry than agriculture—at least in the 16th century (Mintz, 1985: 47).

The plantation was equally time-conscious. While “dictated by the nature of the sugar cane and its processing requirements ... [this time consciousness] permeated all phases of plantation life” (Mintz, 1985: 51; Dunn, 1973: 190–91). In this sense, the early capitalist relation to the ecology of sugar cane not only compressed time by accelerating and simplifying the labor process—and therefore undermining the conditions for sustainability of land and labor alike—but also gave rise to an early form of industrial time (Thompson, 1991) many centuries before the Industrial Revolution.

While Europeans had grown sugar in the Mediterranean from the time of the Crusades, Portugal’s incorporation of the Madeiras and Azores in the mid-fifteenth century inaugurated a new phase of world environmental history. Though small, the Atlantic islands “were as important as continents” (Mauro, 1961: 4). Madeira was destined to play an especially decisive role. Over a decade before Portuguese settlers arrived on this uninhabited island, they had put ashore cows, pigs, and sheep. This practice would be repeated in the Azores, the Cape Verdes, and later the Caribbean. Consequently, the island’s ecology was transformed even before human arrival. This was not always to the settlers’ advantage. The attempted settlement of nearby Porto Santo was hampered by the accidental release of rabbits on the island in the 1420’s. The rabbits devoured the island’s ground cover, leading to wind and rain erosion (Crosby, 1986: 75; Johnson, 1987: 3; Masefield, 1967: 280; Solow, 1987; Verlinden 1970). For the moment, Madeira’s heavy forest cover protected the island from a similar fate.

The forests of Madeira—called “*isola de Madeira*” (island of timber) by the Portuguese (Perlin, 1989: 249)—would not long survive. “There was not a foot of ground that was not entirely covered with great trees,” observed a Venetian traveler in the 1450’s (quoted in Perlin, 1989: 250). Resting on the twin pillars of shipbuilding and sugar production, the political ecology of Portuguese imperialism ensured rapid forest clearance. Its domestic timber supplies chronically deficient (Boxer, 1969: 56), Portugal’s emergence as a world power owed much to the exploitation of these woods. World power required a world naval and merchant fleet. And Madeira provided precisely the right kind of “old growth”

timber—of “record size and quantity” (Perlin, 1989: 252)—for the larger ocean-going vessels that would carry Portuguese power into the Indian Ocean.

If shipbuilding required select timbers, sugar was far less discriminating, and ultimately far more voracious in its appetite for wood fuel. Even with the most favorable soil and climate, no sugar plantation could succeed without access to nearby woodlands (Miller, 1997: 137). Displacing the cereal agriculture of the early settlers, Genoese and Flemish capital financed the new sugar plantations, whose annual output increased from about 80 to 1,300 tons between 1456 and 1494 (Perlin, 1989: 409n; Diffie & Winius, 1977: 306–07; Schwartz, 1985: 8; Lopez, 1964). By the latter date, some 60,000 tons of wood were consumed in the plantation’s boiling-houses (Perlin, 1989: 252). This does not include wood for heating, construction, building casks, or sawmilling planks for export to Lisbon’s shipyards. To place this figure in context, 60,000 tons, while small in relation to Europe’s overall consumption, was nearly twice as much wood as Europe’s merchant shipbuilding consumed every year (Moore & Gildea, 2000).⁴² By the end of the fifteenth century, sugar importers began to build refineries in northern Europe because nearby fuel supplies were rather more plentiful than in the islands (Galloway, 1989: 36).⁴³ Sugar sealed the forests’ fate.

⁴² This calculation is based on the estimate that Europe’s merchant shipping fleet weighed in at around 225,000 tons in 1500 (Zanden & Horiings, 1999: 36). If the average lifespan of ships in this era was around ten years, we can assume that one-tenth of the merchant fleet (22,500 tons) had to be replaced each year (Phillips, 1986: 23; Braudel, 1984: 506; McCracken, 1971: 65). Of course, the shipping fleet was expanding rapidly in the sixteenth century, reaching 600–700,000 tons by 1600 (Braudel, 1981: 362), so some measure of increase should be considered, let’s say 4,000 tons a year. If each ton of shipping consumed 1.25 tons of wood (McCracken, 1971: 65), then 26,500 tons of shipbuilding would take 33,125 tons of timber each year. That said, we should recall that ships demanded specific kinds of timber for masts, planks, and so forth, and as a consequence shipbuilding timber was entirely more scarce than fuelwood.

⁴³ Probably more important than proximity to fuel, Galloway notes, refining sugar closer to northern European markets allowed merchants to avoid the risks associated with transport, during which much sugar arrived in port water-damaged (1989). The risks involved in refining and marketing in Europe were considerably less than those associated with cultivation and transport. Sugar refining in northwestern Europe produced its own ecological problems, of course. Amsterdam, for instance, banned the “use of coal in the [sugar] refineries” in 1614 because of air pollution (Braudel, 1982: 193).

Madeira's sugar revolution was above all the work of human labor. The destruction of the island's forests irrevocably altered its hydrology. Perennial streams went dry, requiring new systems for mobilizing water if sugar was to be grown (Grove, 1995: 29). The ensuing construction of massive irrigation works was as global as it was transformative. Technical expertise and financing were supplied by the Genoese, Portugal provided settlers, and African slaves performed most of the labor. The labor requirements were immense, and they exacted a high price in human lives.

Much of the land was too steep for normal practices of cultivation and had to be terraced. Most back-breaking of all the tasks, *and the most dangerous*, was the creation of a vast and complicated irrigation system to bring water from the windy and sodden uplands to the cultivated fields far below (Crosby, 1986: 78, emphasis added; Watson, 1983: 103).

Once the sugar was harvested, the boiling houses became a "sweet inferno." The men who watched over the boiling sugar—often 30 hours at a stretch—"are so exhausted, covered with smoke, soot, dirt and clay that they resemble demons" (Gregario, 1873: 752 quoted in Perlin, 1989: 251; also John, 1988: 163).

Under the impetus of an expanding world sugar market, the consolidation of large landholdings thanks to Genoese financing, and sufficient labor power provided by the slave trade, Madeira became the world-economy's largest sugar producer by the late fifteenth century (Galloway, 1989: ch. 4; Schwartz, 1985: 8). By the 1490's, however, the world sugar market was glutted. Overproduction coincided with increasing soil erosion and exhaustion. Productivity stagnated and declined, bringing Madeira's sugar experiment to an end.

Not only the soil was exhausted. So were the slaves. By the end of the century, some 2,000 slaves worked the island's sugar plantations. But slave mortality was high. Five to ten percent of the slave population died each a year⁴⁴—and this figure refers to the established plantation, not to the exhausting labor of clearing

⁴⁴ This is the figure that Lockhart and Schwartz (1983: 206) give for Brazil in the 1580's, and which seems reasonable for Madeira a century earlier, and the Caribbean a century later (see also Watts, 1987: 366–68 and *passim*).

forests. To the new plantation regime, however, this was beside the point. Slaves typically lived long enough to recoup the original cost, and then some (Schwartz, 1987: 82–83; Blackburn, 1997: 339). This was all that mattered. Thus, when brought to the modern plantation, at first in Madeira and later in the New World, African slaves not only supplied the labor power necessary to degrade local ecosystems, but in the process of capitalist exploitation the slaves themselves experienced the most thoroughgoing form of ecological degradation—death.

Under conditions of an expanding world market, this dual crisis—of the soil and the worker—led directly to the relocation of sugar production from the Atlantic islands to Brazil by the mid-sixteenth century. Madeira's sugar complex, itself the product of early capitalism's globalizing tendencies as capital accumulation began to shift from the Mediterranean to the Atlantic, had by 1500 generated contradictions that only another wave of global expansion could resolve.

The sugar frontier's movement from the Atlantic island to Brazil, and thence to the Caribbean, is a paradigm case of how capitalism resolves crises in one region only by transferring such "contradictions to a wider sphere and giv[ing] them greater latitude" (Marx, 1967, II: 468). As yields fell on sugar estates in the Atlantic islands, Flemish and Italian capital—the decisive ingredient in the first sugar revolution—began to direct their attention to Brazil (Blackburn, 1997: 169). Among the New World's advantages was plentiful water. The hydrologic cycle was not so easily disrupted, and large-scale irrigation works were typically unnecessary. Indeed, the "discovery that sugar could be grown well in the New World without irrigation made American cane plantations the prototype of virtually" all subsequent plantation systems the world over (Sauer, 1981: 49–50).

As with most economic activities in the periphery—then as now—competition in the sugar sector was intense. Planters were typically heavily indebted and membership in the planter class was highly unstable (Dunn, 1973; Lockhart & Schwartz, 1983: 207; Pares, 1960; Sheridan, 1973). Such instability reinforced the already powerful tendencies of capitalist planters to overexploit land and labor, which over time led to declining productivity, which drove the sugar frontier ever onwards to virgin soil, which in turn required fresh supplies of capital and labor. A vicious cir-

cle indeed! American planters were yoked to a “system of international debt peonage” reminiscent of early modern eastern Europe as well as the contemporary Third World (Wallerstein, 1974: 121–22). Italian, Dutch, and British financiers, not planters, were the primary beneficiaries of the sugar frontier complex (Braudel, 1982: 192–94).

These financiers’ accumulation of money capital of course depended upon renewed primitive accumulation on a massive scale in the Americas, in this instance the incorporation of Brazil’s ecological wealth into the world capitalist system. Reflecting capital’s utter disregard for nature, the early settlers “presumed upon the inexhaustible fertility of cattle, turtles, and birds, and upon the immeasurable resources of the forests: indeed, they seem to have gone berserk in the presence of so much edible wild life and a continent covered with firewood. In time, this waste went too far” (Pares, 1960: 20).

In Brazil as in the Atlantic islands earlier, the forests were laid waste.⁴⁵ Planters believed that sugar grew best on forest soil, and in little over a century (1580–1700), occupied some 1,000 square kilometers. Forest clearance for cultivation was complemented by the plantations’ other needs, fuel above all else. By 1700, “an average 210,000 tons of secondary woodland . . . forest was cut each year” for the furnaces. The result: another 1,200 square kilometers of woodland permanently removed (Dean, 1995: 79–80). Second only to slaves as the largest item in the mill owner’s budget, by the eighteenth century firewood consumed some 12–21% of operating costs (Schwartz, 1987: 93; Barros de Castro, 1977: 9). Together with soil erosion, rising fuel costs contributed to a large number of plantation failures, beginning in the seventeenth century (Edel, 1969: 42). At this time, a large Bahian *engenho* typically required the full-time labor of eight slaves just to gather firewood. Each slave’s *daily* quota was approximately 1,600 pounds of firewood. During the harvest season, every large *engenho* in the region consumed some 12–13,000 pounds of firewood on a daily basis (Schwartz, 1985: 141). In terms of land requirements, one and a half to two acres of forest were needed to process a single acre of

⁴⁵ As in Europe, rapid deforestation in the sixteenth century Bahian Reconcavo “call[ed] forth repeated legislative attempts to preserve and apportion the reserves of hardwood,” valued for shipbuilding (Morton, 1978: 42). The very existence of protective legislation invariably indicated deforestation on a large-scale.

sugar cane. It is hardly surprising that there was widespread deforestation in the Bahian Reconcavo by the mid-seventeenth century (Schwartz, 1985: 302). The region's once-rich soils had given way to "sterile-rock, washed-out soil, eroded lands" (Galeano, 1973: 74).

This basic contradiction was reproduced in the Caribbean during the sixteenth century, as declining soil fertility, slave revolts, war, and a gold boom in the south undercut Brazil's position as a leading sugar producer. Dutch capital and expertise moved north to Barbados. Here too, the forests were removed quickly as "armies of slaves hacked down and burned off millions of hectares of forest in order to plant cane" (McNeill, 1999: 177). Originally covered with "dense tropical forests," Barbados was virtually deforested in the 30 years after initial settlement in the 1630's. By the 1660's, some fifteen years after the first sugar exports, "Barbados had less woodland than most districts of England . . . [C]olonists were complaining of a timber shortage" (Dunn, 1973: 26-27, 67). These colonists even attempted to annex nearby St. Lucia, prized for its dense forests (Silver, 1992: 117).

The forests largely depleted, soils became highly vulnerable to erosion from wind and rain. The sugarcane itself is fairly resilient in severe weather. Its soil is rather more vulnerable. In seventeenth-century Barbados,

Rivers began to silt up and in some cases went completely dry, estuarine habitats were destroyed by siltation and estuarine animals disappeared; and with the loss of the dense tree cover the whole hydrology, and thus the whole climate, of the area was slowly altered, at considerable cost to both land and water species (Sale, 1990: 165).

Erosion from nearby cane fields began to clog Bridgetown harbor in the early 1660's, after just two decades of sugar cultivation (Watts, 1987: 222). By the closing decades of the seventeenth century, Barbadian planters "complained endlessly of declining crop yields, insect and vermin plagues, drought, barren soil, and rising costs" (Dunn, 1973: 203-04; Deerr, 1949-50, I: 166). By 1685, yields on many sugar estates had declined by as much as one-half (Watts, 1987: 397). Declining soil fertility also meant that "ratoon" crops, where the cane root is left in the ground to produce a second (or even third and fourth) cane, experienced sharply declining yields. Although requiring little labor, by the eighteenth cen-

ture yields had fallen so dramatically that “no planter ratooned more than one year” (Pares, 1960: 42). Such exhaustion played a key role in the eighteenth century shift of sugar production from Barbados to the larger islands of Jamaica and St. Domingue, which “had sufficient land to be able to abandon overworked sugar plantations and replant on virgin soil” (Davis, 1973: 254; also Dunn, 1973: 205; Ponting, 1991: 206).⁴⁶

The deepening crisis of the soil demanded ever-greater inputs of fertilizer and labor. The metabolic contradictions *within* the countryside were consequently sharpened as producers became increasingly specialized. The challenge of declining soil productivity was met, in part, by importing animals to supply fertilizer. This option was, however, a limited one in the smaller islands such as Barbados, and at all turns led to more deforestation for pasture, which resulted in yet more soil erosion, which increased demand for fertilizer. In seventeenth-century Brazil, the booming sugar sector provided the impetus to large-scale cattle ranching, where cattle were used initially as a power source for the sugar mills (Crosby, 1972: 90; Furtado, 1963: 58–66; Schwartz, 1973: 167–68). In Barbados by the mid-seventeenth century, fertilizer costs increased to the point where smallholders who did not grow sugar began to raise livestock not for meat or hides, but as a source of manure (Watts, 1987: 222–23; Batie 1991: 50). This spatially concentrated animal population—especially horses, the power source for many sugar mills—provided a favorable disease climate. In 1655–56 “a virulent epidemic almost destroyed the horse population in Barbados.” This development threw the sugar mills into crisis, and induced a shift to wind-power, possible because the island had been so thoroughly deforested (Watts, 1987: 193, 198).

As soil fertility declined, more labor was required—and slaves were the most costly part of the production process (Dunn, 1973: 197; Schwartz, 1987: 93). During the late seventeenth century, slaves in Barbados were put to work carrying soil that had washed to the bottom of cultivated hillsides back to the cane fields (Watts,

⁴⁶ By the nineteenth century, the spatial fixes internal to the Caribbean would give way to an even more extensive form of globalization, as the sugar complex found its way to Pacific-Asia.

1987: 297).¹⁷ Labor costs rose dramatically. “Every decade it took more slaves to produce the same amount of sugar from the same acreage” (Pares, 1960: 41). By 1717, an acre planted with sugar in Barbados required five times as many slaves, “and many more head of cattle and horses,” relative to the larger (and more fertile) French sugar islands (Williams, 1944: 113)—and no doubt, Jamaica too. Over the next half-century, Barbados’ slave population increased by “about 30 percent” but sugar output declined by “more than 20 percent” (Pares, 1960: 41). It is no surprise that profitability fluctuated sharply according to soil conditions (Williams, 1944: 113–14).

When the planter purchased more slaves to compensate for declining yields, pressures to exploit the soil and the slaves were accordingly intensified—above and beyond the chronic pressures of indebtedness and downward price movements. Thus the “terrible depreciation allowance” of slave mortality (Pares, 1960: 39–40). “The sugar plantations on which over three-quarters of all Caribbean slaves worked consumed the lives of slaves almost as voraciously as the mills ground the mounds of cut cane” (Blackburn, 1997: 339). Estimates of slave mortality in the seventeenth century West Indies sugar complex vary, but one trend seems clear. Economic growth and slave mortality were closely linked (Curtin, 1968). Comparatively low mortality in the early years of settlement gave way to escalating mortality rates later on. As Barbados’ sugar exports to London surged between 300–400% in the second half of the seventeenth century, annual slave mortality—3.5% in 1627–50—increased some 40% (to 4.9%) by the turn of the century (Sheridan, 1972: 29; Dunn, 1973: 203). Might this have something to do with available land, and therefore relative soil fertility? One answer is suggested by way of comparison with Jamaica. Slave mortality in Jamaica, an island that could accommo-

¹⁷ Observed planter Edward Littleton:

The amassing of the vast quantities of dung we must use, the carrying it to the field is a mighty labour. An acre of ground well dressed will take thirty load [sic] of Dung . . . we make and scrape Dung out of every corner . . . some save the urine of their people to increase and enrich their Dung. We make high and strong Wears and Walls to stop the Mould that washes from our Grounds, which we carry back in carts or on the Negroes’ heads. Our Negroes work at it like Ants and Bee (1689: 18 quoted in Deerr, 1949–50: 166).

date 25 islands the size of Barbados, was initially lower (2.8%) during the establishment of the plantation regime in the 1650's, and increased much less dramatically (about 25%) in the ensuing 75 years (Sheridan, 1972: 29).

The sugar frontier knitted together deforestation, soil erosion, and human health in one other respect: yellow fever. This would have far-reaching implications for European imperialism in Latin America. Indigenous to tropical Africa, and transported to the New World in slave ships, yellow fever took root in the Americas as a consequence of the Caribbean sugar revolution. Receding forests undermined the bird populations that preyed on fever-carrying mosquitoes, who found the expansion of marshland at the expense of forest a favorable breeding ground. Above all, in concentrating large numbers of workers, the rapid expansion of sugar estates created an enormously favorable environment for the virus. While local populations eventually adapted, yellow fever posed serious difficulties for invading armies. British and French efforts at projecting their hegemony in the region were continually frustrated by the virus during the eighteenth century.⁴⁸ In sum, the epidemiological landscape produced by the sugar frontier's ecological transformations "created a new set of governing conditions for international relations in the American tropics" (McNeill, 1999: 175). Once more we see the intertwined environmental histories of the body, the landscape, and the world-system at play.

Even more starkly than silver mining, the sugar frontier embodied the defining socio-ecological feature of capitalist agriculture: the radical simplification and consequent degradation of land and labor. While many leading environmental historians now speak of capitalism's tendency to simplify or homogenize nonhuman nature, therefore undermining the conditions for ecological sustainability (Cronon, 1991; Worster, 1990), there is little recog-

⁴⁸After the 1770's, differential disease immunity assisted insurgent populations of the American tropics (and sub-tropics) as they sought to end European empires in the New World. In the environmental and epidemiological changes these empires wrought they sowed the (slow-germinating) seeds of their own destruction. A century later, after 1898, a new empire arose in the Caribbean, made possible (or at least inexpensive) by further environmental and epidemiological change: the mosquito control and yellow fever prevention undertaken by the U.S. army (McNeill, 1999: 182).

dition of how this tendency is grounded in the system's political economy, above all in the organization of labor. It bears repeating that capital degrades nature only through the degradation of labor. This, I think, is Marx's point when he stresses that the labor process is not only a social but equally a metabolic process, and that the advent of large-scale industry accelerates the degradation of both the soil and the worker (1977: 283, 636–38).

How capitalism effects this double transformation has everything to do with the labor process. Capital exploits extrahuman nature only through labor power, that is to say human nature. Capital succeeds to the extent that it achieves some measure of control over the labor process, sufficient to generate surplus value. This much is widely known. The precise form of capitalist control over the labor process is, equally, widely debated. What I would like to suggest here is the relevance to environmental history of Braverman's (1974) insights into the capitalist labor process. As we learned earlier, Braverman argued that capitalism tended to dissolve complex labor processes into simple and general motions. This argument builds upon arguments developed in *Capital*, but in certain respects limits the scope of Marx's vision. For Marx, the progress of capital accumulation rested upon the incessant revolutionizing of the social and technical divisions of labor. This progress reduces the laborer to "a mere fragment of his own body" (1977: 482). The result: a "crippling of the [laborer's] body and mind. . . . [Manufacture] attacks the individual at the very roots of his life. . . . [I]t is the first system to provide the materials and the impetus for *industrial pathology*" (1977: 484, emphasis added). At once the condition and consequence of this socio-physical fragmentation (this "industrial pathology"), is a certain fragmentation and homogenization of external nature—this can take the form of a plantation monoculture, or even the advent of mass production with its standardized machinery and the assembly of interchangeable parts.

From this vantage point, the case of sugar is highly suggestive. The very processes by which capitalism degrades the laborer through deskilling, and renders her vulnerable to various bodily pathologies, are those which degrade the land—that is, which generate various ecological pathologies. Modern slavery rested upon a labor process with low skill requirements. In the plantation system this was possible largely to the extent that the physical

organization of the land itself was radically (and progressively) simplified. This is why plantation monocultures and row planting went hand-in-hand with the origins of modern slavery as far back as the fifteenth century. And so capitalist agriculture undermines the biodiversity essential to sustainability as a condition of undermining the complex labor processes involved in precapitalist agriculture. In so doing, the laborers' all-round needs as a human being were subordinated to the simplifying and accelerating tendencies of the law of value. These antagonisms, as we have seen, compelled recurrent waves of global capitalist expansion, as the system went in search for fresh supplies of land and labor.

FEUDALISM, CAPITALISM, SOCIALISM, OR, THE THEORY AND POLITICS OF ECOHISTORICAL TRANSITIONS

This ecohistorical account suggests that the division of labor that emerged during the transition from feudalism to capitalism was knitted together by relations of production as well as relations of exchange—together comprising what Marx calls an “organic whole” (1973: 100). We have concentrated on the dramatic socio-ecological transformations effected by Europe’s conquest of the Americas not simply because they were dramatic, but equally because these transformations were central moments of the “original” accumulation of capital. “The Americas were not incorporated into an already existing capitalist world-economy” (Quijano & Wallerstein, 1992: 549). Rather, their conquest was decisive in channeling the outcome of feudal crisis towards capitalism.⁴⁹

The subordination of the Americas to the law of value should not, however, be seen as exogenous to developments within Europe. The advancing sugar and silver commodity frontiers, signaling “the rosy dawn . . . of capitalist production” (Marx, 1967, I: 703), altered society in Europe as well as the New World. Perhaps most significant was the new relation between town and country,

⁴⁹ Thus the importance of the New World relative to the Indian Ocean: “What decisively transformed the shape of the ‘modern’ world system was not so much the Portuguese takeover of the ‘old world’ but the Spanish incorporation of the ‘New World’” (Abu-Lughod, 1989: 363).

bound up in complex ways with new systems of commodity production in Worlds both Old and New. To mention only a few highlights, we might have considered how more geographically expansive—and ecologically problematic—town-country relations displaced the regional city-hinterland relations of the feudal era. Sixteenth-century Amsterdam, for instance, depended on Baltic grain for a quarter of its needs (Elliot, 1968: 48). One result was widespread soil exhaustion in eastern Europe's grain exporting regions in the next century (Wallerstein, 1980: 132–33). And the timber that flowed from the Baltic's forests—without which the rise of the great Dutch and English merchant fleets was inconceivable, and which found its way to distant ports in Portugal and Castile—was extracted at a high cost. By the seventeenth century, the “reckless exploitation” of Poland's forests “produced a desert in the woods” (Szczygielski, 1967: 94 quoted in Wallerstein, 1980: 133, n. 16; also Richards, 1990: 168). Sand dunes invaded where forests once thrived on the Pomeranian coast (Braudel, 1981: 365; 1961: 256).

We might have observed that the urbanization of the countryside in this era entailed not only divergence between town and country, but also the uneven development of rural society. That is to say, not only was town set against country in dialectical antagonism, but the countryside was set against itself. Increasingly, rural society became an assemblage of monocultural regimes—grain and timber in eastern Europe, sheep raising in Castile and England, sugar in the Americas, and so forth. In these early moments of regional specialization are found the origins of capitalism's radical simplification of the land, which today extends to the very genetic foundations of life.

Finally we might also have noted that it was not only slaves who suffered capitalism's use of “the body as an accumulation strategy” (Harvey, 2000a). Europe's peasants and workers prospered immediately following the Black Death, but suffered a deteriorating diet after the fifteenth-century economic revival. To borrow a phrase from Lynn White, this cereal-heavy diet was a form of “amino-starvation” (1962: 75).⁵⁰ Real wages fell and landlords shifted from

⁵⁰ From 1400 to 1750 Europe was a great consumer of bread and more than half vegetarian. . . . Only this “backward” diet allowed Europe to carry the

cereal agriculture to pasturage. Stock raising was increasingly monopolized by big landowners and cereal prices moved upwards. Increasingly expensive grains displaced even more costly meat in the European diet. As a result, subsistence crises, and the serious epidemics that tended to follow in their wake, persisted throughout the “long” sixteenth century. Mortality in Europe’s rapidly growing cities was high even in average years, “catastrophic” at other times (Helleiner, 1967: 83). Famine “recurred so insistently for centuries on end that it became incorporated into man’s biological regime and built into his daily life” (Braudel, 1981: 73–74). So it was that the transition to capitalism was enabled by a biological regime that placed the (mal)nutritional burden on the bellies of the direct producers.

So there was a metabolic rift—and an ever-widening one at that—between town and country, and crucially, between countryside and countryside, from the very beginnings of the world capitalist system. (Today’s regionally specialized commercial feedlots and grain monocultures have a very long lineage.) This metabolic rift between town and country ruptured the flow of nutrients from country to town, where wastes were not recycled but usually dumped, for example in rivers. Thus capitalism tended to amass pollution in and around the cities and resource depletion in the countryside (Foster, 1992). The raising of livestock was progressively hived off from farming, further rupturing the nutrient cycle (Foster & Magdoff, 1998). Finally, the direct capitalist exploitation of the environment, as in the case of silver and sugar, created new secondary networks of productive activity. Silver and sugar gave

burden of a continually increasing population. . . . What people are generally less well aware of is that this situation sketched in 1750—large rations of bread and a little meat—was itself the result of a deterioration and does not apply when we go back in time to the Middle Ages (Braudel & Spooner, 1967: 413–14; see also Teuteberg, 1975: 64–65).

Indeed, falling real wages in this era left a “large group of consumers . . . with no money for buying meat.” Moreover, even if “money wages . . . followed the price of grain at a certain distance[,] . . . wage-earners were without provision against any sudden rise in prices due to crop failures or delay of shipping” (Slicher van Bath, 1963: 205, 199). Finally, it appears that capitalism’s new town-country relation was inscribed, albeit unevenly, in the bodies of the direct producers themselves: per capita meat consumption among city-dwellers increased modestly in the sixteenth century, but declined sharply for peasants, whose meat consumption was just one-seventh that of the urban poor (Blanchard, 1986: 454–55, 460).

life to cash-cropping in cereal agriculture, forestry, and ranching (among others)—all ecologically destructive to varying degrees. Silver and sugar were not the only commodity frontiers of early capitalism. But they were the most important.

We have focused on developments in the Americas rather than Europe in this sketch because it seems doubtful that capitalism could have arisen solely on the basis of Europe's socio-cultural and ecological advantages, which were not great. Indeed, Europe's greatest advantage was its proximity to the Americas, and its distance from Asia's great agrarian empires and trade networks. The Americas assume such special importance to the question of the transition for several reasons. First, the Americas offered gold and silver. Medieval Europe was desperately, chronically short of bullion—as it would be until the nineteenth century. As we have seen, the influx of American silver provided a crucial hedge against famine, particularly in those cities that played a crucial role in the original accumulation of capital. Secondly, the New World's tropical climates were favorable to an array of cash-crops, many of them imported from Afro-Eurasia in a classic instance of "ecological imperialism" (Crosby, 1986). Thirdly, however spirited, the resistance of indigenous societies to European invasion was largely ineffective, thereby removing in most cases the threat of serious peasant revolts, which proved so troublesome to Europe's ruling strata in the fourteenth and fifteenth centuries. Fourthly, while the great decimation of the New World's population through disease—itsself an ecological crisis probably without precedent in the history of human civilization—undermined the possibilities for effective resistance to imperialism, it also posed a labor problem that could be resolved only through coerced labor. The solution to this labor problem was of course found in the African slave trade. The great advantage of modern slavery over serfdom and its pre-modern antecedents was its geographical mobility; even more than wage-labor, slavery allowed capital and planters to move as ecology and economy demanded (Tomich, 2001). No small matter in the restless frontier societies of the New World.

Early capitalism's socio-ecological contradictions were most dramatic in the New World. As a consequence, the system's demand for fresh supplies of land and labor was greatest in the Americas, which provided hospitable terrain to meet such demand because: 1) there were vast tracts of land for the taking, owing to

weak indigenous resistance; and 2) there were ample labor supplies, owing to the success of the African slave trade. In sum, the Americas were not only economically central to the consolidation of capitalism in the “long” sixteenth century; they were *ecologically* central. In other words, the Americas were economically central to the extent that the natural environment favored the rapid accumulation of capital. The unequal ecological exchange between American peripheries and European cores—and between the country and the city at multiple scales—meant not only that the American environment was laid waste, necessitating further widening of the division of labor. Each new stage of such world capitalist widening involved more intensive capitalist agriculture, a new and more serious break in the nutrient cycling of local ecosystems—in Europe no less than the Americas.

The flow of American agricultural products—above all, sugar—meant that the town-country division of labor within core states could be deepened beyond the capacity of any single “national” economy. Robert Brenner may be right that the social transformation of English agriculture—which made possible increased productivity—also made possible the emergence of a vast reserve army of labor which could be put to work in the satanic mills (1977). But there is far more to the story than this. The profits that resulted both directly through the closely-linked sugar and slave trades, and indirectly through the reduced costs for reproducing the English working class, or the profitable activities of shipping and shipbuilding, contributed to an accumulation fund that made possible the further expansion and intensification of the world capitalist division of labor. African slavery, for example, represented not only an *economic* transfer from an external arena to the capitalist world-economy, but also (equally?) an *ecological* transfer. This was slavery’s “ecological calculus.” Planters “bought slaves ‘grown’ in Africa on African food, applied their labor to the production of carbohydrates for export to Europe, and displayed little concern for their survival past the time when they could perform useful work” (Hugill, 1993: 61). “National” development within Europe was fed with the fruits of slavery’s political ecology.

All of which permitted, and indeed compelled, a widening rift between core and periphery, and between town and country, and within the countryside itself. In equal measure, the capacity of local ecosystems to reproduce themselves within the capitalist

division of labor was radically—and more to the point, *progressively*—undermined. Hence, capital's exploitation of the natural environment—that is to say, the exploitation of (extrahuman) nature through the exploitation of labor power—is one of the most, perhaps *the* most, important contradictions necessitating the continued geographical expansion of the capitalist world-economy.

*Antisystemic Movements, Environmental History,
and the Crisis of the Biosphere*

Historical capitalism's preference for spatial rather than social fixes to its recurrent waves of crisis would seem to present a major problem on a planet with very definite geographical limits. As long as fresh land and labor existed beyond the reach of capital (but still within capital's reach), the system's socio-ecological contradictions could be attenuated. The possibilities for external colonization foreclosed by the twentieth century, capital has been compelled to pursue strategies of "internal" colonization, among which we might include the explosive growth of genetically modified plants and animals since the 1940's; drilling ever-deeper and in ever more distant locales for oil and water; and perhaps most ominously, converting human bodies—especially those belonging to women, people of color, workers, and farmers—into toxic waste dumps for a wide range of carcinogenic and otherwise lethal substances.

These developments are new and not new at the same time, and this is precisely what many in the world's environmental movements have missed. These movements have focused on the proximate factors of contemporary environmental degradation—government policies, multinational corporations, international trade organizations and agreements, and so forth—without situating these factors systemically, much less historically. And yet, if left environmentalism is to find a way between ecological reformism and ultra-leftism, it seems to me that a systemic and world-historical reckoning of capitalism's relation to nature could be very fruitful.

Two questions seem especially pertinent. First, how do we know an ecological crisis when we see one? And secondly, who are the agents of environmental sustainability?

“Crisis” is one of those overused terms that easily degenerates into polemical window-dressing. Let us assume for the moment that the relevant crisis is a crisis of capitalism. Here we shall use the term “ecological crisis” in a fairly basic sense, to refer to ecological problems that have reached the point of destabilizing the established relations of production and reproduction, and thereby destabilizing the production of surplus value—such destabilization requiring a major change in both. (How major remains to be seen.) This is what distinguishes ecological crisis from mere degradation. (The latter often constituting genuine human crises in the sense of compelling profound alterations in the daily relations of production for working people, and even small and middling capitalists.) Of course, an ecological crisis in this sense remains hypothetical. But it seems to me that the mere fact that such a crisis is widely recognized and debated, even (especially?) in its hypothetical form, is in itself some indication of the gravity of the situation.

Capitalism’s genius, we have seen, has been to avoid the costs of local and regional ecological degradation through relocation. Capitalism is by nature a global and globalizing system. Regional ecological crises consequently posed no insuperable obstacles to accumulation on a world-scale—indeed, such crises can positively *enable* accumulation, as Mike Davis demonstrates in his careful study of the relations between El Nino fluctuations, disastrous famine, and primitive accumulation in the late nineteenth century (2001). As we have seen, local ecological crises could be overcome through the global extension of productive activities. Only after the Second World War did this begin to change. For the first time, capitalism’s ecological contradictions began to play out on a scale that corresponded to its economic activities. In organizing “economic processes [that] began to rival the ecological cycles of the planet,” the capitalist world-economy opened “up as never before the possibility of planetwide ecological disaster” (Foster, 1994: 108).

The globalization of capitalism and the globalization of ecological crisis are no less tightly bound in the twentieth century than they were in the sixteenth. The difference is the scale of crisis, and this makes a world of difference for the kind of ecological crisis that we are talking about. The idea of ecological crisis as *absolute ecological crisis*—“planetwide ecological disaster”—is perhaps so terrifying that it has obscured other forms of crisis. Historically, we have seen what might be called *systemic ecological crises*—ecological

crises within a historical system that intersected with other social problems to compel a fundamental shift in the structures of wealth accumulation. This was the case with the transition from feudalism to capitalism. We have also seen *ecohistorical crises* within a social system. These compelled major but not fundamental shifts in its political economy. The history of capitalism, for instance, may be told in part by the history of successive reorganizations of agriculture and extraction, ranging from the agricultural revolutions of the seventeenth and eighteenth centuries to the green revolutions of the twentieth. Every stage of capitalism corresponds to historically specific forms of agro-ecological exploitation, each one taking shape out of the previous era's ecological contradictions (Moore, 2000a).

That the global economy cannot sustain its current relationship to the global environment is widely accepted, outside the political right. What remains to be seen is whether the looming ecological crisis is absolute, systemic, or ecohistorical. Signs point in all directions. Without a conception of ecological crisis that identifies its distinct historical geographies, however, we are left with vague notions of crisis that serve the political right and center rather more than the political left. The best that can be said is that the outcome of the contemporary ecological crisis—which I believe is bound up with crisis of capitalism as a historical system—will depend to a large degree on whose historical-geographical knowledge captures the popular imagination.⁵¹

A big part of any potentially liberatory “historical-geographical knowledge” concerns not just the prediction and retrodiction of ecological crisis, but equally the agents of an ecologically sustainability society. I think here Marx's notion of metabolism (*stoffwechsel*) becomes especially important. Too often, thinking in terms of Marx's categories means thinking solely in terms of class and capital. While problems of ecological crisis under capitalism can be conceptualized fully through Marx's categories, these problems cannot at all times be reduced to capital and class. The dialectics of nature, nature and society, and the metabolism of the labor process itself, although dialectically bound to capital and class in the modern era, are inexplicable solely within these latter.

⁵¹ See Harvey's important article on geographical knowledges (2000b).

They can, however, be conceptualized in terms of metabolism, and the division of labor that shapes—and is shaped by—those material exchanges with nature. In the capitalist epoch, the degradation of the soil occurs because of the world-historical (and globally expansionary) relation between town and country; the degradation of the worker occurs because of the world-historical (and globally expansionary) relation between capital and labor. In this way, the geography of the world capitalist system and the “geography” of the human body are linked in ways that evidently have an awful lot to do with capital accumulation and the expanded (re)production of class relations, but cannot be explained solely in terms of those relations. Through Marx’s conception of metabolism, we might extend the reach of historical materialism to the “larger problem of the ‘fate of the earth’ and its species” (Foster, 2000: 254). Thus, to say that nature has its own dialectics, and in various ways its own autonomy, is not to succumb to environmental determinism (which would displace class struggle as the driving force of history) but rather to reinforce the idea that classes make history, but not in eco-geographical conditions of their own choosing.

I think this is where we can begin to think seriously and actively about the agents of an environmentally sustainable society. Bourgeois ideology has scored one of its greatest victories in separating environmental degradation from class exploitation—indeed, this is but one particularly important manifestations of a Cartesian mind-body dualism whose intellectual history dates back to the “long” sixteenth century. Environmentalism, according to the received wisdom, is a “non-class” movement (O’Connor, 1998: 14). While there is a (very small) kernel of truth in this formulation, it obscures a more significant underlying reality. Since the 1980’s, the upsurge in environmental organizing on a world-scale has been driven in large part by the collective action of the direct producers, especially in underdeveloped regions—for instance, South Asian peasants or the U.S. environmental justice movement. The locus of environmental action has begun to shift towards the sites of production (such as the farm) and reproduction (the community), and beyond narrow struggles to preserve “wilderness.”⁵²

⁵² On the concept of nature as pristine wilderness separated from human intervention, see Cronon (1996), and Williams (1980: 67–85).

Struggles over food and water safety have begun to shift the population imagination away from the environment as “out there” to a conception of the environment as “in here”—unsafe meat, hormone-laden milk, and genetically-modified produce have become contested sites of environmental transformation. Cancers, autoimmune diseases, and other health problems are now increasingly linked to, even conceptualized as, environmental degradation.

While the precise translation of these popular concerns into class concerns is an open question, the present conjuncture seems a propitious moment to retool the left’s historical-geographical critique of capitalism in order to put these questions at the center. By privileging the labor process in ecological transformation, we are able to identify working people as the agents of a more sustainable society. For the socio-ecological contradictions of modern class relations promise not just degradation but liberation. “Freedom,” Marx argues, can only be found when a new society of “the associated producers govern[s] the human metabolism with nature in a rational way” (1981: 959). By locating the origins of environmental crisis in the origins of the capitalist system, the world left might begin to make a strong case that environment and class are inseparable, and that the liberation of the soil and the worker are dialectically bound to the same degree as their degradation.

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