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Marx's Theory of Metabolic Rift: Classical Foundations for Environmental Sociology¹

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This article addresses a paradox: on the one hand, environmental sociology, as currently developed, is closely associated with the thesis that the classical sociological tradition is devoid of systematic insights into environmental problems; on the other hand, evidence of crucial classical contributions in this area, particularly in Marx, but also in Weber, Durkheim, and others, is too abundant to be convincingly denied. The nature of this paradox, its origins, and the means of transcending it are illustrated primarily through an analysis of Marx's theory of metabolic rift, which, it is contended, offers important classical foundations for environmental sociology.

CLASSICAL BARRIERS TO ENVIRONMENTAL SOCIOLOGY

In recent decades, we have witnessed a significant transformation in social thought as various disciplines have sought to incorporate ecological awareness into their core paradigms in response to the challenge raised by environmentalism and by what is now widely perceived as a global ecological crisis. This transformation has involved a twofold process of rejecting much of previous thought as ecologically unsound, together with an attempt to build on the past, where possible. This can be seen as occurring with unequal degrees of success in the various disciplines. Geography, with its long history of focusing on the development of the natural landscape and on biogeography (see Sauer 1963), was the social science that adapted most easily to growing environmental concerns. Anthropol-

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ogy, with a tradition of investigating cultural survival and its relation to ecological conditions (see Geertz 1963; Milton 1996), also adjusted quickly to a period of greater environmental awareness. In other social science disciplines, significant progress in incorporating ecological ideas has been made, yet with less discernible effect on the core understandings of these fields. Economics, which was able to draw on the theoretical foundations provided by A. C. Pigou's *Economics of Welfare* (1920), has seen the rapid development of a distinctive, if limited, approach to environmental issues focusing on the internalization of "externalities"—making "environmental economics . . . one of the fastest-growing academic sub-disciplines throughout the industrial world" (Jacobs 1994, p. 67). As a relatively atheoretical field, political science has had little difficulty in incorporating environmental issues into its analysis of public policy, its focus on pluralist interest groups, its social contract theory, and more recently its emphasis on rational choice (Dryzek 1997)—though the pragmatic character of most political science in the United States, together with the lack of a strong Green political party and the absence of a clear connection between identification with environmental causes and voting behavior, has kept the politics of the environment on the margins of the discipline.

In sociology too, dramatic progress has been made, as seen by the rapid growth of the subfield of environmental sociology in the 1970s and again (after a period of quiescence) in the late 1980s and 1990s (see Dunlap 1997). Nevertheless, sociology is perhaps unique within the social sciences in the degree of resistance to environmental issues. An early barrier erected between society and nature, sociology and biology—dividing the classical sociologies of Marx, Weber, and Durkheim from the biological and naturalistic concerns that played a central role in the preclassical sociology of the social Darwinists—has hindered the incorporation of environmental sociology within the mainstream of the discipline, according to an interpretation repeatedly voiced by prominent environmental sociologists over the last two and a half decades (Burch 1971, pp. 14–20; Dunlap and Catton 1979, pp. 58–59; Benton 1994, pp. 28–30; Murphy 1994, pp. ix–x; Beck 1995, pp. 117–20; Buttel 1996, pp. 57–58; Murphy 1996).

Hence, until recently "there has . . . been general agreement among environmental sociologists that the classical sociological tradition has been inhospitable to the nurturing of ecologically-informed sociological theory" (Buttel 1986, p. 338). "From an environmental-sociological point of view," Buttel (1996, p. 57) has argued, "the classical tradition can be said to be 'radically sociological,' in that in their quest to liberate social thought and sociology from reductionisms, prejudices, power relations, and magic, the classical theorists (and, arguably more so, the 20th century interpreters of the classical tradition) wound up exaggerating the auton-

omy of social processes from the natural world.” Likewise, Benton (1994, p. 29) has observed that “the conceptual structure or ‘disciplinary matrix’ by which sociology came to define itself, especially in relation to potentially competing disciplines such as biology and psychology, effectively excluded or forced to the margins of the discipline questions about the relations between society and its ‘natural’ or ‘material’ substrate.” “Sociology,” according to one prominent environmental sociologist, “was constructed as if nature didn’t matter” (Murphy 1996, p. 10). Such marginalization of the physical environment was made possible, in part, through the enormous economic and technological successes of the industrial revolution, which have long given the impression that human society is independent of its natural environment (Dunlap and Martin 1983, pp. 202–3). This is seen as offering an explanation for the fact that “sociological work on resource scarcity never appeared in the discipline’s top journals” in the United States (Dunlap 1997, p. 23; also Dunlap and Catton 1994, p. 8).

Modern sociology in its classical period, according to the prevailing outlook within environmental sociology, was consolidated around a humanistic worldview that emphasized human distinctiveness in relation to nature. This has been referred to by some as the old “human exemptionalist paradigm” in contrast to the “new environmental paradigm,” which rejects the anthropocentrism supposedly characteristic of the former view (Catton and Dunlap 1978; Dunlap and Catton 1994). With respect to Durkheim, for example, it has been argued that the social constituted a distinct reality, relatively autonomous from the physical individual and from psychological and biological pressures (Benton and Redclift 1994, p. 3; Dunlap and Catton 1979, p. 58). “The thrust of Durkheim’s and Weber’s methodological arguments,” according to Goldblatt (1996, p. 3), was to cordon off sociology from biology and nature, rejecting “all forms of biological determinism”; while Marx’s treatment of such issues, though considerable, was largely confined to the “marginal” realm of agricultural economics.

In the language of contemporary environmentalism, then, sociology is a discipline that is “anthropocentric” in orientation, allowing little room for consideration of society’s relation to nature, much less the thoroughgoing “ecocentrism” proposed by many environmentalists. It is rooted in a “socio-cultural determinism” that effectively excludes ecological issues (Dunlap and Martin 1983, p. 204). For Dunlap and Catton (1994, p. 6), sociology needs to shed “the ‘blindness’ imposed by [human] exceptionalism” and to acknowledge “the ecosystem dependence of all human societies.”

One result of this problem of theoretical dissonance is that environmental sociology, despite important innovations, has continued to have only a

marginal role within the discipline as a whole. Although an environmental sociology section of the American Sociological Association was launched in 1976, it did not have the paradigm-shifting effect on sociology that leading figures in the section expected. Neither was sociology as a whole much affected by the rise of environmental sociology, nor did environmental issues gain much notice within the profession. As one leading practitioner of environmental sociology observed in 1987, "The discipline at large has handily withstood the challenges to its theoretical assumptions posed by environmental sociologists" (Buttel 1987, p. 466).

Where the core sociological discipline has been most ready to acknowledge environmental issues is in the area of environmental movements. There the literature has rapidly expanded in recent years through the growth of the environmental justice movement, concerned with the impact of environmental degradation on distinct sociological groupings, conceived in terms of race, class, gender, and international hierarchy. But this literature owes much more to social movement theory than to the environmentalist challenge to traditional sociological conceptions.

One way in which environmental sociologists have sought to address this problem of what are generally perceived as barriers within classical sociology to any consideration of the physical environment is by reaching out to the preclassical social Darwinist tradition: thinkers such as Malthus and Sumner (Catton 1982). Recently, however, there has been a great deal of research within environmental sociology directed not at circumventing the main classical sociological theorists but at unearthing alternative foundations within the classical literature, neglected in later interpretations. For example, an impressive attempt has been made by Murphy (1994) to establish a neo-Weberian sociology by applying Weber's critique of rationalization to the ecological realm and developing an "ecology of social action." Järvikoski (1996) has argued that we should reject the view that Durkheim simply neglected nature, choosing to address instead Durkheim's social constructionism with respect to nature, while examining how society fit within the hierarchical conception of nature that he generally envisioned. Others have stressed Durkheim's use of biological analogies and the demographic basis that he gave to his social morphology of the division of labor and urbanism, which seemed to foreshadow the urban-oriented human ecology of Park and other Chicago sociologists (Buttel 1986, pp. 341-42). The most dramatic growth of literature in relation to classical sociology, however, has centered on Marx's ecological contributions, which were more extensive than in the other classical theorists, and which have spawned a vast and many-sided international debate, encompassing all stages of Marx's work (e.g., Schmidt 1971; Parsons 1977; Giddens 1981; Redclift 1984; Clark 1989; Benton 1989; McLaughlin 1990;

Mayumi 1991; Grundmann 1991; Eckersley 1992; Perelman 1993; Hayward 1994; Harvey 1996; Burkett 1997; Foster 1997; Dickens 1997; O'Connor 1998).

Significantly, this growing literature on the relation of classical sociological theorists to environmental analysis has caused some of the original critics of classical sociology within environmental sociology to soften their criticisms. Buttel, one of the founders of the subdiscipline, has gone so far as to suggest that, despite all of their deficiencies in this respect, "a meaningful environmental sociology can be fashioned from the works of the three classical theorists" (1986, pp. 340–41). We now know, for example, that Weber, writing as early as 1909 in his critique of Wilhelm Ostwald's social energetics, demonstrated some concern over the continued availability of scarce natural resources and anticipated the ecological economist Georgescu-Roegen in arguing that the entropy law applied to materials as well as energy (Martinez-Alier 1987, pp. 183–92). Durkheim's analysis of the implications of Darwinian evolutionary theory—as we shall see below—pointed toward a complex, coevolutionary perspective. Nevertheless, the widespread impression of rigid classical barriers to environmental sociology continues to exert its influence on most environmental sociologists, leaving them somewhat in the state of the mythical centaur, with the head of one creature and the body of another, unable fully to reconcile their theoretical commitment to classical sociology with their environmental sociology, which demands that an emphasis be placed on the relations between society and the natural environment.

The following will focus on addressing the seemingly paradoxical relation of classical sociological theory and environmental sociology by centering on the work of Marx, while referring only tangentially to the cases of Weber and Durkheim. It will be argued that neglected but crucial elements within Marx's social theory offer firm foundations for the development of a strong environmental sociology. In contrast to most treatments of Marx's ecological writings, emphasis will be placed not on his early philosophical works but rather on his later political economy. It is in the latter that Marx provided his systematic treatment of such issues as soil fertility, organic recycling, and sustainability in response to the investigations of the great German chemist Justus von Liebig—and in which we find the larger conceptual framework, emphasizing the metabolic rift between human production and its natural conditions.²

It may seem ironic, given Marx's peculiar dual status as an insider-founder and outsider-critic of classical sociology (not to mention his repu-

² The issue of sustainability, or the notion that basic ecological conditions need to be maintained so that the ability of future generations to fulfill their needs will not be compromised, is the leitmotif of most contemporary environmental thought.

tation in some quarters as an enemy of nature), to turn to him in order to help rescue sociology from the embarrassing dilemma of having paid insufficient attention to the relation between nature and human society. Yet, the discovery or rediscovery of previously neglected features of Marx's vast intellectual corpus has served in the past to revitalize sociology in relation to such critical issues as alienation, the labor process, and, more recently, globalization. The irony may seem less, in fact, when one considers that there already exists "a vast neo-Marxist literature in environmental sociology, and [that] there are few other areas of sociology today that remain so strongly influenced by Marxism" (Buttel 1996, p. 61).

In constructing this argument around Marx, an attempt will be made to comment more broadly on the paradox of the existence—as we are now discovering—of a rich body of material on environmental issues within classical sociological theory, on the one hand, and the widespread perception that the classical tradition excluded any serious consideration of these issues, and itself constitutes a barrier inhibiting the development of environmental sociology, on the other. Here two hypotheses will be advanced arising out of the treatment of Marx. First, the apparent blindness of classical sociological theory to ecological issues is partly a manifestation of the way classical sociology was appropriated in the late 20th century. This can be viewed as *the appropriation problem*. Second, environmental sociology's critique of classical traditions has itself often been rooted in an overly restrictive conception of what constitutes environmental theorizing, reducing it to a narrow "dark green" perspective (as exemplified by the deep ecology tradition).³ This can be thought of as *the definitional problem*.

THE DEBATE ON MARX AND THE ENVIRONMENT

It is a sign of the growing influence of environmental issues that in recent years numerous thinkers, from Plato to Gandhi, have had their work re-evaluated in relation to ecological analysis. Yet it is in relation to Marx's work that the largest and most controversial body of literature can be found, far overshadowing the debate over all other thinkers. This literature (insofar as it takes environmental issues seriously) has fallen into four camps: (1) those who contend that Marx's thought was antiecological from

³ Environmentalists sometimes use the terms "dark green" and "light green" to refer to the same division as that between "deep ecology" and so-called "shallow ecology." In both cases, the nature of the distinction is the same: between what is thought of as an "anthropocentric" perspective versus a more "ecocentric" one—though such distinctions are notoriously difficult to define. For a sympathetic account of deep ecology, see McLaughlin (1993).

beginning to end and indistinguishable from Soviet practice (Clark 1989; Ferkiss 1993); (2) those who claim that Marx provided illuminating insights into ecology but ultimately succumbed to "Prometheanism" (pro-technological, antiecolological views)—a corollary being that he believed that environmental problems would be eliminated as a result of the "abundance" that would characterize postcapitalist society (Giddens 1981; Nove 1987; Redclift 1984; Benton 1989; McLaughlin 1990; Eckersley 1992; De-*léage* 1994; Goldblatt 1996); (3) those who argue that Marx provided an analysis of ecological degradation within agriculture, which remained, however, segregated off from his core social analysis (O'Connor 1998); and (4) those who insist that Marx developed a systematic approach to nature and to environmental degradation (particularly in relation to the fertility of the soil) that was intricately bound to the rest of his thought and raised the question of ecological sustainability (Parsons 1977; Perelman 1993; Mayumi 1991; Lebowitz 1992; Altvater 1993; Foster 1997; Burkett 1997).

Some of the sharpest criticisms of Marx from an environmentalist standpoint have come from leading sociologists (both non-Marxist and Marxist), particularly in Britain. Giddens (1981, p. 60) has contended that Marx, although demonstrating considerable ecological sensitivity in his earliest writings, later adopted a "Promethean attitude" toward nature. Marx's "concern with transforming the exploitative human social relations expressed in class systems does not extend," Giddens writes, "to the exploitation of nature" (1981, p. 59). Similarly, Redclift (1984, p. 7) has observed that for Marx the environment served "an enabling function but all value was derived from labor power. It was impossible to conceive of a 'natural' limit to the material productive forces of society. The barriers that existed to the full realization of resource potential were imposed by property relations and legal obligations rather than resource endowments." More recently, Redclift and Woodgate (1994, p. 53) have added that, "while Marx considered our relations with the environment as essentially social, he also regarded them as ubiquitous and unchanging, common to each phase of social existence. Hence, for Marx, the relationship between people and nature cannot provide a source of change in society. . . . Such a perspective does not fully acknowledge the role of technology, and its effects on the environment." Finally, Nove (1987, p. 399) has contended that Marx believed that "the problem of production had been 'solved' " by capitalism and that the future society of associated producers therefore would not have "to take seriously the problem of the allocation of scarce resources," which meant that there was no need for an "ecologically conscious" socialism.

Marx thus stands accused of wearing *blind*ers in relation to the following: (1) the exploitation of nature, (2) nature's role in the creation of value,

(3) the existence of distinct natural limits, (4) nature's changing character and the impact of this on human society, (5) the role of technology in environmental degradation, and (6) the inability of mere economic abundance to solve environmental problems. If these criticisms were valid, Marx's work could be expected to offer no significant insights into problems of ecological crisis and indeed would itself constitute a major obstacle to the understanding of environmental problems.

In contrast, an attempt will be made to demonstrate here, in the context of a systematic reconstruction of Marx's theory of metabolic rift, that these ecological blinders are not in fact present in Marx's thought—and that each of the problems listed above were addressed to some extent in his theory. Of more significance, it will be contended that Marx provided a powerful analysis of the main ecological crisis of his day—the problem of soil fertility within capitalist agriculture—as well as commenting on the other major ecological crises of his time (the loss of forests, the pollution of the cities, and the Malthusian specter of overpopulation). In doing so, he raised fundamental issues about the antagonism of town and country, the necessity of ecological sustainability, and what he called the “metabolic” relation between human beings and nature. In his theory of metabolic rift and his response to Darwinian evolutionary theory, Marx went a considerable way toward a historical-environmental-materialism that took into account the coevolution of nature and human society.

MARX AND THE SECOND AGRICULTURAL REVOLUTION: THE METABOLIC RIFT

The Concept of the Second Agricultural Revolution

Although it is still common for historians to refer to a single agricultural revolution that took place in Britain in the 17th and 18th centuries and that laid the foundation for the industrial revolution that followed, agricultural historians commonly refer to a second and even a third agricultural revolution. The first agricultural revolution was a gradual process occurring over several centuries, associated with the enclosures and the growing centrality of market relations; technical changes included improved techniques of crop rotation, manuring, drainage, and livestock management. In contrast, the second agricultural revolution (Thompson 1968) occurred over a shorter period (1830–80) and was characterized by the growth of a fertilizer industry and a revolution in soil chemistry, associated in particular with the work of the great German agricultural chemist Justus von Liebig.⁴ The third agricultural revolution was to occur still

⁴ Thompson (1968) designates the second agricultural revolution as occurring over the years 1815–80, that is, commencing with the agricultural crisis that immediately followed the Napoleonic Wars. I have narrowed the period down to 1830–80 here in

later, in the 20th century, and involved the replacement of animal traction with machine traction on the farm and the eventual concentration of animals in massive feedlots, together with the genetic alteration of plants (resulting in narrower monocultures) and the more intensive use of chemical inputs—such as fertilizers and pesticides.

Marx's critique of capitalist agriculture and his main contributions to ecological thought have to be understood in relation to the second agricultural revolution occurring in his time. For Marx, writing in *Capital* in the 1860s, there was a gulf separating the treatment of agricultural productivity and soil fertility in the work of classical economists like Malthus and Ricardo, and the understanding of these problems in his own day. In Marx's ([1863–65] 1981, pp. 915–16) words, "The actual causes of the exhaustion of the land . . . were unknown to any of the economists who wrote about differential rent, on account of the state of agricultural chemistry in their time."

The source of the differential fertility from which rent was derived was, in the work of Malthus and Ricardo in the opening decades of the 19th century, attributed almost entirely to the natural or absolute productivity of the soil—with agricultural improvement (or degradation) playing only a marginal role. As Ricardo (1951, p. 67) observed, rent could be defined as "that portion of the produce of the earth, which is paid to the landlord for the use of the original and indestructible powers of the soil." These thinkers argued—with the presumed backing of natural law—that lands that were naturally the most fertile were the first to be brought into production and that rising rent on these lands and decreasing agricultural productivity overall were the result of lands of more and more marginal fertility being brought into cultivation, in response to increasing demographic pressures. Further, while some agricultural improvement was possible, it was quite limited, since the increases in productivity to be derived from successive applications of capital and labor to any given plot of land were said to be of diminishing character, thereby helping to account for the slowdown in growth of productivity in agriculture. All of this pointed to the Malthusian dilemma of a tendency of population to outgrow food supply—a tendency only countered as a result of vice and misery that served to lower fecundity and increase mortality, as Malthus emphasized in his original essay on population, or through possible moral restraint, as he was to add in later editions of that work.

order to distinguish between the crisis that to some extent preceded the second agricultural revolution and the revolution proper, for which the turning point was the publication of Liebig's *Organic Chemistry* in 1840 followed by J. B. Lawes's building of the first factory for the production of synthetic fertilizer (superphosphates) a few years later.

Classical Marxism, in contrast, relied from the beginning on the fact that rapid historical improvement in soil fertility was possible, though not inevitable, given existing social relations. In his "Outlines of a Critique of Political Economy," published in 1844, a young Friedrich Engels was to point to revolutions in science and particularly soil chemistry—singling out the discoveries of such figures as Humphry Davy and Liebig—as constituting the main reason why Malthus and Ricardo would be proven wrong about the possibilities for rapidly improving the fertility of the soil and thereby promoting a favorable relation between the growth of food and the growth of population. Engels (1964, pp. 208–10) went on to observe that, "To make earth an object of huckstering—the earth which is our one and all, the first condition of our existence—was the last step toward making oneself an object of huckstering." Three years later in *The Poverty of Philosophy*, Marx (1963, pp. 162–63) wrote that at "every moment the modern application of chemistry is changing the nature of the soil, and geological knowledge is just now, in our days, beginning to revolutionize all the old estimates of relative fertility. . . . Fertility is not so natural a quality as might be thought; it is closely bound up with the social relations of the time."

This emphasis on historical changes in soil fertility in the direction of agricultural improvement was to be a continuing theme in Marx's thought, though it eventually came to be coupled with an understanding of how capitalist agriculture could undermine the conditions of soil fertility, resulting in soil degradation rather than improvement. Thus in his later writings, increasing emphasis came to be placed on the exploitation of the earth in the sense of the failure to sustain the conditions of its reproduction.

Liebig and the Depletion of the Soil

During 1830–70 the depletion of soil fertility through the loss of soil nutrients was the overriding environmental concern of capitalist society in both Europe and North America, comparable only to concerns over the growing pollution of the cities, deforestation of whole continents, and the Malthusian fears of overpopulation (Foster 1997; O'Connor 1998, p. 3). In the 1820s and 1830s in Britain, and shortly afterward in the other developing capitalist economies of Europe and North America, widespread concerns about "soil exhaustion" led to a phenomenal increase in the demand for fertilizer. The value of bone imports to Britain increased from £14,400 in 1823 to £254,600 in 1837. The first boat carrying Peruvian guano (accumulated dung of sea birds) unloaded its cargo in Liverpool in 1835; by 1841, 1,700 tons were imported, and by 1847, 220,000 (Ernle [1912] 1961, p. 369). European farmers in this period raided Napoleonic battlefields such

as Waterloo and Austerlitz, so desperate were they for bones to spread over their fields (Hillel 1991, pp. 131–32).

The second agricultural revolution associated with the rise of modern soil science was closely correlated with this demand for increased soil fertility to support capitalist agriculture. In 1837, the British Association for the Advancement of Science commissioned Liebig to write a work on the relationship between agriculture and chemistry. The following year saw the founding of the Royal Agricultural Society of England, viewed by economic historians as a leading organization in the British high-farming movement—a movement of wealthy landowners to improve farm management. In 1840, Liebig published his *Organic Chemistry in Its Applications to Agriculture and Physiology*, which provided the first convincing explanation of the role of soil nutrients, such as nitrogen, phosphorous, and potassium, in the growth of plants. One of the figures most influenced by Liebig's ideas was the wealthy English landowner and agronomist J. B. Lawes. In 1842, Lawes invented a means of making phosphate soluble, enabling him to introduce the first artificial fertilizer, and in 1843, he built a factory for the production of his new "superphosphates." With the repeal of the Corn Laws in 1846, Liebig's organic chemistry was seen by the large agricultural interests in England as the key to obtaining larger crop yields (Brock 1997, pp. 149–50).

In the 1840s, this scientific revolution in soil chemistry, together with the rise of a fertilizer industry, promised to generate a faster rate of agricultural improvement—impressing many contemporary observers, including Marx and Engels, who up to the 1860s believed that progress in agriculture might soon outpace the development of industry in general. Still, capital's ability to take advantage of these scientific breakthroughs in soil chemistry was limited by development of the division of labor inherent to the system, specifically the growing antagonism between town and country. By the 1860s, when he wrote *Capital*, Marx had become convinced of the contradictory and unsustainable nature of capitalist agriculture, due to two historical developments in his time: (1) the widening sense of crisis in agriculture in both Europe and North America associated with the depletion of the natural fertility of the soil, which was in no way alleviated, but rather given added impetus by the breakthroughs in soil science; and (2) a shift in Liebig's own work in the late 1850s and early 1860s toward an ecological critique of capitalist development.

The discoveries by Liebig and other soil scientists, while holding out hope to farmers, also intensified in some ways the sense of crisis within capitalist agriculture, making farmers more acutely aware of the depletion of soil minerals and the paucity of fertilizers. The contradiction was experienced with particular severity in the United States—especially among farmers in New York and in the plantation economy of the Southeast.

Blocked from ready access to guano (which was high in both nitrogen and phosphates) by the British monopoly of Peruvian guano supplies, U.S. capitalists spread across the globe looking for alternative supplies. Nevertheless, the quantity and quality of natural fertilizer obtained in this way fell far short of U.S. needs (Skaggs 1994).

Peruvian guano was largely exhausted in the 1860s and had to be replaced by Chilean nitrates. Potassium salts discovered in Europe gave ample access to that mineral, and phosphates became more readily available through both natural and artificial supplies. Yet prior to the development of a process for producing synthetic nitrogen fertilizer in 1913, fertilizer nitrogen continued to be in chronically short supply. It was in this context that Liebig was to state that what was needed to overcome this barrier was the discovery of "deposits of manure or guano . . . in volumes approximating to those of the English coalfields" (quoted in Kautsky [(1899) 1988], vol. 1, p. 53).

The second agricultural revolution, associated with the application of scientific chemistry to agriculture, was therefore at the same time a period of intense contradictions. The decline in the natural fertility of the soil due to the disruption of the soil nutrient cycle, the expanding scientific knowledge of the need for specific soil nutrients, and the simultaneous limitations in the supply of both natural and synthetic fertilizers, all served to generate serious concerns about present and future soil fertility under capitalist agriculture.

In upstate New York, increased competition from farmers to the west in the decades following the opening of the Erie Canal in 1825 intensified the concern over the "worn-out soil." In 1850, the British soil chemist, James F. W. Johnston, whom Marx (Marx and Engels 1975a, vol. 38, p. 476) was to call "the English Liebig," visited the United States. In his *Notes on North America*, Johnston (1851, pp. 356–65) recorded the depleted condition of the soil in upstate New York, comparing it unfavorably to the more fertile, less exhausted farmlands to the west. These issues were taken up by the U.S. economist Henry Carey, who in the late 1840s and 1850s laid stress on the fact that long-distance trade, which he associated with the separation of town from country and of agricultural producers from consumers ([1847] 1967a, pp. 298–99, 304–8), was the major factor in the net loss of nutrients to the soil and in the growing soil fertility crisis. "As the whole energies of the country," Carey wrote of the United States in his *Principles of Social Science*, "are given to the enlargement of the trader's power, it is no matter of surprise that its people are everywhere seen employed in 'robbing the earth of its capital stock'" ([1858–59] 1867, p. 215; also Carey [1853] 1967b, p. 199).

Carey's views were to have an important impact on Liebig. In his *Letters on Modern Agriculture* (1859), Liebig argued that the "empirical agri-

culture" of the trader gave rise to a "spoliation system" in which the "conditions of reproduction" of the soil were undermined. "A field from which something is permanently taken away," he wrote, "cannot possibly increase or even continue equal in its productive power." Indeed, "every system of farming based on the spoliation of the land leads to poverty" (1859, pp. 175–78). "Rational agriculture, in contrast to the spoliation system of farming, is based on the principle of restitution; by giving back to the fields the conditions of their fertility, the farmer insures the permanence of the latter." For Liebig, English "high farming" was "not the open system of robbery of the American farmer . . . but is a more refined species of spoliation which at first glance does not look like robbery" (1859, p. 183). Echoing Carey (1858), Liebig (1859, p. 220) observed that there were hundreds, sometimes thousands, of miles in the United States between the centers of grain production and their markets. The constituent elements of the soil were thus shipped to locations far removed from their points of origin, making the reproduction of soil fertility that much more difficult.

The problem of the pollution of the cities with human and animal wastes was also tied to the depletion of the soil. In Liebig's (1863, p. 261) words, "If it were practicable to collect, with the least loss, all the solid and fluid excrements of the inhabitants of the town, and return to each farmer the portion arising from produce originally supplied by him to the town, the productiveness of the land might be maintained almost unimpaired for ages to come, and the existing store of mineral elements in every fertile field would be amply sufficient for the wants of increasing populations." In his influential *Letters on the Subject of the Utilization of the Municipal Sewage* (1865) Liebig argued—basing his analysis on the condition of the Thames—that organic recycling that would return the nutrients contained in sewage to the soil was an indispensable part of a rational urban-agricultural system.

Marx and the Metabolic Rift

When working on *Capital* in the early 1860s, Marx was deeply affected by Liebig's analysis. In 1866, he wrote to Engels that in developing his critique of capitalist ground rent, "I had to plough through the new agricultural chemistry in Germany, in particular Liebig and Schönbein, which is more important for this matter than all the economists put together" (Marx and Engels 1975a, vol. 42, p. 227). Indeed, "to have developed from the point of view of natural science the negative, i.e., destructive side of modern agriculture," Marx was to note in *Capital*, "is one of Liebig's immortal merits" ([1867] 1976, p. 638). Far from having ecological blinders with regard to the exploitation of the earth, Marx, under the influence of Liebig's work of the late 1850s and early 1860s, was to develop

a systematic critique of capitalist "exploitation" (in the sense of robbery, i.e., failing to maintain the means of reproduction) of the soil.

Marx concluded both of his two main discussions of capitalist agriculture with an explanation of how large-scale industry and large-scale agriculture combined to impoverish the soil and the worker. Much of the resulting critique was distilled in a remarkable passage at the end of Marx's treatment of "The Genesis of Capitalist Ground Rent" in *Capital*, volume 3, where he wrote:

Large landed property reduces the agricultural population to an ever decreasing minimum and confronts it with an ever growing industrial population crammed together in large towns; in this way it produces conditions that provoke an irreparable rift in the interdependent process of the social metabolism, a metabolism prescribed by the natural laws of life itself. The result of this is a squandering of the vitality of the soil, which is carried by trade far beyond the bounds of a single country. (Liebig.) . . . Large-scale industry and industrially pursued large-scale agriculture have the same effect. If they are originally distinguished by the fact that the former lays waste and ruins the labour-power and thus the natural power of man, whereas the latter does the same to the natural power of the soil, they link up in the later course of development, since the industrial system applied to agriculture also enervates the workers there, while industry and trade for their part provide agriculture with the means of exhausting the soil. (Marx 1981, pp. 949–50)

Marx provided a similar and no less important distillation of his critique in this area in his discussion of "Large-scale Industry and Agriculture" in volume 1 of *Capital*:

Capitalist production collects the population together in great centres, and causes the urban population to achieve an ever-growing preponderance. This has two results. On the one hand it concentrates the historical motive force of society; on the other hand, it disturbs the metabolic interaction between man and the earth, i.e. it prevents the return to the soil of its constituent elements consumed by man in the form of food and clothing; hence it hinders the operation of the eternal natural condition for the lasting fertility of the soil. . . . But by destroying the circumstances surrounding that metabolism . . . it compels its systematic restoration as a regulative law of social production, and in a form adequate to the full development of the human race. . . . All progress in capitalist agriculture is a progress in the art, not only of robbing the worker, but of robbing the soil; all progress in increasing the fertility of the soil for a given time is a progress toward ruining the more long-lasting sources of that fertility. . . . Capitalist production, therefore, only develops the techniques and the degree of combination of the social process of production by simultaneously undermining the original sources of all wealth—the soil and the worker. (Marx 1976, pp. 637–38)

In both of these passages from Marx's *Capital*—the first concluding his discussion of capitalist ground rent in volume 3 and the second concluding

his discussion of large-scale agriculture in volume 1—the central theoretical construct is that of a “rift” in the “metabolic interaction between man and the earth,” or in the “social metabolism prescribed by the natural laws of life,” through the removal from the soil of its constituent elements, requiring its “systematic restoration.” This contradiction is associated with the growth simultaneously of large-scale industry and large-scale agriculture under capitalism, with the former providing agriculture with the means of the intensive exploitation of the soil. Following Liebig, Marx argued that long-distance trade in food and clothing made the problem of the alienation of the constituent elements of the soil that much more of an “irreparable rift.” As he indicated elsewhere in *Capital* (vol. 1), the fact that “the blind desire for profit” had “exhausted the soil” of England could be seen daily in the conditions that “forced the manuring of English fields with guano” imported from Peru (1976, p. 348). Central to Marx’s argument was the notion that capitalist large-scale agriculture prevents any truly rational application of the new science of soil management. Despite all of its scientific and technological development in the area of agriculture, capitalism was unable to maintain those conditions necessary for the recycling of the constituent elements of the soil.

The key to Marx’s entire theoretical approach in this area is the concept of social-ecological metabolism (*Stoffwechsel*), which was rooted in his understanding of the labor process. Defining the labor process in general (as opposed to its historically specific manifestations), Marx employed the concept of metabolism to describe the human relation to nature through labor:

Labour is, first of all, a process between man and nature, a process by which man, through his own actions, mediates, regulates and controls the metabolism between himself and nature. He confronts the materials of nature as a force of nature. He sets in motion the natural forces which belong to his own body, his arms, legs, head and hands, in order to appropriate the materials of nature in a form adapted to his own needs. Through this movement he acts upon external nature and changes it, and in this way he simultaneously changes his own nature. . . . It [the labor process] is the universal condition for the metabolic interaction [*Stoffwechsel*] between man and nature, the everlasting nature-imposed condition of human existence. (Marx 1976, pp. 283, 290)

Only a few years before this, Marx had written in his *Economic Manuscript of 1861–63* that “actual labour is the appropriation of nature for the satisfaction of human needs, the activity through which the metabolism between man and nature is mediated.” It followed that the actual activity of labor was never independent of nature’s own wealth-creating potential, “since material wealth, the world of use values, exclusively consists of

natural materials modified by labour” (Marx and Engels 1975a, vol. 30, p. 40).⁵

Much of this discussion of the metabolic relation between human beings and nature reflected Marx’s early, more directly philosophical attempts to account for the complex interdependence between human beings and nature. In the *Economic and Philosophical Manuscripts* of 1844, Marx had explained that, “Man *lives* from nature, i.e., nature is his *body*, and he must maintain a continuing dialogue with it if he is not to die. To say that man’s physical and mental life is linked to nature simply means that nature is linked to itself, for man is a part of nature” (1974, p. 328; emphasis in original). But the later introduction of the concept of metabolism gave Marx a more solid—and scientific—way in which to depict the complex, dynamic interchange between human beings and nature, resulting from human labor. The material exchanges and regulatory action associated with the concept of metabolism encompassed both “nature-imposed conditions” and the capacity of human beings to affect this process. According to Hayward (1994, p. 116), Marx’s concept of socio-ecological metabolism “captures fundamental aspects of humans’ existence as both natural and physical beings: these include the energetic and material exchanges which occur between human beings and their natural environment. . . . This metabolism is regulated from the side of nature by natural laws governing the various physical processes involved, and from the side of society by institutionalized norms governing the division of labor and distribution of wealth etc.”

Given the fundamental way in which Marx conceived of the concept of metabolism—as constituting the complex, interdependent process linking human society to nature—it should not surprise us that this concept enters

⁵ Marx highlighted the methodological importance of the concept of “material exchange [*Stoffwechsel*] between man and nature” in his *Notes on Adolph Wagner*, his last economic work, written in 1880 (1975, p. 209). As early as 1857–58 in the *Grundrisse*, Marx had referred to the concept of metabolism (*Stoffwechsel*) in the wider sense of “a system of general social metabolism, of universal relations, of all-round needs and universal capacities . . . formed for the first time” under generalized commodity production (1973, p. 158). Throughout his later economic works, he employed the concept to refer both to the actual metabolic interaction between nature and society through human labor, and also in a wider sense to describe the complex, dynamic, interdependent set of needs and relations brought into being and constantly reproduced in alienated form under capitalism, and the question of human freedom that this raised—all of which could be seen as being connected to the way in which the human metabolism with nature was expressed through the organization of human labor. Marx thus gave the concept of metabolism both a specific ecological meaning and a wider social meaning. It makes sense therefore to speak of the “socioecological” nature of his concept.

into Marx's vision of a future society of associated producers: "Freedom, in this sphere [the realm of natural necessity]," he wrote in *Capital* (volume 3), "can consist only in this, that socialized man, the associated producers, govern the human metabolism with nature in a rational way, bringing it under their own collective control rather than being dominated by it as a blind power; accomplishing it with the least expenditure of energy and in conditions most worthy and appropriate for their human nature" (1981, p. 959).

Just as the introduction of the concept of "metabolism" allowed Marx to provide a firmer, scientific grounding for his ideas, so the central position that this concept came to occupy in his theory encouraged him to draw out some of its larger implications. The term "metabolism" (*Stoffwechsel*) was introduced as early as 1815 and was adopted by German physiologists in the 1830s and 1840s to refer to material exchanges within the body, related to respiration (Bing 1971; Caneva 1993). But the term was given a somewhat wider application (and therefore greater currency) in 1842 by Liebig in his *Animal Chemistry*, the great work that followed his earlier work on the soil, where he introduced the notion of metabolic process (in the context of tissue degradation). It was subsequently generalized still further and emerged as one of the key concepts, applicable both at the cellular level and in the analysis of entire organisms, in the development of biochemistry (Liebig [1842] 1964; Brock 1997, p. 193; Caneva 1993, p. 117).

Within biological and ecological analysis, the concept of metabolism, beginning in the 1840s and extending down to the present day, has been used as a central category in the systems-theory approach to the relation of organisms to their environments. It refers to a complex process of metabolic exchange, whereby an organism (or a given cell) draws upon materials and energy from its environment and converts these by way of various metabolic reactions into the building blocks of proteins and other compounds necessary for growth. The concept of metabolism is also used to refer to the regulatory processes that govern this complex interchange between organisms and their environment (Fischer-Kowalski 1997, p. 120). Leading system ecologists like Odum (1969, p. 7) employ "metabolism" to refer to all biological levels, beginning with the single cell and ending with the ecosystem.

Recently, the notion of metabolism has become what Fischer-Kowalski (1997, pp. 119–20) has called "a rising conceptual star" within social-ecological thought, as a result of the emergence of cross-disciplinary research in "industrial metabolism." For some thinkers, it offers a way out of one of the core dilemmas of environmental sociology raised by Dunlap and Catton (1979) and Schnaiberg (1980), which requires a way of envisioning the complex interaction between society and nature (Hayward 1994, pp. 116–

17; Fischer-Kowalski 1997). Further, the concept of metabolism has long been employed to analyze the material interchange between city and country, in a manner similar to the way in which Liebig and Marx used the concept (Wolman 1965; Giradet 1997). Within this rapidly growing body of literature on social-ecological metabolism, it is now well recognized that “within the nineteenth-century foundations of social theory, it was Marx and Engels who applied the term ‘metabolism’ to society” (Fischer-Kowalski 1997, p. 122).

Indeed, environmental sociologists and others exploring the concept of “industrial metabolism” today argue that just as the materials that birds use to build their nests can be seen as material flows associated with the metabolism of birds, so similar material flows can be seen as part of the human metabolism. Fischer-Kowalski has thus suggested “considering as part of the metabolism of a social system *those material and energetic flows that sustain the material compartments of the system*” (1997, pp. 121, 131; emphasis in original). The tough question, however, is how such a human metabolism with nature is regulated on the side of society. For Marx, the answer was human labor and its development within historical social formations.

MARX AND SUSTAINABILITY

An essential aspect of the concept of metabolism is the notion that it constitutes the basis on which life is sustained and growth and reproduction become possible. Contrary to those who believe that he wore an ecological blinder that prevented him from perceiving natural limits to production, Marx employed the concept of metabolic rift to capture the material estrangement of human beings in capitalist society from the natural conditions of their existence. To argue that large-scale capitalist agriculture created such a metabolic rift between human beings and the soil was to argue that basic conditions of sustainability had been violated. “Capitalist production,” Marx ([1861–63] 1971*b*, p. 301) wrote, “turns toward the land only after its influence has exhausted it and after it has devastated its natural qualities.” Moreover, this could be seen as related not only to the soil but to the antagonism between town and country. For Marx, like Liebig, the failure to recycle nutrients to the soil had its counterpart in the pollution of the cities and the irrationality of modern sewage systems. In *Capital* (volume 3), he observed: “In London . . . they can do nothing better with the excrement produced by 4 1/2 million people than pollute the Thames with it, at monstrous expense” (1981, p. 195). Engels was no less explicit on this point. In addressing the need to transcend the antagonism between town and country, he referred, following Liebig, to the fact that “in London alone a greater quantity of manure than is produced by

the whole kingdom of Saxony is poured away every day into the sea with an expenditure of enormous sums" and to the consequent need to reestablish an "intimate connection between industrial and agricultural production" along with "as uniform a distribution as possible of the population over the whole country" (Engels [1872] 1975, p. 92). For Marx, the "excrement produced by man's natural metabolism," along with the waste of industrial production and consumption, needed to be recycled back into the production, as part of a complete metabolic cycle (1981, p. 195).

The antagonistic division between town and country, and the metabolic rift that it entailed, was also evident at a more global level: whole colonies saw their land, resources, and soil robbed to support the industrialization of the colonizing countries. "For a century and a half," Marx wrote, "England has indirectly exported the soil of Ireland, without as much as allowing its cultivators the means for making up the constituents of the soil that had been exhausted" (1976, p. 860).

Marx's view of capitalist agriculture and of the necessity of cycling the nutrients of the soil (including the organic wastes of the city) thus led him to a wider concept of ecological sustainability—a notion that he thought of very limited practical relevance to capitalist society, which was incapable of such consistent rational action, but essential for a future society of associated producers. "The way that the cultivation of particular crops depends on fluctuations in market prices and the constant change in cultivation with these prices—the entire spirit of capitalist production, which is oriented towards the most immediate monetary profits—stands in contradiction to agriculture, which has to concern itself with the whole gamut of permanent conditions of life required by the chain of successive generations" (Marx 1981, p. 754).

In emphasizing the need to maintain the earth for "successive generations," Marx captured the essence of the contemporary notion of sustainable development, defined most famously by the Brundtland Commission as "development which meets the needs of the present without compromising the ability of future generations to meet their needs" (World Commission on Environment and Development 1987, p. 43). For Marx, the "conscious and rational treatment of the land as permanent communal property" is "the inalienable condition for the existence and reproduction of the chain of human generations" (1981, pp. 948–49). Indeed, in a remarkable, and deservedly famous, passage in *Capital* (vol. 3), Marx wrote, "From the standpoint of a higher socio-economic formation, the private property of particular individuals in the earth will appear just as absurd as the private property of one man in other men. Even an entire society, a nation, or all simultaneously existing societies taken together, are not owners of the earth, they are simply its possessors, its beneficiaries, and

have to bequeath it in an improved state to succeeding generations as *boni patres familias* [good heads of the household]" (1981, p. 911).

This took on greater significance near the end of Marx's life, when, as a result of his investigations into the revolutionary potential of the archaic Russian commune (the Mir), he argued that it would be possible to develop an agricultural system "organized on a vast scale and managed by cooperative labor" through the introduction of "modern agronomic methods." The value of such a system, he argued, would be that it would be "in a position to incorporate all the positive acquisitions devised by the capitalist system" without falling prey to the purely exploitative relation to the soil, that is, the robbery, that characterized the latter (Marx and Engels 1975a, vol. 24, p. 356). Marx's absorption in the literature of the Russian populists at the end of his life, and his growing conviction that the revolution would emerge first within Russia—where economic, and more specifically agricultural, abundance could not be assumed—forced him to focus on agricultural underdevelopment and the ecological requirements of a more rational agricultural system.⁶

Marx and Engels did not restrict their discussions of environmental degradation to the robbing of the soil but also acknowledged other aspects of this problem, including the depletion of coal reserves, the destruction of forests, and so on. As Engels observed in a letter to Marx, "the working individual is not only a stabiliser of *present* but also, and to a far greater extent, a squanderer of *past*, solar heat. As to what we have done in the way of squandering our reserves of energy, our coal, ore, forests, etc., you are better informed than I am" (Marx and Engels 1975a, vol. 46, p. 411; emphasis in original). Marx referred to the "devastating" effects of "deforestation" (Marx and Engels 1975a, vol. 42, p. 559) and saw this as a long-term result of an exploitative relation to nature (not simply confined to capitalism): "The development of civilization and industry in general," Marx wrote, "has always shown itself so active in the destruction of forests that everything that has been done for their conservation and production is completely insignificant in comparison" ([1865–70] 1978, p. 322). He lamented the fact that the forests in England were not "true forests" since "the deer in the parks of the great are demure domestic cattle, as fat as London aldermen"; while in Scotland, the so-called "deer-forests" that were established for the benefit of huntsmen (at the expense of rural laborers) contained deer but no trees (1976, pp. 892–93). Under the influence of Darwin, Marx and Engels repudiated the age-old view that human beings were at the center of the natural universe. Engels expressed "a

⁶ On this later phase of Marx's analysis, in which he addressed the agricultural concerns of the Russian populists, see Shanin (1983).

withering contempt for the idealistic exaltation of man over the other animals" (Marx and Engels 1975*b*, p. 102).

Some critics attribute to Marx an ecological blinder associated with an overly optimistic faith in the cornucopian conditions supposedly made possible by the forces of production under capitalism. In this view, he relied so much on the assumption of abundance in his conception of a future society that ecological factors such as the scarcity of natural resources were simply nonexistent. Yet whatever Marx may have thought in his more "utopian" conceptions, it is clear from his discussions of both capitalism and of the transition to socialism that he was far from believing, as Nove (1987, p. 399) contends, "that the problem of production" had already been "solved" under capitalism or that natural resources were "inexhaustible." Rather, capitalism, as he emphasized again and again, was beset with a chronic problem of production in agriculture, which ultimately had to do with an unsustainable form of production in relation to natural conditions. Agriculture, Marx observed, "when it progresses spontaneously and is not *consciously controlled* . . . leaves deserts behind it" (Marx and Engels 1975*b*, p. 190; emphasis in original). Within industry too, Marx was concerned about the enormous waste generated and emphasized the "reduction" and "re-use" of waste—particularly in a section of *Capital* (volume 3), entitled, "Utilization of the Refuse of Production" (1981, pp. 195–97). Moreover, he gave every indication that these problems would continue to beset any society attempting to construct socialism (or communism). Hence, although some critics, such as McLaughlin (1990, p. 95), assert that Marx envisioned "a general material abundance as the substratum of communism," and therefore saw "no basis for recognizing any interest in the liberation of nature from human domination," overwhelming evidence to the contrary (much of it referred to above) suggests that Marx was deeply concerned with issues of ecological limits and sustainability.

Moreover, there is simply no indication anywhere in Marx's writings that he believed that a sustainable relation to the earth would come automatically with the transition to socialism. Rather, he emphasized the need for planning in this area, including such measures as the elimination of the antagonism between town and country through the more even dispersal of the population (Marx and Engels [1848] 1967, pp. 40–41) and the restoration and improvement of the soil through the recycling of soil nutrients. All of this demanded a radical transformation in the human relation to the earth via changed production relations. Capitalism, Marx wrote, "creates the material conditions for a new and higher synthesis, a union of agriculture and industry on the basis of the forms that have developed during the period of their antagonistic isolation" (1976, p. 637). But in order to achieve this "higher synthesis" in a society of freely associated

producers, he argued, it would be necessary for the associated producers to “govern the human metabolism with nature in a rational way”—a requirement that raised fundamental challenges for postcapitalist society (1981, p. 959; 1976, pp. 637–38).

Another ecological blinder commonly attributed to Marx is that he denied the role of nature in the creation of wealth by developing a labor theory of value that saw all value as derived from labor, and by referring to nature as a “free gift” to capital, lacking any intrinsic value of its own (Deléage 1994, p. 48; Churchill 1996, pp. 467–68; Georgescu-Roegen 1971, p. 2). Yet this criticism is based on a misunderstanding of Marx’s political economy. Marx did not invent the idea that the earth was a “gift” of nature to capital. This notion was advanced as a key proposition by Malthus and Ricardo in their economic works (Malthus 1970, p. 185). It was taken up later on by the great neoclassical economist Alfred Marshall (1920) and persisted in neoclassical economics textbooks into the 1980s. Thus, in the 10th edition of a widely used introductory economics textbook, we discover the following: “Land refers to all natural resources—all ‘free gifts of nature’—which are usable in the production process.” And further on we read, “Land has no production cost; it is a ‘free and nonreproducible gift of nature’” (McConnell 1987, pp. 20, 672). Marx was aware of the social-ecological contradictions embedded in such views, and in his *Economic Manuscript of 1861–63* he attacked Malthus repeatedly for falling back on the “physiocratic” notion that the environment was “a gift of nature to man,” while ignoring how this was connected to the definite set of social relations brought into being by capital (Marx and Engels 1975a, vol. 34, pp. 151–59).

To be sure, Marx agreed with liberal economics that under the law of value of capitalism nature was accorded no value. “The earth . . . is active as agent of production in the production of a use-value, a material product, say wheat,” he wrote. “But it has nothing to do with producing the *value of the wheat*” (1981, p. 955). The value of the wheat as in the case of any commodity under capitalism was derived from labor. For Marx, however, this merely reflected the narrow, limited conception of wealth embodied in capitalist commodity relations and in a system built around exchange value. Genuine wealth consisted of use values—the characteristic of production in general, transcending its capitalist form. Hence, nature, which contributed to the production of use values, was just as much a source of wealth as labor. “What Lucretius says,” Marx wrote in *Capital* (1976, p. 323), “is self-evident: *nil posse creari de nihilo*, out of nothing, nothing can be created. . . . Labour-power itself is, above all else, the material of nature transposed into a human organism.”

It follows that “labour,” as Marx stated at the beginning of *Capital*, “is not the only source of material wealth, that is, of the use-values it pro-

duces. As William Petty says, labour is the father of material wealth, and the earth is its mother" (1976, p. 134). In the *Critique of the Gotha Programme*, Marx criticized those socialists who had attributed what he called "supernatural creative power to labour" ([1875] 1971a, p. 11; emphasis in original) by viewing it as the sole source of wealth and disregarding the role of nature. Under communism, he argued, wealth would need to be conceived in far more universal terms, as consisting of those material use values that constituted the basis for the full development of human creative powers, "the development of the rich individuality which is all sided in its production as in its consumption"—expanding the wealth of connections allowed for by nature, while at the same time reflecting the developing human metabolism with nature ([1857–58] 1973, p. 325).

Marx therefore set himself in opposition to all those who thought the contribution of nature to the production of wealth could be disregarded, or that nature could be completely subordinated to human ends regardless of their character. Commenting in the *Grundrisse* on Bacon's ([1620] 1994, pp. 29, 43) great maxim that "nature is only overcome by obeying her"—on the basis of which Bacon also proposed to "subjugate" nature—Marx replied that for capitalism the theoretical discovery of nature's "autonomous laws appears merely as a ruse so as to subjugate it under human needs, whether as an object of consumption or a means of production" (1973, pp. 409–10).

For Engels too, it was clear that to construct a society built on the vain hope of the total conquest of external nature was sheer folly. As he wrote in *The Dialectics of Nature* ([1874–80] 1940, pp. 291–92), "Let us not, however, flatter ourselves overmuch on account of our human conquest of nature. For each such conquest takes revenge on us. . . . At every step we are reminded that we by no means rule over nature like a conqueror over a foreign people, like someone standing outside nature—but that we, with flesh, blood, and brain, belong to nature, and exist in its midst, and that all our mastery of it consists in the fact that we have the advantage of all other beings of being able to know and correctly apply its laws."

For Marx, "the human metabolism with nature" was a highly dynamic relationship, reflecting changes in the ways human beings mediated between nature and society through production. Engels and Marx read *The Origin of Species* soon after it appeared in 1859 and were enthusiastic supporters of Darwin's theory of natural selection. Marx (1976, p. 461) called Darwin's book an "epoch-making work," and in January 1861, Marx wrote a letter to the German socialist Ferdinand Lasalle stating that Darwin had dealt the "death blow" to "'teleology' in the natural sciences" (Marx and Engels 1975a, vol. 41, pp. 246–47). Marx expressed no reservations about Darwin's fundamental theory itself—not even with regard to

Darwin's application of the Malthusian "struggle for existence" to the world of plants and animals—yet he was sharply critical of all attempts by social Darwinists to carry this analysis beyond its proper domain and to apply it to human history. Unfortunately, some critics have viewed his cautionary notes in this respect as criticisms of Darwin himself.⁷

Darwin's evolutionary theory led Marx and Engels to what would now be called a "cautious constructionism" (Dunlap 1997, pp. 31–32). For Marx, human evolution, that is, human history, was distinct from evolution as it occurred among plants and animals, in that the natural evolution of the physical organs of the latter, that is, "the history of natural technology," had its counterpart in human history in the conscious development of the "productive organs of man in society" (technology), which helped establish the conditions for the human mediation between nature and society via production (Marx 1976, p. 493). Marx was of course aware that the Greek word organ (organon) also meant tool, and that organs were initially viewed as "grown-on" tools of animals—an approach that was utilized by Darwin himself, who compared the development of specialized organs to the development of specialized tools (see Pannekoek 1912; Darwin [1859] 1968, pp. 187–88).

Engels was later to add to this an analysis of "The Part Played by Labour in the Transition from Ape to Man" (Engels 1940, pp. 279–96). According to this theory (verified in the 20th century by the discovery of *Australopithecus*), erect posture developed first (prior to the evolution of the human brain), freeing the hands for tools. In this way, the human (hominid) relation to the local environment was radically changed, altering the basis of natural selection. Those hominids that were most successful at toolmaking were best able to adapt, which meant that the evolutionary process exerted selective pressures toward the development of the brain, eventually leading to the rise of modern humans. The human brain, according to Engels, evolved then through a complex, interactive process, now referred to as "gene-culture evolution." As biologist and paleontolo-

⁷ Marx and Engels's complex relation to Darwin's work—which neither denied a relation between society and biology nor reduced one to the other—may also have something to say about why they never utilized the term "ecology," coined by Darwin's leading German follower Ernst Haeckel in 1866, the year before the publication of volume 1 of *Capital*. Although the concept of ecology only gradually came into common usage, Marx and Engels were very familiar with Haeckel's work and so may have been aware of his coinage of this concept. Yet, the way that Haeckel, a strong social Darwinist, originally defined the term was unlikely to have predisposed them to its acceptance. "By ecology," Haeckel had written, "we mean the body of knowledge concerning the economy of nature . . . in a word, ecology is the study of all those complex interrelations referred to by Darwin as the conditions of the struggle for existence" (Golley 1993, p. 207).

gist Stephen Jay Gould has observed, all scientific explanations of the evolution of the human brain thus far have taken the form of gene-culture coevolution, and "the best nineteenth-century case for gene-culture coevolution was made by Friedrich Engels" (Gould 1987, pp. 111-12). The analysis of Marx and Engels thus pointed to coevolution (Norgaard 1994), neither reducing society to nature, nor nature to society, but exploring their interactions. Indeed, the view that "nature reacts on man and natural conditions everywhere exclusively determined his historical development," Engels observed, "is . . . one-sided and forgets that man also reacts on nature, changing it and creating new conditions of existence for himself" (1940, p. 172).

The key to the metabolic relation of human beings to nature then is technology, but technology as conditioned by both social relations and natural conditions. Contrary to those who argue that Marx wore an ecological blinder when it came to envisioning the limitations of technology in surmounting ecological problems, he explicitly argued in his critique of capitalist agriculture, that while capitalism served to promote "technical development in agriculture," it also brought into being social relations that were "incompatible" with a sustainable agriculture (1981, p. 216). The solution thus lay less in the application of a given technology than in the transformation of social relations. Moreover, even if the most advanced technical means available were in the hands of the associated producers, nature, for Marx, sets certain limits. The reproduction of "plant and animal products," for example, is conditioned by "certain organic laws involving naturally determined periods of time" (1981, p. 213). Marx reiterated the Italian political economist Pietro Verri's statement that human production was not properly an act of creation but merely "the reordering of matter" and was thus dependent on what the earth provided (1976, p. 132). The human interaction with nature always had to take the form of a metabolic cycle that needed to be sustained for the sake of successive generations. Technological improvements were a necessary but insufficient means for the "improvement" in the human relation to the earth. For Marx, human beings transformed their relation to nature but not exactly as they pleased; they did so in accordance with conditions inherited from the past and as a result of a complex process of historical development that reflected a changing relation to a natural world, which was itself dynamic in character. Redclift and Woodgate (1994, p. 53) are therefore wrong when they say that Marx wore blinders in relation to the coevolution of nature and society, viewing the human relation to nature as an "unchanging" one. Engels began his *Dialectics of Nature* with a dramatic description of the historic defeat of 18th-century conceptions of nature in which the natural world existed only in space not in time; "in which all change, all development of nature was denied" (1940, p. 6).

BEYOND THE APPROPRIATION AND DEFINITIONAL PROBLEMS

The foregoing suggests that Marx's analysis provides a multilayered and multivalent basis for linking sociology (and in particular the classical tradition of sociology) with environmental issues. Yet, if this is so, why has this concern with ecological issues not found a strong echo in the Marxist tradition throughout its development, and why has our understanding of Marx so often excluded these issues? Why has environmental sociology, which is concerned directly with these questions, been so slow to acknowledge Marx's importance in this respect? The first question relates to what we referred to at the beginning of this article as "the appropriation problem," the second to what was labeled "the definitional problem."

The Appropriation Problem

Marx's reputation as an ecological thinker was no doubt affected by the fact that, as Massimo Quaini (1982, p. 136) has pointed out, he "denounced the spoliation of nature before a modern bourgeois ecological conscience was born." Nevertheless, Marx's ecological critique was fairly well-known and had a direct impact on Marxism in the decades immediately following his death. It came to be discarded only later on, particularly within Soviet ideology, as the expansion of production at virtually any cost became the overriding goal of the Communist movement. The influence of Marx's critique in this respect can be seen in the writings of such leading Marxist thinkers as Kautsky, Lenin, and Bukharin.

Kautsky's great work, *The Agrarian Question*, published in 1899, contained a section on "The Exploitation of the Countryside by the Town" in which he held that the net external flow of value from countryside to town "corresponds to a constantly mounting loss of nutrients in the form of corn, meat, milk and so forth which the farmer has to sell to pay taxes, debt-interest and rent. . . . Although such a flow does not signify an exploitation of agriculture in terms of the law of value [of the capitalist economy], it does nevertheless lead . . . to its material exploitation, to the impoverishment of the land of its nutrients" (Kautsky 1988 [1899], p. 214).⁸ Arguing at a time when the fertilizer industry was further developed than

⁸ In saying there was no exploitation of agriculture in law of value terms, Kautsky was arguing that transactions here, as in other areas of the economy, were based on equal exchange. Nonetheless, he insisted that "material exploitation" (related to use values) was present insofar as the soil was being impoverished. Marx too argued that the soil was being "robbed" or "exploited" in the latter sense and connected this to the fact that the land under capitalism was regarded as a "free gift" (as Malthus had contended) so that the full costs of its reproduction never entered into the law of value under capitalism.

in Marx's day, Kautsky discussed the fertilizer treadmill resulting from the metabolic rift:

Supplementary fertilisers . . . allow the reduction in soil fertility to be avoided, but the necessity of using them in larger and larger amounts simply adds a further burden to agriculture—not one unavoidably imposed by nature, but a direct result of current social organization. By overcoming the antithesis between town and country . . . the materials removed from the soil would be able to flow back in full. Supplementary fertilisers would then, at most, have the task of enriching the soil, not staving off its impoverishment. Advances in cultivation would signify an increase in the amount of soluble nutrients in the soil without the need to add artificial fertilisers. (Kautsky 1988, vol. 2, pp. 214–15)

Some of the same concerns were evident in Lenin's work. In *The Agrarian Question and the "Critics of Marx,"* written in 1901, he observed that, "The possibility of substituting artificial for natural manures and the fact that this is already being done (partly) do not in the least refute the irrationality of wasting natural fertilisers and thereby polluting the rivers and the air in suburban factory districts. Even at the present time there are sewage farms in the vicinity of large cities which utilise city refuse with enormous benefit to agriculture; but by this system only an infinitesimal part of the refuse is utilized" (1961, pp. 155–56).

It was Bukharin, however, who developed the most systematic approach to ecological issues in his chapter on "The Equilibrium between Society and Nature" in *Historical Materialism* his important work of the 1920s. Cohen (1980, p. 118) has characterized Bukharin's position as one of " 'naturalistic' materialism," because of its emphasis on the interaction between society and nature. As Bukharin wrote,

This material process of "metabolism" between society and nature is the fundamental relation between environment and system, between "external conditions" and human society. . . . The metabolism between man and nature consists, as we have seen, in the transfer of material energy from external nature to society. . . . Thus, the interrelation between society and nature is a process of social reproduction. In this process, society applies its human labor energy and obtains a certain quantity of energy from nature ("nature's material," in the words of Marx). The *balance* between expenditures and receipts is here obviously the decisive element for the growth of society. If what is obtained exceeds the loss by labor, important consequences obviously follow for society, which vary with the amount of this excess. (Bukharin 1925, pp. 108–12)

For Bukharin, technology was the chief mediating force in this metabolic relationship between nature and society. The human metabolism with nature was thus an "unstable equilibrium," one which could be progressive or regressive from the standpoint of human society. "The productivity of labor," he wrote, "is a precise measure of the 'balance' between

society and nature.” An increase in social productivity was seen as a progressive development; conversely, if the productivity of labor decreased—here Bukharin cited “the exhaustion of the soil” as a possible cause of such a decline—the relationship was a regressive one. Such a decline in social productivity resulting from an ill-adapted metabolic relation between society and nature could, he argued, lead to society being “barbarianized” (1925, pp. 77, 111–13).

Thus the whole “process of social production,” Bukharin (1925, p. 111) wrote, “is an adaptation of human society to external nature.” “Nothing could be more incorrect than to regard nature from the teleological point of view: man, the lord of creation, with nature created for his use, and all things adapted to human needs” (1925, p. 104). Instead, human beings were engaged in a constant, active struggle to adapt. “Man, as an animal form, as well as human society, are products of nature, part of this great, endless whole. Man can never escape from nature, and even when he ‘controls’ nature, he is merely making use of the laws of *nature* for his own ends” (1925, p. 104). “No system, including that of human society,” Bukharin (1925, p. 89) insisted, “can exist in empty space; it is surrounded by an ‘environment,’ on which all its conditions ultimately depend. If human society is not adapted to its environment, it is not meant for this world.” “For the tree in the forest, the environment means all the other trees, the brook, the earth, the ferns, the grass, the bushes, together with all their properties. Man’s environment is society, in the midst of which he lives; the environment of human society is external nature” (1925, p. 75). Indeed, human beings, as Bukharin emphasized in 1931, need to be conceived as “living and working in the biosphere” (1971, p. 17).⁹

Other early Soviet thinkers connected to Bukharin demonstrated a similar concern for ecological issues. Komrov (1935, pp. 230–32) quoted at length from the long passage on the illusion of the conquest of nature in Engels’s *Dialectics of Nature* and went on to observe that, “The private owner or employer, however necessary it may be to make the changing of the world comply with the laws of Nature, cannot do so since he aims at profit and only profit. By creating crisis upon crisis in industry he lays waste natural wealth in agriculture, leaving behind a barren soil and in mountain districts bare rocks and stony slopes.” Similarly, Uranovsky

⁹In referring to the “biosphere,” Bukharin drew upon V. I. Vernadsky’s *The Biosphere*, first published in 1922, which was one of the great works in ecological science of the 20th century and was extremely influential in Soviet scientific circles in the 1920s and early 1930s. Vernadsky was “the first person in history to come [to] grips with the real implications of the fact that the Earth is a self-contained sphere” (Margulis et al. 1998, p. 15). He achieved international renown both for his analysis of the biosphere and as the founder of the science of geochemistry (or biogeochemistry) (Vernadsky [1922] 1998).

(1935, p. 147) placed heavy emphasis, in a discussion of Marxism and science, on Marx's research into Liebig and "the theory of the exhaustion of the soil."¹⁰

Bukharin's ecological work and that of those associated with him was a product of the early Soviet era. The tragedy of the Soviet relation to the environment, which was eventually to take a form that has been characterized as "ecocide" (Feshbach and Friendly 1992; Peterson 1993), has tended to obscure the enormous dynamism of early Soviet ecology of the 1920s and the role that Lenin personally played in promoting conservation. In his writings and pronouncements, Lenin insisted that human labor could never substitute for the forces of nature and that a "rational exploitation" of the environment, or the scientific management of natural resources, was essential. As the principal leader of the young Soviet state, he argued for "preservation of the monuments of nature" and appointed the dedicated environmentalist Anatolii Vasil'evich Lunacharskii as head of the People's Commissariat of Education (Enlightenment), which was put in charge of conservation matters for all of Soviet Russia (Weiner 1988a, pp. 4, 22–28, 259; Weiner 1988b, pp. 254–55; Bailes 1990, pp. 151–58). Lenin had considerable respect for V. I. Vernadsky, the founder of the science of geochemistry (or biogeochemistry) and the author of *The Biosphere*. It was in response to the urging of Vernadsky and mineralogist E. A. Fersman that Lenin in 1919 established in the southern Urals the first nature preserve in the USSR—and indeed the first reserve anywhere by a government exclusively aimed at the scientific study of nature (Weiner 1988a, p. 29; Bailes 1990, p. 127). Under Lenin's protection, the Soviet conservation movement prospered, particularly during the New Economic Policy period (1921–28). But with the early death of Lenin and the triumph of Stalinism in the late 1920s, conservationists were attacked for being "bourgeois." Worse still, with the rise of Trofim Denisovich Lysenko, as an arbiter of biological science, "scientific" attacks were launched first on ecology and then genetics. By the late 1930s, the conservation movement in the Soviet Union had been completely decimated (Weiner 1988b, pp. 255–56).

The disconnection of Soviet thought from ecological issues, from the 1930s on, was severe and affected Marxism in the West as well, which

¹⁰ Uranovsky was one of the first scientists to be arrested, in 1936, in the Stalinist purges (Medvedev [1971] 1989, p. 441). Accompanying Bukharin as a member of the Soviet delegation to the Second International Conference of the History of Science and Technology, London 1931, was also the brilliant plant geneticist N. I. Vavilov (one of the greatest figures in the history of ecological science), founder and first president of the Lenin Agricultural Academy, who applied a materialist method to the question of the origins of agriculture with the support of early Soviet science (Vavilov 1971). Like Bukharin and Uranovsky, he fell prey to the Stalinist purges.

between the 1930s and the 1970s tended to ignore ecological issues, though there was a revival of interest in this area in Marxism as well with the renewal of environmentalism following the publication of Rachel Carson's *Silent Spring* in 1962. To be sure, when Western Marxism had first emerged as a distinct tradition in the 1920s and 1930s, one of the major influences was the Frankfurt School, which developed an ecological critique (Horkheimer and Adorno 1972). But this critique was largely philosophical, and while it recognized the ecological insights in Marx's *Economic and Philosophical Manuscripts*, it lost sight of the ecological argument embedded in *Capital*. Hence, it generally concluded that classical Marxism (beginning with the later Marx) supported a "Promethean" philosophy of the straightforward domination of nature. Not until the 1960s and 1970s did a more complex interpretation begin to emerge in the writings of the thinkers influenced by the Frankfurt tradition (Schmidt 1971; Leiss 1974). And it was not until the late 1980s and 1990s that scholars began to resurrect Marx's argument on soil fertility and organic recycling (Perelman 1988; Hayward 1994; Foster 1997; Fischer-Kowalski 1997). Much of the renewed emphasis on Marx's (and Liebig's) treatment of soil fertility and its ecological implications has come from agronomists and ecologists concerned directly with the debates around the evolution of soil science and the struggles over agribusiness versus organic agriculture (Mayumi 1991; Magdoff, Lanyon, and Liebhardt 1997; Gardner 1997).

It is scarcely surprising, then, that interpretations of Marx within sociology, and environmental sociology in particular, have been affected by an "appropriation problem." Sociologists in general tend to have little knowledge of volume 3 of Marx's *Capital*, where his critique of capitalist agriculture (and of the undermining of soil fertility) is most fully developed, and while these issues were well-known to the generations of Marxist thinkers who immediately followed Marx, they largely vanished within Marxist thought in the 1930s. Even today, treatments of Marx's relation to ecology that purport to be comprehensive focus on his early writings, largely ignoring *Capital* (Dickens 1992). This appropriation problem had important ramifications. It left the appearance that there were no explicit linkages between human society and the natural world within classical Marxism, thus facilitating the notion that there was an unbridgeable gulf between classical sociology and environmental sociology.

Analogous appropriation problems might be raised with respect to the other classical theorists. Martinez-Alier (1987, pp. 183-92) has argued that Weber's important essay on Ostwald's social energetics has also been neglected; indeed it has yet to be translated into English. This has left the false impression that Weber had nothing to say in this area. Durkheim discussed the sociological origins of the classification of nature within what he called the "first philosophy of nature," and related this to modern

scientific evolutionism. He also commented in profound ways about Darwinian evolutionary theory, the indestructibility of matter, the conservation of energy, and so on (Durkheim and Mauss 1963, pp. 81–88; Durkheim [1893] 1984, pp. 208–9; Durkheim [1911–12] 1983, pp. 21–27, 69–70). The systematic character of his more naturalistic thinking has never been properly addressed, and works like *Pragmatism and Sociology*, in which he presents some of his more complex views in this regard, have generally been ignored. Nevertheless, it is clear that his analysis pointed toward a complex, coevolutionary perspective. “Sociology,” he wrote, “introduces a relativism that rests on the relation between the physical environment on the one hand and man on the other. The physical environment presents a relative fixity. It undergoes evolution, of course; but reality never ceases to be what it was in order to give way to a reality of a new kind, or to one constituting new elements. . . . The organic world does not abolish the physical world and the social world has not been formed in contradistinction to the organic world, but together with it” (Durkheim 1983, pp. 69–70).

The Definitional Problem

Along with the appropriation problem, which deals with how received sociology has been affected by the selective appropriation of the classical tradition, there is also the definitional problem, which stands for the fact that sociology’s (specifically environmental sociology’s) failure to address the classical inheritance in this regard is at least partly due to overly narrow, preconceived definitions as to what constitutes genuinely environmental thought.

Here a major role was assumed by the contrast, drawn by Catton and Dunlap (1978), between the “human exemptionalist paradigm” and the “new environmental paradigm.” All of the competing perspectives in sociology, such as “functionalism, symbolic interactionism, ethnomethodology, conflict theory, Marxism, and so forth” were seen as sharing a common trait of belonging to a “human exceptionalist paradigm” (later renamed “human exemptionalist paradigm”), and thus the “apparent diversity” of these theories was “not as important as the fundamental anthropocentrism underlying *all* of them” (Catton and Dunlap 1978, p. 42). The human exemptionalist paradigm was depicted as embracing the following assumptions: (1) the existence of culture makes human beings unique among the creatures of the earth, (2) culture evolves much more rapidly than biology, (3) most human characteristics are culturally based and hence can be socially altered, and (4) a process of cultural accumulation means that human progress can be cumulative and without limit. The habits of mind produced by this human exemptionalist paradigm,

Catton and Dunlap (1978, pp. 42–43) argued, led to an overly optimistic faith in human progress, a failure to acknowledge ecological scarcity, and a tendency to neglect fundamental physical laws such as the entropy law.

For Catton and Dunlap, this “human exemptionalist paradigm,” which encompassed nearly all of existing sociology could be contrasted to what they termed the “new environmental paradigm” emerging from environmental sociology, which was based on the following assumptions: (1) human beings are one of many species that are interdependently connected within the biotic community; (2) the biotic community consists of an intricate web of nature, with complex linkages of cause and effect; and (3) the world itself is finite, there are natural (physical, biological) limits to social and economic progress (1978, p. 45). In contrast to the “anthropocentrism” that characterized the human exemptionalist paradigm, the new environmental paradigm represented a shift toward what is now called an “ecocentric” point of view in which human beings are seen as part of nature, interconnected with other species and subject to the natural limits of the biosphere.

Ironically, the chief problem with this contrast between the human exemptionalist paradigm and the new environmental paradigm is that, even while emphasizing environmental factors, it tended to perpetuate a dualistic view of society versus the physical environment, anthropocentrism versus ecocentrism, and thus easily fell into the fallacy of the excluded middle (or a false dichotomy). There is a tendency in this view to see any theory that emphasizes socioeconomic progress or cultural accumulation as thereby “anthropocentric” and opposed to an “ecocentric” perspective, which seeks to decenter the human world and human interests. Nevertheless, logic suggests that there is no reason for such a stark opposition, since there are numerous ways in which sociology can embrace a concern for ecological sustainability without abandoning its emphasis on the development of human culture and production. Moreover, extreme ecocentrism runs the risk of losing sight of the sociological construction of much of the “natural world.” Although classical sociology may have been anthropocentric to some extent in its focus on socioeconomic advance and its relative neglect of external nature, it was not necessarily antiecological (in the sense of ignoring natural limits) insofar as it acknowledged ecological sustainability as a requirement of social progress. The current preoccupation with sustainable development and coevolutionary theories within environmental discussions suggests that there have always been complex views that attempted to transcend the dualisms of humanity versus nature, anthropocentrism versus ecocentrism, socioeconomic progress versus natural limits.

Marx in particular has been criticized for being “anthropocentric” rather than “ecocentric” in orientation and hence outside of the framework of green theory (Eckersley 1992, pp. 75–95). Yet this kind of dualistic

conception would have made little sense from his more dialectical perspective, which emphasized the quality (and sustainability) of the *interaction* between society and its natural conditions. It is the commitment to ecological sustainability, not the abstract notion of "ecocentrism," which most clearly defines whether a theory is part of ecological discourse. Moreover, a comprehensive *sociology* of the environment must by definition be co-evolutionary in perspective, taking into account changes in both society and nature and their mutual interaction.

CONCLUSION: THE ELEMENTS OF ENVIRONMENTAL SOCIOLOGY

The burden of argument in this article has been to demonstrate, using the case of Marx, that it is wrong to contend that classical sociology "was constructed as if nature didn't matter" (Murphy 1996, p. 10). A central claim of this article, backed up by logic and evidence, has been that each of the six ecological blinders commonly attributed to Marx—namely his alleged inability to perceive (1) the exploitation of nature, (2) nature's role in the creation of wealth, (3) the existence of natural limits, (4) nature's changing character, (5) the role of technology in environmental degradation, and (6) the inability of mere economic abundance to solve environmental problems—are in fact wrongly (or misleadingly) attributed to him. The point of course is not that Marx provided definitive treatments of all of these problems but rather that he was sufficiently cognizant of these issues to elude the main traps and to work the vitally important notion of the "human metabolism with nature" into his overall theoretical framework. Hence his work constitutes a possible starting point for a comprehensive sociology of the environment. No doubt some will still insist, despite the argument presented above, that Marx did not place sufficient *emphasis* on natural conditions, or that his approach was too anthropocentric, more along the lines of utilitarian-conservationism than genuine green radicalism. Some will still say that he in fact never entirely renounced economic development despite his insistence on a sustainable relation to the earth. But the evidence regarding his concern with ecological issues—particularly the crisis of the soil as it was perceived in the mid-19th century—is too extensive, and too much a part of his overall critique of capitalism, to be simply disregarded. Marx certainly argued *as if nature mattered*, and his sociology thus takes on a whole new dimension when viewed from this standpoint.

Just as Marx translated his early theory of the alienation of labor into more material terms through his later analysis of exploitation and the degradation of work, so he translated his early notion of the alienation of nature (part of the Feuerbachian naturalism that pervaded his *Economic and Philosophical Manuscripts*) into more material terms through his later

concept of a metabolic rift. Without the latter concept, it is impossible to understand Marx's developed analysis of the antagonism of town and country, his critique of capitalist agriculture, or his calls for the "restoration" of the necessary metabolic relation between humanity and the earth, that is, his basic notion of sustainability. Marx's response to Liebig's critique of capitalist agriculture was coupled, moreover, with a sophisticated response to Darwin's evolutionary theory. What emerges from this is a historical materialism that is ultimately connected to natural history; one that rejects the crude, one-sided traditions of mechanical materialism, vitalism, and social Darwinism that existed in Marx's day. Yet, at the same time, Marx avoided falling into the trap of Engels's later "dialectical materialism," which, ironically, drew too heavily on both Hegel's *Logic* and his *Philosophy of Nature*, abstractly superimposing a despiritualized Hegelian dialectic (i.e., conceived in purely logical terms, divorced from Hegel's self-mediating spirit) on top of what was otherwise a mechanical view of the universe. Instead, Marx provides, as we have seen, a cautious constructionism, fully in tune with his own practical materialism, which always emphasized the role of human praxis, while remaining sensitive to natural conditions, evolutionary change, and the metabolic interaction of humanity and the earth.

Marx's main contribution in this area was methodological. He saw "the economic formation of society" as part of a process of "natural history" and struggled within his critique of political economy to take account of both natural conditions and the human transformation of nature (1976, p. 92). In the process, he applied a dialectical mode of analysis not to external nature itself (recognizing that the dialectic had no meaning aside from the self-mediating role of human beings as the agents of history) but rather to the *interaction* between nature and humanity, emphasizing the alienation of nature in existing forms of reproduction and the contradictory, nonsustainable character of the metabolic rift between nature and society that capitalism in particular had generated. Moreover, Marx conceived this metabolic rift not simply in abstract terms but in terms of the concrete crisis represented by the degradation of the soil and by the problem of human and animal "wastes" that engulfed the cities. Both were equal indications, in his analysis, of the metabolic rift between humanity and the soil, reflected in the antagonism of town and country.

The way in which Marx's analysis prefigured some of the most advanced ecological analysis of the late 20th century—particularly in relation to issues of the soil and the ecology of cities—is nothing less than startling. Much of the recent work on the ecology of the soil (Magdoff et al. 1997; Mayumi 1991; Gardner 1997) has focused on successive, historical breaks in nutrient cycling. The first such break, associated with the second agricultural revolution, is often conceived in essentially the same

terms in which it was originally discussed by Liebig and Marx and is seen as related to the physical removal of human beings from the land. This resulted in the failure to recycle human organic wastes back to the land, as well as the associated break in the metabolic cycle and the net loss to the soil arising from the transfer of organic products (food and fiber) over hundreds and thousands of miles. It was these developments that made the creation of a fertilizer industry necessary. A subsequent break occurred with the third agricultural revolution (the rise of agribusiness), which was associated in its early stages with the removal of large animals from farms, the creation of centralized feedlots, and the replacement of animal traction with farm machinery. No longer was it necessary to grow legumes, which had the beneficial effect of naturally fixing nitrogen in the soil, in order to feed ruminant animals. Hence, the dependence on fertilizer nitrogen increased, with all sorts of negative environmental consequences, including the contamination of ground water, the "death" of lakes, and so on. These developments, and other related processes, are now seen as related to the distorted pattern of development that has characterized capitalism (and other social systems such as the Soviet Union that replicated this pattern of development, sometimes in even more distorted fashion), taking the form of a more and more extreme metabolic rift between city and country—between what is now a mechanized humanity and a mechanized nature. Similarly, the ecological problem of the city is increasingly viewed in terms of its metabolic relationship to its external environment (focusing on the flows of organic nutrients, energy, etc.) and the ecological distortions that this entails (Wolman 1965; Giradet 1997; Fischer-Kowalski 1997; Opschoor 1997).

The fact that Marx was able to conceive a sociological approach that pointed to these developments when they were still in their very early stages represents one of the great triumphs of classical sociological analysis. It stands as a indication of how sociology could be extended into the ecological realm. It reinforces the view that ecological analysis, devoid of sociological insight, is incapable of dealing with the contemporary crisis of the earth—a crisis which has its source and its meaning ultimately in society itself.

It is not just Marxist sociology that is in a position to draw on Marx's insights in this respect, which are sociological as much as they are Marxist. Moreover, other paradigms within classical sociology have much more to contribute to the analysis of the natural environmental context of human social development than is commonly supposed. There is no doubt that Weber and Durkheim were both concerned in their own ways with the metabolic interaction between nature and society. Although systematic investigations into the work of Weber and Durkheim in this respect still

have to be undertaken, it is not to be doubted that embedded in their sociologies were important insights into ecological problems. When Weber wrote at the end of *The Protestant Ethic and the Spirit of Capitalism* of a civilization characterized by “mechanized petrification” that might continue along the same course—that of formal or instrumental rationality—“until the last ton of fossilized coal” was burnt, he was suggesting the possibility of a wider social and environmental critique of this civilization (Weber [1904–5] 1930, pp. 181–82). Likewise, Durkheim’s discussions of Darwinian theory and its implications for social analysis pointed the way toward a sociological understanding of the coevolution of nature and society. In the cases of Weber and Durkheim—as in Marx—we may surmise that an appropriation problem, coupled with a definitional problem, has hindered the appreciation of the way in which their sociologies took natural conditions into account.

Today, even among leading environmental sociologists who criticized the classical traditions of sociology for failing to take into account the physical environment, there is a dawning recognition that these classical traditions have proven themselves to be resilient in the face of challenges of environmental sociologists and are open to reinterpretation and reformulation along lines that give greater weight to ecological factors. Dunlap points to the emergence, in recent years, of “‘greener’ versions of Marxist, Weberian and symbolic interactionist theories” (1997, p. 34). Ironically, it is coming to be recognized that the problem of “human exemptionalism,” that is, the neglect of the physical environment, may have been less characteristic of classical sociology than it was of the sociology that predominated after World War II—during a period when the faith in technology and the human “conquest” of nature reached heights never before attained, only to lead to disillusionment and crisis beginning with the 1960s. Developing an environmental sociology as an integral part of sociology as a whole thus requires that we reach back into past theories in order to develop the intellectual means for a thoroughgoing analysis of the present. For environmental sociology the crucial issue today is to abandon the “strong constructionism” of most contemporary sociological theory, which tends to view the environment as simply a product of human beings, and to move toward a more “cautious constructionism” that recognizes that there is a complex metabolic relation between human beings and society (Dunlap 1997, pp. 31–32, 35; Dickens 1996, p. 71). Surprisingly, this is turning out to be an area in which the classical sociology of the mid-19th and early 20th centuries still has much to teach us as we enter the 21st century—a century that is bound to constitute a turning point for good or ill in the human relation to the environment.

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