

Capitalism and the Metabolic Rift—a 152-page special Issue

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The Robbery of Nature

By John Bellamy Foster and Brett Clark
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The chapter on “Machinery and Large-Scale Industry” in the first volume of Karl Marx’s *Capital* closes with this statement: “All progress in capitalist agriculture is a progress in the art, not only of robbing the worker, but of robbing the soil.... 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.” “Robbing the worker” referred to the theory of exploitation, which entailed the expropriation of the worker’s surplus labor by the capitalist. But what did Marx mean by “robbing the soil”? Here robbery was connected to his theory of the metabolic rift arising from the expropriation of the earth. As he stated earlier in the same paragraph, “capitalist production...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.”¹

The same basic logic was present in the other famous passage on the metabolic rift, at the end of the chapter on “The Genesis of Capitalist Ground Rent” in the third volume of *Capital*. There Marx referred to “the squandering of the vitality of the soil” by large-scale capitalist enterprise, generating “an irreparable rift in the interdependent process of social metabolism, a metabolism prescribed by the natural laws of life itself.”²

In both instances, Marx's notion of the robbery of the soil is intrinsically connected to the rift in the metabolism between human beings and the earth. To get at the complexities of his metabolic rift theory, it is therefore useful to look separately at the issues of the *robbery* and the *rift*, seeing these as separate moments in a single development. This is best done by examining how Marx's ecological critique in this area emerged in relation to the prior critique of industrial agriculture provided by the celebrated German chemist Justus von Liebig. Of particular importance in this context is Liebig's notion of the "robbery system" (*Raubsystem*) or "robbery economy" (*Raubwirtschaft*), which he associated with British high farming.³

For Marx, as for Liebig, this robbery was not of course confined simply to external nature, since humans as corporeal beings were themselves part of nature.⁴ The expropriation of nature in capitalist society thus had its counterpart, in Marx's analysis, in the expropriation of human bodily existence. The robbery and the rift in nature's metabolism was also a robbery and a rift in the human metabolism. This was visible in the many forms of bonded labor, in the conditions of social reproduction in the patriarchal household, and in the destructive physical impacts and the loss of the vital powers of individual human beings.

Liebig: Industrial Agriculture and the Alienation of the Soil

Beginning in the late 1850s and early 1860s, Liebig, who had long advocated the use of scientific methods in agriculture, began to argue that British high farming's systematic "alienating [of] the crops" of the fields was irrational from a long-term perspective, since it ultimately despoiled the earth of its nutrients. "A farmer," he declared, "may sell and permanently alienate all that portion of

the produce of his farm which has been supplied by the atmosphere [but not the constituents of the soil]—a field from which something is permanently taken away, cannot possibly increase or even continue equal in productive power.” He stressed that “the axiom thus enunciated is simply a natural law.”⁵

The “natural law” at issue here was what Liebig called the “law of compensation” or law of replacement (*Gesetz des Ersatzes*), whereby nutrients removed from the soil had to be restored.⁶ This was in turn based on the recognition of the metabolic interaction (*Stoffwechsel*) governing the exchanges of matter and energy between life forms and their environments. Metabolism was a fundamental concept of natural science, and Liebig was one of its nineteenth-century pioneers.⁷ In essence, it raised the question of the material interchanges and processes governing the complex interrelations between organic and inorganic nature.

“All plants, without exception,” Liebig wrote, “exhaust the soil, each of them in its own way, of the conditions for their reproduction.” To sell the food and fiber to populations in cities hundreds and thousands of miles from the land prevented the return of these essential nutrients to the soil, resulting in a system of “spoliation.” Attempts to compensate for this—for example, through Britain’s massive imports of guano from Peru, and bones from the battlefields and catacombs of Europe—were temporary and makeshift solutions, almost inherently insufficient, that plundered other countries of their earthly resources.⁸

Liebig’s emphasis in the late 1850s and early 1860s on the alienation and robbery of the soil can be seen as a product of developments that began in the 1840s and that extended to the time that Marx was writing *Capital* in the 1860s. Responding to the deterioration of soil conditions and the commercial demands for higher agricultural productivity—what historians have called the

Second Agricultural Revolution—English farmers in 1841 began importing massive amounts of guano from Peru.⁹ Meanwhile, the Irish potato famine, beginning in 1845, led to the abolition of the Corn Laws in England, allowing for the importation of cheaper grain and forcing new, competitive market conditions, which in turn gave rise to what Marx called a “new regime” of the international food system.¹⁰ This period saw the development of “high farming” or intensive agriculture in England (itself symbolized by the importation of guano, bones, oil cakes, and other natural fertilizers), and the shift to an increasingly meat-based agricultural system grounded in agricultural practices such as the famous Norfolk rotation, establishing a mixed animal-crop system.¹¹ In this context, concerns were raised about the loss of soil nutrients to the land from new, intensive forms of agriculture and the waste of nutrients in human sewage resulting from massive food and fiber imports to the cities.¹² In Germany and other parts of Europe, there were growing worries among agronomists and soil scientists about England’s voracious importation of bones from the Continent. The entire period of the Second Agricultural Revolution was thus one of crisis and transformation in the socio-ecological metabolism of British soil cultivation, associated with the Industrial Revolution.

To underscore the enormity of the crisis of soil ecology, Liebig made a point of attacking entrenched notions propounded by some agriculturalists and the classical political-economist David Ricardo that the “power of the soil” on any given plot of land was “indestructible” and hence “inexhaustible.”¹³ The development of modern chemistry had discredited such views. Plant growth, Liebig contended, depended on “eight substances” (today we know this to be eighteen; sixteen of which, excluding carbon and oxygen, are chemical elements plants derive from the soil and not the atmosphere) — all of which had to be replenished for the soil to

remain fertile.¹⁴ Of these, the nutrients needed in the largest quantities were nitrogen, phosphorus, and potassium. Liebig's famous "law of the minimum," moreover, indicated that there was a complex balance of soil nutrients such that, to enhance the productivity of the soil in a given area, it was necessary to supply the nutrient in which the soil was most deficient, to the point at which that nutrient was once again in proportion with the next-most deficient soil mineral. Growth rates were determined by the most limited factor. Soil "exhaustion" meant that the mineral composition of the earth had been so compromised that nutrients needed to be massively imported by "the hand of man" from outside the farm. "In this sense," Liebig declared, "most of our cultivated fields are exhausted," requiring massive infusions of chemical nutrients from outside.¹⁵

Liebig was not alone from the 1850s through the 1870s in addressing the issue of the destructive relation to the soil. Other major natural scientists, agronomists, and political economists raised the same questions, including George Waring, Henry Carey, James F. W. Johnston, Carl Fraas, and Wilhelm George Friedrich Roscher—all of whom (except Waring) Marx studied closely.¹⁶ It was Liebig, however, who advanced the most critical and global concerns with respect to large-scale industrial agriculture. In doing so, he focused in particular on the extraordinary ascent of the guano trade as a measure of the extent of the European soil crisis.

By far the richest deposits of guano were to be found on the Chincha Islands off the coast of Peru, where it was the product of cormorants, boobies, and pelicans feeding since time immemorial on huge shoals of fish in the coastal currents and depositing their excrement in what became mountains of natural fertilizer. Peruvian guano was rich in nitrogen, ammonia, phosphates, and alkaline salts. Historian Gregory Cushman writes that "all told,

from 1840 to 1879, Peru exported an estimated 12.7 million metric tons of guano from its islands," the great bulk of it destined for British fields.¹⁷

Between 1841 and 1855, according to Liebig, "upwards of 1,500,000 metric tons" of Peruvian guano had been imported into Great Britain, and two million tons into Europe as a whole. This was enough, based on the figures for Europe in this period, to produce an additional 200 million cwts (or hundredweights—an imperial hundredweight is 112 pounds) of grain more than would have been produced without the guano. This was "sufficient to feed perfectly 26 $\frac{3}{4}$ million human beings [more than the population of England, Wales, and Scotland at that time] for one year." Liebig indicated that "one cwt. of guano was, in terms of the effective mineral constituents it contained, the equivalent of 25-80 cwt. of wheat."¹⁸

A sense of the deficiency in English agricultural fields in relation to their full productivity could thus be found in the immense quantity of guano imported at great cost and applied to the fields—as well in the importation of bones (bonemeal), nitrates, oil cakes, and other fertilizers and feeding stuffs for farm animals. Reflecting on this situation, Liebig charged that if England were to continue with its high farming system—a high-input, high-output, capital-intensive form of large-scale industrial agriculture—it would so despoil the soil and become so dependent on increasing inputs that it would need quantities of guano "of about the extent of the English coal fields." No wonder that "British and American ships have searched through all the seas, and there is no small island, no coast, which has escaped their enquiries after guano."¹⁹

All this reinforced Liebig's argument that the much-vaunted industrial agriculture of British high farming was simply a more

intensive, modern “robbery system” undermining the conditions of reproduction for future generations. To be sure, this was a more “refined” form of robbery, where “robbery improves the art of robbery.” But the resulting impoverishment was the same. Indeed, the system’s new techniques often effected an even more thoroughgoing impoverishment of the constituents of the soil. Rather than a “mark of progress,” under these circumstances, an increase in crop production was likely a sign of long-term regression—the more so if examined on a global scale.²⁰ The English importation of bones from the Continent to be used as fertilizer, and its effect on the growth of individuals, could be seen in the greater height of British military conscripts relative to their Continental counterparts. “Great Britain,” Liebig declared, “robs all countries of the conditions of their fertility; she has already ransacked the battle-fields of Leipzig, Waterloo, and the Crimea for bones, and consumed the accumulated skeletons of many generations in the Sicilian catacombs.... We may say to the world that she hangs like a vampire on the neck of Europe, and seeks out its hearts-blood, without any necessity and without permanent benefit to herself.”²¹

Such a modern robbery culture, based on the total alienation of the soil, was the antithesis of a rational agriculture rooted in the application of science. Liebig did not hesitate to point out the structural reasons for this contradiction. As he wrote in the conclusion to the introduction to the 1862 edition of his *Agricultural Chemistry*, the entire rapacious system associated with industrial agriculture could be attributed to “the folly and ignorance...which private property interposes” in the way of the “recovery” of the constituents of the soil. The natural law of compensation was being violated by a production system which knew no bounds, operating as if “the Earth is inexhaustible in its gifts.”²² Moreover, attempts to compensate for the loss of soil

nutrients by using only particular fertilizers might yield still more irrational results in the form of an “excess of nutritive substances,” as opposed to “rational husbandry.”²³

Marx: The Robbery of Nature and the Metabolic Rift

Marx’s conception of the robbery or expropriation of nature was necessarily much broader than that of Liebig, though the latter’s natural-scientific researches had a decisive impact on Marx’s thought. Marx emerged as a materialist thinker in his early twenties through a long and intense struggle with the Hegelian system of German idealism, in which his doctoral dissertation on Epicurus’s ancient materialist philosophy of nature played a central role (together with his encounter with the work of Ludwig Feuerbach). Epicurean materialism, which exerted a powerful influence on the scientific revolution of the seventeenth century, would remain a crucial reference point in Marx’s critical outlook, even as he developed his own historical-materialist approach.²⁴ As a thinker concerned centrally with the human relation to the earth through production, his analysis already displayed, in the early 1840s, a broad ecological outlook, though his sharper critique of the environmental contradictions of capitalist development was only developed in his mature works. Still, already in the 1840s, he addressed such issues as the expropriation and alienation of the land; the division between town and country; the pollution of air, water, and food in the cities; and the corporeal reality of humanity, since human beings remained inherently “a part of nature,” albeit increasingly alienated from their natural environments.²⁵

By the 1850s, due to the influence of his close friend Roland Daniels—physician, natural scientist, communist organizer, and author of *Mikrokosmos* (which Marx read and commented on, but

which, due to Daniels's premature death was not published until late in the twentieth century)—Marx took up the concept of metabolism, integrating it into his system.²⁶ No doubt he also drew upon Liebig. During this period, he introduced the concept of “social metabolism,” representing the real material relation between nature and humanity formed by the labor and production process.²⁷ The “social metabolic process,” he wrote, constituted “the real exchange of commodities,” including the productive exchange with nature, encompassing both matter and form, “use-value and...exchange-value.” The labor process itself was defined as the “eternal natural necessity which mediates the metabolism between man and nature, and therefore human life itself.”²⁸

Marx's analysis of the social metabolism was thus never conceptually divorced from what he called the “universal metabolism of nature”—of which the human social metabolism was simply a part.²⁹ His entire dialectical framework rested on what would today be called an ecological (or socioecological) systems theory, connecting the materialist conception of history to that of nature—and requiring continuing study not only of changing developments in human history, but also in natural history (which in Marx's work took the form of extensive inquiries into geology, agronomy, chemistry, physics, biology, physiology, mathematics, and more).³⁰

While writing *Capital* in the late 1850s and 1860s, Marx famously paused twice, not only to absorb Charles Darwin's evolutionary theory and its implications for the human relation to the environment, but also to study Liebig's analysis of the more intensive robbery system characterizing modern agriculture. In taking up Liebig's critique, he was to develop this more fully than Liebig had, forging a dynamic theory of the alienated social metabolism based on the exploitation of human labor. For Marx it

was clear that socioecological contradictions were embedded in the process of capital accumulation in historical ways that went far beyond Liebig's natural-scientific perspective.³¹ The result was a much deeper and richer sense of the structural imperatives underlying the expropriation of nature in the modern system of commodity production, informed by developments in natural science while also connecting these processes to the inner contradictions of capitalism as a historical social system.

To understand Marx's ecological critique, it is necessary to recognize that the contradiction between natural-material use values and economic exchange values lay at the core of his entire system. Inspired by G. W. F. Hegel's contradiction between matter and form, Marx's critique of the capitalist political economy rested in large part on the contradiction between metabolic interchange and the economic value form of commodities. The circuit of exchange value ultimately depended on the production and exchange of commodities embodying natural-material use values. "The chemical process, regulated by labor," Marx wrote, "has everywhere consisted of an exchange of (natural) equivalents," whose violation meant the expropriation of nature, with disastrous consequences.³² The capitalist valorization process could thus never free itself from the conditions of "metabolic interaction [*Stoffwechsel*] between man and nature."³³ All attempts to do so, as in industrial agriculture or the exploitation of labor power, generated a metabolic rift, a crisis of social-metabolic reproduction.

Marx's concern with the break in social-metabolic reproduction of capitalism was undoubtedly deeply affected by the growing public discussions in the 1850s, during the Second Agricultural Revolution, of soil nutrients, the impact of the guano trade, and the enormous waste of human sewage. These developments all derived from the growth of English high farming, and what Marx

called the “new regime” of international food production following the abolition of the Corn Laws. He stressed in the *Grundrisse* how “self-sustaining agriculture” had broken down and been replaced by an industrial agriculture that required “machinery, chemical fertilizer acquired through exchange, seeds from different countries; etc.,” while guano was being imported from Peru in exchange for the export of other products.³⁴ In the new regime of food production, 25 percent of the wheat consumed in Britain in the mid-1850s was imported. Meanwhile, “large tracts of arable land in Britain” were being transformed into pasture. The derangement of the British food trade in the period, including competitive price instability, which interfered with securing the necessary foreign supplies, was such as to make “even an abundant harvest, under the new regime, [appear] relatively defective.”³⁵

These concerns regarding the contradictions of capitalist agriculture and its material impacts were further heightened by Marx’s reading of the 1862 edition of Liebig’s *Agricultural Chemistry*, especially its long incendiary introduction, on which Marx took extensive notes in 1865–66, while struggling to complete the first edition of *Capital*. “One of Liebig’s immortal merits,” Marx declared in *Capital*, was “to have developed from the point of view of natural science, the negative, i.e. destructive side of modern agriculture.” Nevertheless, he followed this immediately by pointing out that Liebig’s work contained the most egregious errors wherever its author ventured beyond the laws of natural science to comment on the laws of political economy.³⁶ Only by integrating these new natural-scientific developments with the critique of capital would it be possible to understand the wider implications for the human-nature metabolism. Thus, in *Capital*, Marx argued that “all progress in increasing the fertility of the soil for a given time is a progress

towards ruining the more long-lasting sources of that fertility,” and that “the more a country proceeds from large-scale industry as the background of its development, as in the case of the United States, the more rapid is this process of destruction.”³⁷ Here he emphasized that capital accumulation through its rapacious expropriation of nature inevitably promoted ecological destruction. Hence, in his *Economic Manuscript of 1864–65*, he expressly raised the question of “the declining productivity of the soil when successive capital investments are made.”³⁸

At the heart of the contradiction was the reality that the human metabolism with nature under capitalism was mediated by value. Thus “the cultivation of particular crops depends on fluctuations in market prices and the constant changes in cultivation with these price fluctuations.” This reflects the fact that “the entire spirit of capitalist production, which is oriented toward the most immediate monetary profit—stands in contradiction to agriculture, which has to concern itself with the whole gamut of permanent conditions of life required by the chain of human generations.”³⁹ Writing in *Theories of Surplus Value*, Marx observed that

even manure, plain muck, has become merchandise, not to speak of bone-meal, guano, potash, etc. That the [natural] elements of production *are estimated* in terms of money is not merely due to the formal change in production [as compared with pre-capitalist forms of agriculture]. New materials are introduced into the soil and its old ones are sold for reasons of *production*.... The seed trade has risen in importance to the extent to which the importance of seed rotation has been recognised.⁴⁰

Yet the mediation of value, the high inputs and high outputs required by capitalist agriculture, long-distance trade, and the pressures on the soil all pointed to the intensification and long-term instability of the agricultural metabolism.

Marx argued that more intensive forms of agriculture, even as they produced a record harvest, could so deplete the soil that famine followed, requiring years for the soil to recover.⁴¹ Ireland, he noted, was even forced to “export its manure” across the sea to England in a dramatic instance of ecological imperialism.⁴² In the East Indies, “English-style capitalist farming...only managed to spoil indigenous agriculture and to swell the number and intensity of famines.” This was part of a colonial “bleeding process, with a vengeance!”⁴³

The deeper significance of Marx’s analysis became clear as he developed the implications already present in his concept of social metabolism, in order to conceptualize the systemic nature of the ecological contradictions of capitalism. Hence, in *Capital*, he brought the natural-material or ecological side of his social-metabolic reproduction to the fore in an attempt to understand the wider ramifications of the capitalist robbery system and its disruptive, indeed destructive, impact on natural systems. It was in this context that he raised the critical issue of the “irreparable rift in the interdependent process of social metabolism.”⁴⁴ By “irreparable rift,” he did not of course mean that a restoration of a rational and sustainable metabolism between human beings and the earth was impossible—indeed he was to define the need for socialism ultimately in these terms.⁴⁵ Nevertheless, the destructive aspects of capitalism’s alienated metabolic relation to the earth were not to be denied.

Here Marx’s deep understanding of Epicurean materialism is evident. Central to his materialist ontology was the Epicurean conception of mortality, to which he often made reference.⁴⁶ Thus, in *The Poverty of Philosophy*, he referred to “*mors immortalis*” (“death the immortal”)—an allusion to Lucretius’s “immortal death has taken away mortal life.”⁴⁷ Both in Epicurean materialism

and in Marx's own philosophy, this referred to the transitoriness of things as the only permanent material reality.

Thus, in evoking the enormity of capitalism's destructive impact on the "metabolism prescribed by the natural laws of life itself," nothing would have been more characteristic for Marx than to recall Lucretius's epic poem *De Rerum Natura*. In Thomas Charles Baring's classic 1884 translation, we read: "A property is that which ne'er can cut itself adrift; / Nor can be sundered anyhow, without a fatal rift."⁴⁸

It is quite conceivable that Marx, confronted with capitalism's growing ecological contradictions, turned back to Epicurus (and Lucretius) to call up the notion of a "fatal rift" (or "irreparable rift"), reflecting the disruption and destruction of nature's properties and processes. In this perspective, capitalism, by robbing the elements of reproduction on which future generations depended, undermined not only external nature, but also the basis of human life itself.

The Corporeal Rift

The metabolic rift generated by capitalism is not confined to the alienated relation to external nature, but affects the human metabolism itself, the bodily existence of human beings—a phenomenon that we can call the corporeal rift. This is related to what socialist ecofeminist Ariel Salleh has called "metabolic value," that is, struggles around social reproduction focused on the household and the reproduction of humans themselves, as both physical and social beings.⁴⁹ It is also connected to what Howard Waitzkin called "the second sickness"—the social-epidemiological effects of capitalist development.⁵⁰

A key component of Epicurean materialism, one that distinguished it from later Cartesian dualism, was the fundamentally corporeal nature of human beings, who are part of and dependent on nature. As Norman Wentworth DeWitt explained, “to Epicurus body and soul are alike corporeal; they are coterminous.”⁵¹ Following this approach, Marx consistently integrated his materialist conception of history with the materialist conception of nature, as developed within modern science, while also incorporating physiological developments. Human beings, like other animals, have specific bodily needs essential to their survival, such as hydration, sufficient calories, sleep, and clean air. Marx argued that in meeting these physiological imperatives, human beings actively make history, transform the world, and produce a social metabolism interconnected with the universal metabolism.⁵² Yet while humans can make history, there are real constraints on this potential, given the limits associated with “inherited socio-cultural conditions,” the corporeal structure related to evolutionary descent, and the biophysical characteristics and processes of the Earth System.⁵³ With these considerations in mind, Marx offered a rich historical examination of the numerous ways that the capital system degraded, undermined, or disrupted the corporeal metabolism, thwarting human social development.

During the long transition from mercantilism to industrial capitalism, the expropriation of nature also involved the extreme expropriation of human bodily existence. Marx wrote that “this history,” which involves the outright seizure of title to property from immediate producers, “is written in the annals of mankind in letters of blood and fire.”⁵⁴ Peasants were forcibly removed from the countryside when the customary rights associated with land tenure were abolished. British soldiers carried out evictions by burning villages, as well as individuals who refused to leave.

Bourgeois property laws helped steal the land, ushering in a revolutionary transformation, whereby the human population was progressively removed from access to the means of subsistence. As a result, landowners “conquered the field of capitalist agriculture, incorporated the soil into capital, and created for the urban industries the necessary supplies of free and rightless proletarians,” who had to sell their labor-power to earn wages to purchase the means of subsistence.⁵⁵ This is a relationship of force and deprivation, because, as Marx remarked, “if the workers could live on air, it would not be possible to buy them at any price.”⁵⁶

With colonial expansion and European settlement of distant lands, the violation of corporeal existence took the form of the expropriation associated with the genocide against the indigenous peoples of the Americas and the enslavement of Africans.⁵⁷ Violence and coercion were integral components of the bonded labor system: confinement, flogging, beating, and rape were commonplace. In this living nightmare, slaves were beasts of burden, regularly deprived of the conditions that allowed for adequate sustenance. Escaped slaves were hunted, tortured, and killed, so long as there was a steady supply of more bonded workers.⁵⁸

With the demise of slavery, the British devised the infamous “coolie” trade. Large numbers of Chinese bonded workers were forced to dig in the guano islands off the coast of Peru, to provide the fertilizer to spread on English fields. As one contemporary English observer described the conditions of these workers:

I can state that their lot in these dreary spots is a most unhappy one. Besides being worked almost to death, they have neither sufficient food nor passably wholesome water. Their rations consist of two pounds of rice and about half a pound of meat. This is generally served out to them between ten and eleven in the

morning, by which time they have got through six hours' work. Each man is compelled to clear from four to five tons of guano a day. During the last quarter of 1875, it is reported that there were 355 Chinamen employed at Pabellon de Pica alone, of whom no less than 98 were in the hospital. The general sickness is swelled legs, caused, it is supposed, by drinking condensed water not sufficiently cooled, and by a lack of vegetable diet. The features of this disease are not unlike those of scurvy or purpura.

The bodily metabolism of these workers was thus being sacrificed to obtain the guano to compensate for the impaired soil metabolism on English fields. The suicide rate of the Chinese bonded workers digging the guano was so high that, as a U.S. consul to Peru noted in 1870, guards had to be placed "around the shores of the Guano Islands, where they are employed, to prevent them [the Coolies] from committing suicide by drowning, to which end the Coolie rushes in his moments of despair."⁵⁹

Throughout their critique of capital, Marx and Engels exhaustively assessed the system's effects on corporeal conditions. They were horrified by the extent to which it failed to meet bodily needs, resulting in disease, suffering, and shortened lives. Marx stressed that capitalist production "squanders human beings, living labor, more readily than does any other mode of production, squandering not only flesh and blood, but nerves and brain as well."⁶⁰ This tension and contradiction exists at the heart of the capital system, whose "purpose is not the satisfaction of needs but the production of profit."⁶¹

Drawing on first-hand experience, field work, and official reports and studies, Marx and Engels detailed changes in corporeal existence. In 1839, when Engels was nineteen years old, he wrote a vivid description in his "Letters from Wuppertal" of corporeal and ecological conditions in his birthplace, Barmen, Germany, then the most industrialized city in the region. He observed that

the river was red due to pollution from cotton factories using “Turkey red” as a dye. He linked many of the city’s problems, such as the lack of a “vigorous life” and degraded health, to working conditions, both in factories and at home. “Work in low rooms where people breathe in more coal fumes and dust than oxygen—and in the majority of cases beginning already at the age of six—is bound to deprive them of all strength and joy in lives,” he wrote. “The weavers, who have individual looms in their homes, sit bent over them from morning till night, and desiccate their spinal marrow in front of a hot stove.”⁶²

For *The Condition of the Working Class in England*, his pioneering study in urban sociology and environmental injustice, Engels, accompanied by his partner Mary Burns, went door to door conducting interviews and collected official medical and public health reports, documenting and analyzing the social and ecological conditions in Manchester, whose dominance in spinning and weaving cotton had made it the center of the Industrial Revolution. The city was ominous, due to the black smoke that blocked out the sun. Charles Dickens described this ceaseless smoke pollution as “black vomit, blasting all things living or inanimate, shutting out the face of day, and closing in on all these horrors with a dense dark cloud.”⁶³ Engels detailed how the conditions within factories further robbed workers of their health, “The atmosphere of the factories is, as a rule, at once damp and warm, unusually warmer than is necessary, and, when the ventilation is not *very* good, impure, heavy, deficient in oxygen, filled with dust and the smell of the machine oil, which almost everywhere smears the floor, sinks into it, and becomes rancid.”⁶⁴ These workers spent long hours, day after day, tending to machines. As a result, they were physically exhausted, yet only slept a couple hours a day, preventing rest and restoration of their bodies and making them more susceptible to diseases.

Engels documented how specific types of work contributed to distinct corporeal problems.⁶⁵ Working in mills caused curvatures in the spine and bowing of leg bones. Women suffered pelvis deformities. Winders suffered from eye problems, such as diminished eyesight, cataracts, and, in time, blindness. Dressmakers were confined in small rooms with “almost total exclusion from fresh air,” breathing in “foul air.” These girls also experienced skeletal deformities at a young age, and their growth was stunted. Exposure to dust, toxins, and air contaminants was a major problem. Workers in the combing rooms of spinning mills breathed in “fibrous dust,” causing “chest affections,” such as asthma, constant coughing, and difficulty breathing. These health problems also resulted in a loss of sleep.⁶⁶ Metal workers laboring at grinders inhaled sharp metal particles, often developing Grinder’s asthma, which included shortness of breath, spitting blood, and coughing fits. The conditions were worse for those who worked with a dry stone versus a wet stone; the average life span was thirty-five years for the former and forty-five years for the latter.⁶⁷ Workers bleaching textiles were exposed to chlorine. Potters who dipped the wares were exposed to lead and arsenic. Their clothing was contaminated with these dangerous materials, to which their family members at home were thus also exposed. These workers in particular experienced stomach and intestine disorders, epilepsy, and paralysis.⁶⁸ Using medical reports, Engels considered how miners, which included adults and children, were exposed to “the inhalation of an atmosphere containing little oxygen, and mixed with dust and the smoke of blasting powder, such as prevails in the mines, [which] seriously affects the lungs, disturbs the action of the heart, and diminishes the activity of the digestive organs.” He noted that these miners developed “black spittle” disease when their lungs were saturated with coal

particles, causing intense pain, headaches, and difficulty breathing.⁶⁹

All these ailments and conditions disrupt corporeal existence, disturb metabolic bodily processes, and shorten workers' lives. Engels illuminated corporeal class differences, as machine operators looked decades older than their wealthy counterparts.⁷⁰ The bodies of workers were simply worn out due to the conditions of work. Reflecting on the consequences of factory conditions and their effects on the human metabolism, Marx wrote that

Every sense organ is injured by the artificially high temperatures, by the dust-laden atmosphere, by the deafening noise, not to mention the danger to life and limb among machines which are so closely crowded together, a danger which, with the regularity of the seasons, produces its list of those killed and wounded in the industrial battlefield. The economical use of the social means of production, matured and forced as in a hothouse by the factory system, is turned in the hands of capital into systematic robbery of what is necessary for the life of the worker while he is at work, i.e. space, light, air, and protection against the dangerous or the unhealthy concomitants of the production process, not to mention the theft of appliances for the comfort of the worker.⁷¹

Technological innovations, which could improve working conditions, were only employed if they reduced labor costs and increased production – or when there was enough social pressure that forced protection and regulation.⁷² As Marx pointed out, “the decisive factor is not the health of the worker, but the ease with which the product may be constructed...which is on the one hand a source of growing profit for the capitalist [and] on the other hand the cause of a squandering of the worker's life and health.”⁷³

In addition to documenting how working conditions robbed workers of their health and shortened their lives, Marx analyzed

extensively the ways that the system of capital affected the nutritional intake and corporeal constitution of workers. This issue is especially important, given that nutrients provide energy and support vital bodily functions. Thus, an insufficient supply causes an array of corporeal problems. On this front, two of the major concerns for Marx included adequate quantity of food/calorie consumption and health risks associated with food adulteration.

Drawing on official reports regarding public health in the United Kingdom, such as those by John Simon, Marx considered how class and gender influenced calorie intake. He noted that agricultural families had diets deficient in protein and carbohydrates. “Insufficiency of food” among these families “fell as a rule chiefly on the women and children.” Adult industrial workers consumed around nine pounds of bread each week, constituting almost their entire diet. Needlewomen consumed the least, at just under eight pounds, while shoemakers ate the most, at eleven-and-a-half pounds. In general, as far as consumption of butter, meat, sugar, and milk, “the worst-nourished categories were the needlewomen, silk-weavers and kid-glovers” – all jobs predominantly occupied by women.⁷⁴ Historian Anthony Wohl stresses that at the time of these studies, individuals performed very physically demanding labor and had to walk long distances to work. Thus, the caloric intake for the average working-class family was not sufficient. They ate few fresh green vegetables and drank little liquid, water or otherwise. As a result, they received minimal protein and were deficient in vitamins A and D. Families with children too young to work suffered even greater food insufficiencies.⁷⁵

“The intimate connection between the pangs of hunger suffered by the most industrious layers of the working class,” Marx explained, “and the extravagant consumption, coarse or refined,

of the rich, from which capitalist accumulation is the basis, is only uncovered when the economic laws are known.”⁷⁶ Capitalists attempted to “reduce the worker’s individual consumption [as far as the means of subsistence] to the necessary minimum,” except in special cases, such as in the mines in South America. Quoting Liebig, Marx noted that these mine owners force workers to consume bread and beans, given “that the men cannot work so hard [carrying almost 200 pounds of metals up 450 feet] on bread” alone.⁷⁷

Using this documentation, Marx and Engels highlighted how the capital system disrupted corporeal metabolic processes due to insufficient or inadequate food, leading to various illnesses, ailments, and starvation diseases. In particular, Engels detailed how working-class children were very vulnerable to rickets and scrofula due to poor-quality food and inadequate nutrition.⁷⁸ In working-class neighborhoods, sewage ran through the streets and no clean water was available. When food prices increased, families reduced their daily rations. All these conditions made them more susceptible to contagious diseases and illnesses, such as during the regular cholera epidemics of the period.

To make matters worse, the adulteration of food, drink, and medicine were common practice. The working poor consumed dark bread rather than the white loaves prepared for the wealthy. The former was made with alum, sand, and bone earth, often with feces and cockroaches baked into it.⁷⁹ Other common adulterations included adding mercury to pepper; white lead to tea; dirt and red lead to cocoa; clay and sand to medicinal opium; copper in gin, bread, and butter; chalk in milk; and strychnine to beer. Regular consumption of these items resulted in chronic gastritis and food poisoning, which was sometimes fatal.⁸⁰ Many of the pigments used to color food were poisonous and would accumulate in workers’ bodies.

Marx remained concerned about corporeal issues throughout his life. In “A Workers’ Inquiry,” a questionnaire he devised by Marx in 1880 at the request of *La Revue socialiste* that asked French workers to share details and stories of their labor conditions, he listed a hundred specific questions, many of which addressed bodily matters. In particular, he requested information related to the sizes of work rooms, including details regarding ventilation and temperature; muscle strain; exposure to industrial effluvia and specific diseases related to the work; safety standards and actions in case of accidents; specific bodily dangers and health related to work; whether or not children were working at the site; duration of shifts; time it took to travel to and from work; prices of lodging and food, including types of food consumed; how many years workers average within specific trades; and “the general physical, intellectual, and moral conditions of life of the working men and women employed” in the trade.⁸¹

Just as the profit-driven capital system disrupts natural processes and cycles, it creates corporeal rifts, undermining general health, the bodily metabolism, and longevity. It violates an array of “biological needs whose satisfaction is an absolute prerequisite of human existence.”⁸² The satisfaction of basic bodily needs is central to humans’ capacity to make history. Joseph Fracchia argues that Marx’s materialist focus on bodily questions

enabled him to decipher the exploitative character of capitalism and to expose the corporeal depths of capitalist immiseration. In this way, he wielded human corporeal organization as a limited, but effective normative measure for social critique and as an attribute of freedom: labor practices which deform the body and atrophy its dexterities are indicators of exploitation [and expropriation], while those that enhance its capacities and cultivate its dexterities are emancipatory.⁸³

Marx and Engels sought to uproot the capital system “which, vampire-like, lives only by sucking living labor, and lives the more, the more labor it sucks.”⁸⁴ None of this was inherent in the human condition, nor had the human body been so systematically and intensively exploited before; capitalist methods were designed to carry corporeal exploitation, i.e., expropriation of bodily powers, to its maximum. Nothing could be more at odds with the ancient Epicurean materialists, who rejected the pursuit of wealth at the cost of the human being. As Lucretius writes in the opening paragraph of Book II of *De Rerum Natura*: “Therefore we see that our corporeal life / Needs little, altogether, and only such, / As takes the pain away” (II, 20).⁸⁵

For Marx and Engels, a society of associated producers—i.e., socialism—is founded on mending this corporeal rift, along with the rift in the metabolism between society and nature in general, to establish a sustainable path for human social development, and to overcome needless pain and suffering. It is necessary, as Salleh has argued, to develop a society that moves beyond capitalist commodity value to one that emphasizes “metabolic value,” encompassing the entirety of social and environmental needs.⁸⁶

The Conditions of Reproduction of Nature and Humanity

For Marx, “it is not the *unity* of living and active humanity with the natural, inorganic conditions of their metabolic exchange with nature, and hence their appropriation of nature, which requires explanation or is the result of a historical process, but rather the *separation* between these inorganic conditions of human existence and this active existence, a separation which is completely posited only in the relation of wage labor and capital.”⁸⁷ Likewise, we can say that it is not the *universal metabolism of nature* (or even the human-social metabolism) that

requires explanation, but rather the *metabolic rift*, the active estrangement of this universal/social metabolism with nature.

Human beings in Marx's conception were "corporeal" beings, constituting a "specific part of nature" – the "self-mediating beings" of nature.⁸⁸ With the development of class society, this crucial self-mediating characteristic that distinguishes human species-being, takes an alienated form. The expropriation of nature on behalf of the capitalist class becomes the basis for the further expropriation and exploitation of humanity and nature, in a vicious circle leading ultimately to a rupture in the metabolism of nature and society, including corporeal existence.

In the most important revelation to come out of Marx's doctoral thesis on ancient materialism, he wrote: "It was only with Epicurus that appearance is grasped as appearance, i.e. as an *alienation of the essence which gives practical proof of its reality through such an alienation.*"⁸⁹ For Marx, the alienated social metabolism between humanity and nature provided the "practical proof" of the possibility of a new, more organic system of social metabolic reproduction, to be organized by the freely associated producers. Stripping away the alienation and destruction, it was possible to perceive the potential for more egalitarian, collective, and sustainable relations. In such a higher society, "socialized man, the associated producers, [would] govern the human metabolism of nature in a rational way...accomplishing it with the least expenditure of energy and in conditions most worthy and appropriate for their human nature."⁹⁰

Should we see Marx's theory of metabolic rift as ecological by today's standards? Some have argued not. Sven-Eric Liedman, in his ambitious and in many ways enlightening 2018 biography *A World to Win: The Life and Works of Karl Marx*, insists that Marx cannot be considered "an ecologically conscious person in the

modern sense.” True, he notes, “Marx found support in Liebig for his thesis that over the longer term capitalism was devastating in all aspects.” But Marx, Liedman tells us, “also imagined that the society that would replace capitalism could also restore the balance between humanity and nature in agriculture.” Hence “the pessimistic conclusions that Marx...drew from Liebig’s book” were “not unconditional. In *another* society, agriculture would not drain nature of its resources, just as industry would not devastate the air, water, and soil.... The ‘irreparable break’ he spoke about is thus only irreparable in a capitalist society.”⁹¹

By Liedman’s yardstick, then, it is precisely because Marx offered a conception of a future society beyond capitalism, directed to sustainable human development, in which the associated producers would rationally regulate the metabolism between nature and society, that his views can be said to have fallen short of those who can be considered “ecologically conscious person[s] in the modern sense.” The implication is that modern Green thinkers, by definition, see ecological devastation as “unconditional” and hence wholly insurmountable, and are inherently pessimistic and apocalyptic, conceiving of no way forward for humanity – at least if this requires a break with the existing social order. This is no doubt an accurate description of the views of most mainstream environmentalists today, who categorically refuse to consider any solution that involves going beyond capitalist relations of production. For Marx, in contrast, it was essential to treat nature, as the Epicureans had, as “my *friend*,” challenging the entire system of the alienation of nature and society.⁹² If the classical historical-materialist ecological critique little resembles today’s contemporary mainstream ecology, this is hardly because Marx’s critique is somehow antiquated. Rather it is Marx’s critique that has emerged in recent years as the theoretical and practical point of departure for the most advanced planetary movement of the twenty-first century: ecosocialism. In our time, the famous words of the “Internationale” take on new meaning: “The earth shall rise on new foundations / We have been naught, we shall be all.”

Notes

1. Karl Marx, *Capital*, vol. 1 (London: Penguin, 1976), 637–38. On how Marx saw the exploitation process as revealing the expropriation of the surplus labor of the worker within production, which was concealed by equal exchange relations within circulation, see *Capital*, vol. 1, 728–29; Karl Marx and Fredrick Engels, *Collected Works*, vol. 33 (New York: International Publishers, 1991), 301, and vol. 34 (New York: International Publishers, 1994), 134; Karl Marx, *Texts on Method* (Oxford: Blackwell, 1975), 186–87.
2. Karl Marx, *Capital*, vol. 3 (London: Penguin, 1981), 949–50. In his recent biography of Marx, Sven-Eric Liedman writes that “in his treatment, Engels made rearrangements in the text and moved the expression ‘irreparable break’ to a later context, where the reader gets the impression that it is the transition from small-scale to large-scale agriculture that creates the growing gap.” This is incorrect, however: Engels moved not only this passage but the whole section (some two pages of discussion) on the transition from small-scale to large-scale agriculture, to the end to form a conclusion, preserving intact Marx’s argument—and thus not creating any false impression, as Liedman contends. Sven-Eric Liedman, *A World to Win* (London; Verso, 2018), 479; Karl Marx, *Economic Manuscript of 1864–1865* (Boston: Brill, 2016), 797–98, 882–83.
3. See Justus von Liebig, “1862 Preface to *Agricultural Chemistry*,” *Monthly Review* 70, no. 3 (July–August 2018): 146–50; William H. Brock, *Justus von Liebig* (Cambridge: Cambridge University Press, 1997), 177–78.
4. On Marx’s corporeal materialism, see Joseph Fracchia, “Organisms and Objectifications: A Historical-Materialist Inquiry into the ‘Human and Animal,’” *Monthly Review* 68, no 10 (March 2017): 1–16; John Fox, *Marx, the Body, and Human Nature* (London: Palgrave Macmillan, 2015).
5. Justus von Liebig, *Letters on Modern Agriculture* (London: Walton and Maberly, 1859), 175–77, *The Natural Laws of Husbandry* (New York: Appleton, 1863), 177–78. The quoted sentence from *Letters on Modern Industry* was Liebig’s restatement of a proposition by the practical farmer Albrecht Brecht: “A farmer can afford to sell and permanently alienate only that portion of the produce of his farm which has been supplied by the atmosphere—a field from which nothing is abstracted can only increase, not decrease in productive power.”
6. Liebig *Letters on Modern Agriculture*, 179, 254–55; *The Natural Laws of Husbandry*, 233; Kohei Saito, *Karl Marx’s Ecosocialism* (New York: Monthly Review Press, 2017), 154.

7. Saito, *Karl Marx's Ecosocialism*, 68–70; John Bellamy Foster, *Marx's Ecology* (New York: Monthly Review Press, 2000), 159–61.
8. Liebig, *Letters on Modern Agriculture*, 175–77, 220, 230; Justus von Liebig, *Introduction to Agricultural Chemistry*, seventh ed. (1862), translated by Lady Gilbert, archives, Rothamsted Research, Hertfordshire, United Kingdom (hereafter Liebig, *Einleitung*; page numbers refer to Gilbert translation), 72, 80–85. Although Liedman claims that “most” of Liebig’s readers saw him as simply a proponent of industrial progress through the use of fertilizers, and only a “minority” interpreted him otherwise, this is too simple a depiction of the intellectual climate of the time. It is true that Liebig’s most severe indictment of British high farming, in his introduction to the 1862 edition of his *Agricultural Chemistry*, was never published in English, as it was considered too incendiary. But especially after the publication of his *Letters on Modern Agriculture*, Liebig’s criticism of the wasting of soil nutrients and its relation to the sewage in the towns was widely debated, for example in the *London Times*. His analysis was taken up by many leading thinkers of the time, extending to political economy in the works of Henry Carey in the United States and Wilhelm Roscher in Germany. The importance of his critical analysis in the era’s debates over the political economy of agriculture can hardly be overstated, and was not, as Liedman suggests, a particular obsession on Marx’s part. See Liedman, *A World to Win*, 478–79; Foster, *Marx's Ecology*, 147–63; Saito, *Karl Marx's Ecosocialism*, 75–78, 183–86, 221–26.
9. F. M. L. Thompson, “The Second Agricultural Revolution, 1815–1880,” *Economic History Review* 21, no. 1 (1968): 62–77.
10. Karl Marx, *Dispatches for the New York Tribune* (London: Penguin, 2007), 169; John Bellamy Foster, “Marx as a Food Theorist,” *Monthly Review* 68, no. 7 (December 2016): 12–14.
11. See Foster, “Marx as a Food Theorist,” 10–11.
12. On Liebig and the sewage controversy, see Ian Angus, “Cesspools, Sewage, and Social Murder: Ecological Crisis and Metabolic Rift in Nineteenth-Century London,” *Monthly Review* 70, no. 3 (July–August 2018): 33–69.
13. Liebig, *Letters on Modern Agriculture*, 137–38, 147, 161; *Cultivator: Journal for the Farm and Garden* 8, third series (1860): 22; David Ricardo, *Principles of Political Economy and Taxation* (Cambridge: Cambridge University Press, 1951), 67.
14. Liebig, *Letters on Modern Agriculture*, 28; Fred Magdoff and Harold van Es, *Building Soils for Better Crops* (Burlington: Sustainable Agricultural Publications, 2000), 149; John Bellamy Foster and Paul Burkett, *Marx and the Earth* (Chicago: Haymarket, 2016), 29. It is worth emphasizing, following Magdoff and van Es, that the vitality of the soil is best seen in terms of the *soil organic matter* in all its numerous aspects, including a diversity of

- microorganisms such as bacteria, viruses, fungi, protozoa, and of plant roots, insects, and earthworms, while constituting the home of larger animals as well. The living portion represents 15 percent of the overall soil organic matter. Soil organic matter also includes organic material at various levels of decomposition. Although the nutrient cycle is at the center of soil metabolism, of which Liebig was the leading nineteenth-century analyst, it would be a mistake to reduce the vitality of the soil simply to the question of nutrients or soil chemistry alone. Magdoff and van Es, *Building Soils*, 9–10.
15. Liebig, *The Natural Laws of Husbandry*, 180, 210. Although known as Liebig’s Law of the Minimum, it was first advanced by Liebig’s contemporary, the German soil scientist Philipp Carl Sprengel. See R. R. van der Ploeg, W. Böhm, and M. B. Kirkham, “On the Origin of the Theory of Mineral Nutrition of Plants and the Law of the Minimum,” *Soil Science Society of America Journal* 63 (1999): 1055–62.
 16. Foster, *Marx’s Ecology*, 149–63; Saito, *Karl Marx’s Ecosocialism*.
 17. Gregory T. Cushman, *Guano and the Opening of the Pacific World* (Cambridge: University of Cambridge Press, 2013), 45, 170–73.
 18. Liebig, *Einleitung*, 76–78, and *Letters on Modern Agriculture*, 219–22, 269–70; *Census of England and Wales for the Year 1861*, vol. 3., *General Report*, 5. Liebig’s figures for the import of guano greatly exceed those presented in a table by Thompson in his classic article. Nevertheless, Liebig’s data is in line with the numbers presented in the work of more recent historians who have examined official records. See C. Alexander G. de Secada, “Arms, Guano, and Shipping,” *Business History Review* 59, no. 4 (1985): 597–621; Brett Clark and John Bellamy Foster, “Guano,” in Alf Hornborg, Brett Clark, and Kenneth Hermele, ed., *Ecology and Power* (London: Routledge, 2012), 75; F. M. L. Thompson, “The Second Agricultural Revolution,” 75.
 19. Liebig, *Einleitung*, 79–81.
 20. Liebig, *Einleitung*, 79, 94, and *Letters of Modern Industry*, 183, 188; Saito, *Karl Marx’s Ecosocialism*, 202.
 21. Liebig, *Einleitung*, 85; Brock, *Justus von Liebig*, 178.
 22. Liebig, *Einleitung*, 96, 101.
 23. Liebig, *The Natural Law of Husbandry*, 233.
 24. See Foster, *Marx’s Ecology*, 39–65.
 25. Karl Marx, *Early Writings* (London: Penguin, 1974), 318–19, 323–28, 348–50, 359–60, 389–91.
 26. Saito, *Karl Marx’s Ecosocialism*, 72–78; Roland Daniels, *Mikrokosmos* (Frankfurt am Main: Lang, 1988).
 27. Karl Marx, *Grundrisse* (London: Penguin, 1973), 158; Karl Marx, *A Contribution to a Critique of Political Economy* (Moscow: Progress Publishers, 1970), 51–52.

28. Marx, *Contribution to a Critique of Political Economy*, 86; *Capital*, vol. 1, 133.
29. Marx, *Grundrisse*, 271, 489, Marx and Engels, *Collected Works*, vol. 30 (New York: International Publishers, 1988), 54–66; John Bellamy Foster, “Marx and the Rift in the Universal Metabolism of Nature,” *Monthly Review* 65, no. 7 (2013): 1–19.
30. See Fred Magdoff and Chris Williams, *Creating an Ecological Society* (New York: Monthly Review Press, 2017), 76, 217.
31. Marx contended that Liebig used the word “labor” in a quite “different sense from that adopted by political economy,” thereby confusing his analysis. For Liebig’s approach to labor, which he conflated with the “labor” of organisms in general, see Justus von Liebig, *Familiar Letters on Chemistry* (London: Taylor, Walton, and Maberly, 1851), 468–69.
32. Marx, *Grundrisse*, 360–61, and *Texts on Method*, 190–91; Georg Wilhelm Friedrich Hegel, *Science of Logic* (New York: Humanity, 1969), 450–56; Saito, *Karl Marx’s Ecosocialism*, 75–76.
33. Marx, *Capital*, vol. 1, 290.
34. Marx, *Grundrisse*, 527.
35. Mette Ejrnæs, Karl Gunnar Persson, and Søren Rich, “Feeding the British,” *Economic History Review* 61, no. S1 (2008): 140–71; Marx, *Dispatches for the New York Tribune*, 169; Foster, “Marx as a Food Theorist,” 12–13.
36. Marx, *Capital*, vol. 1, 638–39.
37. Marx, *Capital*, vol. 1, 638.
38. Marx, *Economic Manuscript of 1864–65*, 882.
39. Marx, *Capital*, vol. 3, 754.
40. Karl Marx, *Theories of Surplus Value*, Part Two (Moscow: Progress Publishers, 1968), 24.
41. Marx and Engels, *Collected Works*, vol. 46, 62.
42. Karl Marx and Frederick Engels, *Ireland and the Irish Question* (Moscow: Progress Publishers, 1971), 120–42; Karl Marx, *On the First International* (New York: McGraw Hill, 1973), 90; Marx, *Capital*, vol. 1, 860. Eamonn Slater has brilliantly shown that Marx’s argument on the robbery of the soil and the resulting metabolic rift had its counterpart in Ireland, where cultivators were actively prevented from replenishing the soil. Eamonn Slater, “Marx on the Colonization of Irish Soil,” Social Science Institute, Maynooth University, MUSSI Working Paper Series, no. 3 (January 2018): 4, 10.
43. Karl Marx, “Drafts of a Reply to Vera Zasulich,” in Teodor Shanin, ed., *Late Marx and the Russian Road* (New York: Monthly Review Press, 1983), 121; Marx and Engels, *Collected Works*, vol. 46 (New York: International Publishers, 1992), 63–64.
44. Marx, *Capital*, vol. 3, 949.

45. Paul Burkett, “Marx’s Vision of Sustainable Human Development,” *Monthly Review* 57, no. 5 (2005): 34–62; John Bellamy Foster, “The Meaning of Work in a Sustainable Society,” *Monthly Review* 69, no. 4 (2017): 1–14; John Bellamy Foster, *The Ecological Revolution* (New York: Monthly Review Press 2008); John Bellamy Foster, Brett Clark, and Richard York, *The Ecological Rift* (New York: Monthly Review Press, 2010); Fred Magdoff, “Ecological Civilization,” *Monthly Review* 62, no. 8 (2011): 1–25.
46. Foster, *Marx’s Ecology*, 36, 225.
47. Karl Marx, *The Poverty of Philosophy* (New York: International Publishers, 1963), 110, 228; Lucretius, *On the Nature of the Universe*, trans. Ronald Melville (Oxford: Oxford University Press), 93 (III, 869).
48. Lucretius, *The Scheme of Epicurus (De Rerum Natura)*, trans. Thomas Charles Baring, (London: Kegan Paul, Trench, 1884), 21 (I: 450–52). Other translations from Lucretius convey the same idea in slightly different and less colorful language. W. E. Leonard’s translation reads: “A property is that which not at all / Can be disjoined and severed from anything / Without a final dissolution”; Melville: “A property is something that cannot be separated / Or removed from a thing without destroying it”; Cyril Bailey: “That is a property which can in no way case be sundered or separated without the fatal disunion of the thing.” Lucretius, *On the Nature of Things*, translated by W. E. Leonard (New York: Dutton, 1921), 18; Lucretius, *On the Nature of the Universe*, trans. Melville, 16; Lucretius, *Lucretius on the Nature of Things*, translated by Cyril Bailey (Oxford: Oxford University Press, 1910), 41–42.
49. Ariel Salleh, “From Metabolic Rift to ‘Metabolic Value,’” *Organization & Environment* 23, no. 2 (2010): 205–19; Ariel Salleh, ed., *Eco-Sufficiency and Global Justice* (London: Pluto, 2009).
50. Howard Waitzkin, *The Second Sickness* (Boston: Rowman and Littlefield, 2000).
51. Norman Wentworth DeWitt, *Epicurus and His Philosophy* (Minneapolis: University of Minnesota Press, 1954), 133.
52. Karl Marx, *Early Writings* (New York: McGraw Hill, 1964), 207; Foster, “Marx and the Rift in the Universal Metabolism of Nature”; Fracchia, “Organisms and Objectifications.”
53. Joseph Fracchia, “Beyond the Human–Nature Debate: Human Corporeal Organisation as the ‘First Fact’ of Historical Materialism,” *Historical Materialism* 13, no. 1 (2005): 43.
54. Marx, *Capital*, vol. 1, 875.
55. Marx, *Capital*, vol. 1, 891–95.
56. Marx, *Capital*, vol. 1, 748.
57. Marx, *Capital*, vol. 1, 915; also see Roxanne Dunbar-Ortiz, *An Indigenous Peoples’ History of the United States* (Boston: Beacon, 2014); John Bellamy

- Foster and Brett Clark, “The Expropriation of Nature,” *Monthly Review* 69, no. 10 (2018): 1–27.
58. Edward E. Baptist, *The Half Has Never Been Told* (New York: Basic, 2016); Sven Beckert, *Empire of Cotton* (New York: Vintage, 2014).
 59. Watt Stewart, *Chinese Bondage in Peru: A History of the Chinese Coolie in Peru: 1849–1874* (Westport, CT: Greenwood, 1951), 96–98; see also Brett Clark, Daniel Auerbach, and Karen Xuan Zhang, “The Du Bois Nexus: Intersectionality, Political Economy, and Environmental Injustice in the Peruvian Guano Trade in the 1800s,” *Environmental Sociology* 4, no. 1 (2018): 54–66.
 60. Marx, *Capital*, vol. 3, 182.
 61. Marx, *Capital*, vol. 3, 365.
 62. Marx and Engels, *Collected Works*, vol. 2 (New York: International Publishers, 1975), 7-9.
 63. John Green, *A Revolutionary Life* (London: Artery, 2008), 70; Steven Marcus, *Engels, Manchester, and the Working Class* (New York: Norton, 1985), 98–99; Roy Whitfield, “The Double Life of Friedrich Engels,” *Manchester Region History Review* (Spring/Summer 1988): 13–19; Charles Dickens, *The Old Curiosity Shop* (New York: Dutton, 1908), 327.
 64. Marx and Engels, *Collected Works*, vol. 4, 447–48.
 65. See Waitzkin, *The Second Sickness*, 67–70.
 66. Marx and Engels, *Collected Works*, vol. 4 (New York: International Publishers, 1975), 448–54, 498–99.
 67. Marx and Engels, *Collected Works*, vol. 4, 492–94.
 68. Marx and Engels, *Collected Works*, vol. 4, 495–96.
 69. Marx and Engels, *Collected Works*, vol. 4, 531–35.
 70. Marx and Engels, *Collected Works*, vol. 4, 450.
 71. Marx, *Capital*, vol. 1, 552–53.
 72. Marx, *Capital*, vol. 3, 181–85.
 73. Marx, *Capital*, vol. 3, 185.
 74. Marx, *Capital*, vol. 1, 809–11.
 75. Anthony Wohl, *Endangered Lives* (Cambridge: Harvard University Press, 1983), 50–52.
 76. Marx, *Capital*, vol. 1, 811.
 77. Marx, *Capital*, vol. 1, 718.
 78. Marx and Engels, *Collected Works*, vol. 4.
 79. Marx, *Capital*, vol. 1, 359–61.
 80. Wohl, *Endangered Lives*, 52–53.
 81. Marx, “A Workers’ Inquiry,” available at <http://marxists.org>; Asad Haider and Salar Mohandesi, “Workers’ Inquiry: A Genealogy,” *Viewpoint* 3, September 27, 2013, <http://viewpointmag.com>.

82. Fracchia, “Beyond the Human–Nature Debate,” 50.
83. Fracchia, “Beyond the Human–Nature Debate,” 57.
84. Marx, *Capital*, vol. 1, 342.
85. Lucretius, *On the Nature of Things*, trans. Leonard, 45.
86. Salleh, ed., *Eco-Sufficiency and Global Justice*, 24–25, 306. For Salleh, metabolic value constitutes a larger category of socioecological value, extending beyond use value.
87. Marx, *Grundrisse*, 489.
88. Marx, *Early Writings*, 61, 328, 389; István Mészáros, *Marx’s Theory of Alienation* (London: Merlin, 1970), 82, 100–01, 163–65; Marx and Engels, *Collected Works*, vol. 3 (New York: International Publishers, 1975), 7.
89. Marx and Engels, *Collected Works*, vol. 1 (New York: International Publishers, 1975), 64; translation according to Mészáros, *Marx’s Theory of Alienation*, 351.
90. Marx, *Capital*, vol. 3, 959.
91. Liedman, *A World to Win*, 479–80.
92. Marx and Engels, *Collected Works* vol. 5 (New York: International Publishers, 1975), 141–42.

Source:



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