CHAPTER 33

METABOLIC RIFTS AND THE ECOLOGICAL CRISIS

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The Anthropocene is marked by a great acceleration in human impacts on the Earth System, undermining the conditions that have long supported life (Crutzen and Stoermer 2000). Climatologists warn that failure to reorganize human society and its interactions with the larger biophysical world will lead to runaway climate change, as the accumulation of carbon dioxide and other greenhouse gases from anthropogenic sources triggers feedbacks—such as the thawing of permafrost, the dieback of the Amazonian rainforest and Boral forests, and the diminished capacity of carbon sinks—that will hasten warming, leading to "Hothouse Earth" (Steffen et al. 2018). In addition to climate change, the planetary boundaries are being transgressed on multiple fronts, including increasing ocean acidification, stratospheric ozone depletion, the rupture of the nitrogen and the phosphorus cycles, the degradation and pollution of global freshwater, and the amplification of biodiversity loss (Barlow et al. 2018; Rockström et al. 2009). Clive Hamilton and Jacques Grinevald (2015:67) note that these factors signify a "anthropogenic rift in the natural history of planet earth."

Karl Marx developed a sophisticated metabolic analysis for assessing socioecological relationships and conditions. His materialist conception of history was undergirded by a materialist conception of nature, serving as a basis for a unified socioecological critique of the capital system (Foster 2000). He embedded the socioeconomic system in the larger biophysical world and explicitly studied the interchange of matter and energy between the environment and society (Foster and Burkett 2016). Paying particular attention to scientific debates and discoveries, Marx (1975a:209; see also Marx [1861–1863] 1975b:553) incorporated the concept of metabolism into his critique of political economy, explaining that it denoted "the 'natural' process of production as the material exchange [*Stoffwechsel*] between man and nature." He explained that there is a necessary "metabolic interaction" between humans and the earth and that labor serves as "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" (Marx [1887] 1976:283). Marx's groundbreaking analysis on this front involves a triadic scheme, consisting of "the universal metabolism of nature," the "social metabolism," and the metabolic rift (Foster and Clark 2016).

"The universal metabolism of nature" consists of specific cycles and processes within the broader biophysical world that produce and regenerate ecological conditions (Foster 2013; Marx [1861–1863] 1975b:54–66). Human societies and all life in general exist within, depend on, and interact with this earthly metabolism. Marx avoided subsuming society into nature, as well as vice versa, in order to avoid "the pitfalls of both absolute idealism and mechanistic science" (Foster 2013:8). Through their productive lives and activities, humans create a social metabolism between themselves and the rest of nature—both the macrocosm and the microcosm (e.g., the human microbiome)—which requires interchange of matter and energy (Friedman 2018). Thus, the social metabolism of humans takes place in relation to the universal metabolism of nature. This interaction is shaped by the historically specific political-economic organization of labor and production of society. Marxist philosopher István Mészáros (1995) explains that each mode of production generates a distinct social metabolic order that influences the interchange and interpenetration of society and ecological systems. Thus, the social metabolism under capitalism materializes in a manner unlike other previous socioecological systems (i.e., it takes an alienated form). The practical activities of life are shaped by the expansion and accumulation of capital. As Sweezy (2004:86–93) explained, in their "pursuit of profit . . . capitalists are driven to accumulate ever more capital, and this becomes both their subjective goal and the motor force of the entire economic system." The demands of capital are imposed on nature, increasing the pressures placed on ecological systems and the production of wastes, generating distinct metabolic rifts (or ruptures) within both the social metabolism itself and the wider universal metabolism, consisting of various natural cycles and processes.

1. Historical Development

In developing his metabolic analysis, Marx drew on a long scientific and intellectual history. In the early nineteenth century, physiologists introduced the concept of metabolism to examine the biochemical processes between a cell and its surroundings, as well as the interactions and exchanges between an organism and the biophysical world. The physician Roland Daniels, who was Marx's friend and comrade, extended the use of metabolism to whole complexes of organisms, foreshadowing its application in ecosystem analysis (Saito 2014). While his work was not published during his lifetime, he shared his ideas with Marx and others. His broad idea represented what would become the basis for examining the metabolic relations and processes at higher levels of organization and interdependency.

The German soil chemist Justus von Liebig (1859) also helped generalize the concept of metabolism, using it to examine the exchange of nutrients between Earth and humans. In order to produce crops, soil must contain essential nutrients—such as (but not limited to) nitrogen, phosphorus, and potassium. As plants grow, they take up these nutrients. Liebig determined that the long-term productivity of the soil demanded following the "law of compensation" or law of replacement, whereby the nutrients that are removed from the land must be restored (Liebig 1859:254-255, 1863:233). He pointed out that British high-farming techniques constituted a "robbery system," stealing nutrients from the soil, contributing to despoliation of the earth (Foster and Clark 2018; Liebig 2018). Horrified by the scale of soil degradation, Liebig (1859:130–131) exclaimed, "Truly, if this soil could cry out like a cow or a horse which was tormented to give the maximum quantity of milk or work with the smallest expenditure of fodder, the earth would become to these agriculturalists more intolerable than Dante's infernal regions."

Drawing on this work, Marx developed a broader metabolic analysis, which he demonstrated in his critique of capitalist agriculture. He recognized that soil fertility was influenced by the historical development of socioecological relations. For example, in many precapitalist societies, particularly in Europe, farm animals were directly incorporated into agricultural production. They were fed grains from farms, and the nutrients, in the form of manure, were actively reincorporated into the soil as fertilizer. Also, people who lived in the countryside or near production sources primarily consumed the food and fiber, and local nutrient cycling was a regular practice.

Marx explained how this particular metabolic interchange was reconfigured in large part by the enclosure movement, the division between town and country, the property rights associated with the capital system, the new industrial systems, the drive to maximize profits, and the application of novel agricultural techniques and practices. Food and fiber were increasingly shipped to distant markets, transferring the nutrients of the soil from the country to distant cities, where they accumulated as waste rather than being returned to the soil (Angus 2018; Clark and Longo 2018). The application of industrial power increased the scale of operations, transforming and intensifying the social metabolism while exacerbating the depletion of the soil nutrients. Marx ([1887] 1976:637–638) explained that capitalist agriculture progressively "disturbs the metabolic interaction between man and the earth," preventing 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. . . . 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 progress towards ruining the more long-lasting sources of that fertility. . . . Capitalist production, therefore, only develops the technique 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."

In other words, the social metabolic order of capital progressively violated the earthly metabolism—in this case the law of compensation—creating a metabolic rift in the soil nutrient cycle (Foster 2000).

This ecological rift impoverished rural lands, creating an environmental problem for European societies in the 1800s. The nutrients were washed to sea, as it was not profitable to capture and return them to the countryside. Thus, other means were sought to replenish the land with needed nutrients. Bones from battlefields across Europe and from the catacombs in Sicily were ground up and spread across agricultural land (Mårald 2002:74). Between 1840 and 1880, millions of tons of guano and nitrates from Peru and Chile were shipped to Great Britain and other countries in the Global North. During these decades, Peruvian guano was the most prized fertilizer, given the concentration of nutrients and its ability to enrich fields (Clark and Foster 2009). In 1890, Egyptian mummified cats, which were pulverized into powder, were used as fertilizer for English farms in an attempt to compensate for some of the lost nutrients (Kahn 2015; Strange History.net 2013). Just prior to World War I, the process for producing nitrates by fixing nitrogen from the air was developed, allowing for the large-scale production of synthetic fertilizer. However, given the growth imperative of capital, the failure to recycle nutrients, and the ongoing intensification of agricultural practices, the metabolic rift in the soil nutrient cycle remains a persistent problem (Magdoff 2011; Mancus 2007).

2. Contemporary Influence

Del Weston (2014:66), in *The Political Economy of Global Warming*, proposes that the "metabolic rift is at the crux of Marx's ecological critique of capitalism, denoting the disjuncture between social systems and the rest of nature." Marx's triadic scheme of "the universal metabolism of nature," the "social metabolism," and the metabolic rift has served as the foundation for important ecosocialist scholarship over the last two decades, addressing both historical and contemporary environmental problems. Research on food production highlights how the social metabolic order of capital has further intensified the social metabolism—often through technological development to enhance economic efficiency—exacerbating existing and creating additional ecological rifts. Growth hormones in animal feed are used to accelerate the development of cows and chickens (Heffernan 2000; Longo, Clausen, and Clark 2015; Weis 2007). Concentrated animal feeding operations separate animals from pasture, as well as fish from marine systems. Feed is grown on distant land, or captured at sea, and transferred to animal production sites. Animal wastes, including important soil nutrients, accumulate in cesspools, polluting water systems (Clausen and Clark 2005; Edwards and Driscoll 2009; Longo, Clausen, and Clark 2014; Weis 2013). These operations enhance the ability of corporate enterprises to control the entire life cycle of animals in an attempt to decrease the time between birth and slaughter. At the same time, these enterprises increase commodity production but, more importantly, increase value. Factory farms require massive amounts of animal feed, growth hormones, and antibiotics. They also generate enormous quantities of waste not readily reincorporated into ecosystems (Gunderson 2011). Essentially the life cycles of plants and animals are increasingly geared to market cycles. Production practices such as these increase the amount of matter and energy required to maintain this food system.

Marxist metabolic research has examined how the social metabolism of capitalism is associated with specific environmental problems, including climate, oceanic, hydraulic, and forest systems (Austin and Clark 2012; Clark and York 2005; Longo 2012; Longo and Clark 2016). For example, capitalist growth has been dependent on burning massive quantities of coal, natural gas, and oil (Clark and York 2005; Foster and Clark 2012). This process has resulted in breaking the solar-income budget, releasing enormous quantities of carbon that had been sequestered. At the same time, consequent growth-driven, ecological degradation (e.g., deforestation) substantially reduces carbon sinks, further contributing to the accumulation of atmospheric carbon dioxide, resulting in a carbon rift that exacerbates human-caused climate change. As the growth imperative of capitalism intensifies the social metabolism, without any regard for natural limits, socioecological rifts are created within specific natural cycles and systems. Even in overlooked realms, such as marine systems, the social metabolism of capitalism is altering ecosystem dynamics and life cycles. For instance, capital accumulation processes have been demonstrated to play a primary role in the structure and function of the fishing industry on a global scale. Capitalist economic forces have led to fish being harvested at a rate faster than they can reproduce and, at times, to the collapse of fisheries (Longo 2012; Longo, Clausen, and Clark 2015).

The intensification of the social metabolic order of capital demands more energy and raw materials, generating an array of ecological contradictions and rifts (Burkett 2006; Foster, Clark, and York 2010). Technological innovation plays a crucial role in capitalist development as it helps rationalize the labor process and reduce costs via automation. New technologies often make energy and raw material usage more efficient, but this innovation does not necessarily lower the overall demands placed on the biophysical world. In fact, more efficient resource usage often increases aggregate consumption of that particular resource—creating a socioeconomic dynamic known as the Jevons paradox, named after the nineteenth-century economist William Stanley Jevons (Clark and Foster 2001; Jevons [1865] 1906; Polimeni et al. 2008). In *The Coal Question*, Jevons noted this paradoxical relationship, whereby increased consumption outstrips gains made in energy efficiency. Ecosocialist scholars explain that efficient operations produce savings, which are used to expand investment in production and thereby promote increased production and consumption, and accordingly total energy consumed, raw materials used, and carbon dioxide produced (Foster, Clark, and York 2010; York 2010). The Jevons paradox is a product of capitalist social relations. It illustrates that purely technological means cannot solve ecological problems.

As a dynamic system, capitalism confronts environmental obstacles—such as a shortage or exhaustion of particular resources—through a series of shifts and technological fixes to maintain its expansion. Here environmental constraints are addressed by incorporating new resources into the production process, changing the location of production, or developing new technologies to increase efficiency. Rather than solving ecological rifts, such shifts generally create new cumulative problems, generating additional disruptions in the conditions of life, often on a larger scale (Foster, Clark, and York 2010). Currently, the drive for capital accumulation is disrupting the planetary metabolism at cumulatively higher levels, creating a collapse in biodiversity, and propelling the earth into a "Hothouse" state. In this, the alienated social metabolism of capital is creating potentially irreversible, catastrophic impacts, which are undermining the conditions of life.

It is dramatically clear that revolutionary transformation in the socioeconomic relationships that govern our productive lives is necessary. Associated producers must regulate the social metabolism in accord with the requirements of the universal metabolism of nature, while fulfilling human needs in a sustainable fashion. Here socioeconomic relations and production can be directed toward metabolic restoration—and the creation of an unalienated world of sustainable human development.

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