

Epidemics and Social Metabolism

Nature, Capitalism, and Rifts

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While human epidemics long antedate capitalism, the accelerating emergence of epidemics since the Industrial Revolution (for example, cholera), and especially in the later twentieth century (e.g., HIV, SARS, COVID-19), is temporally and fundamentally related to the capitalist mode and social relations of production, to the alienated social metabolism with nature, and to a rapid acceleration of the breaching of Earth System boundaries.¹ These epidemics are tightly linked to fully developed capitalism, its high velocity, and long distance circulation of commodities and workers along with other animals, plants, and microscopic organisms.² These interactions are mediated through human contacts with existing potentially pathogenic microorganisms, including species undergoing anthropogenic evolution, and through their impact, in socially constructed contexts, on populations unevenly subjected to capitalism-induced metabolic and corporeal rifts.

Many discussions of epidemics present a superficial approach to the “causes” of epidemics, seeing epidemics as unfortunate but otherwise natural, random events whose emergence cannot be prevented or avoided, but which can perhaps be predicted and responded to with interventions (for example, vaccines, medications, better ventilation, or less contaminated water) that mediate either the contact with, or impacts of, microorganisms.³ Even some Marxist historians have treated epidemics, including plague, as part of “an arbitrary world of natural catastrophes.”⁴ This approach erroneously and misleadingly decontextualizes epidemics from human activity, bounded by a too narrow level of abstraction in which many relevant aspects of reality are not considered.⁵ Rob Wallace and colleagues wrote that “if the vantage points proposed are limited enough, disease research presumes state and market neoliberalism as a part of the natural order[,] even [if] other studies show the system’s mechanisms are central to the problem of disease.”⁶ Decades earlier, Richard Levins noted that much of the analysis of disease and health is atheoretic and suffers from intellectual blinders due to narrow perspectives and fail-

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ures to consider complexity, evolution, history, context, and reciprocal interconnections, and that these blinders are reinforced by notions that “theory is almost a dirty word.”⁷

The Universal Metabolism of Nature, the Social Metabolism with Nature, and Metabolic and Corporeal Rifts

As John Bellamy Foster has demonstrated, Karl Marx adopted and extended Justus von Liebig’s analysis of metabolism with respect to soil fertility to characterize the human interaction with the rest of nature through its appropriation via labor.⁸ Marx considered the specific cycles and processes of energy, chemicals, and interacting living organisms in the broader biophysical world that support life to be the *universal metabolism of nature*, “a metabolism prescribed by the natural laws of life itself.”⁹ The human social metabolism with nature involves the specific processes and cycles of labor with and through which humans exist, depend on, and interact with the rest of nature to produce their subsistence and reproduction, allowing them to live their lives. As Marx wrote: “Labor is...a process between [hu]man[s] and nature, a process by which [humans] through...[their] own actions, mediate, regulate, and control the metabolism between themselves and [the rest of] nature.”¹⁰ The specifics of the social metabolism are historically and contextually contingent.

Marx further stressed that the social metabolism with nature under capitalism results in perturbations of otherwise sustainable cycles of nature, referred to as *metabolic rifts*, as a consequence of production for exchange value rather than use value. István Mészáros referred to this as capital’s “absolute imperative of self-reproduction on an ever-expanded scale,” which disrupts these sustained cycles.¹¹ Foster and Brett Clark further note that the rifts generated by capitalism are “not confined to the alienated relation to external nature but affect the human metabolism itself, the bodily existence of human beings,” and referred to these as *corporeal rifts*.¹²

Marx also mentioned that these rifts include “periodic epidemics.”¹³ This was an astute observation, particularly since in that era – before the germ theory, antibiotics, and almost all vaccines – infections and epidemics were normalized aspects of everyday life, and many children commonly died of infections, including several of Marx’s children.¹⁴ While Marx integrated an understanding of the universal metabolism of nature and the social metabolism into his theorization and into *Capital* – and while Bob Jessop has highlighted that advances in cell biology may have informed Marx’s decision to begin *Capital* with the commodity as the “economic cell-form” of the capitalist mode of production – there was

only an incipient understanding of microorganisms and their association with infection during his life.¹⁵

Research has documented the dramatic adverse impacts of capitalism on the *abiotic* (inanimate) environment, on processes such as nitrogen cycles and soil fertility, on the acidification of oceans, and on the warming of the atmosphere.¹⁶ Adverse impacts on the *biotic* environment include deforestation, biodiversity loss, and species extinctions, with most analyses focusing on humans and nonhuman animals and plants, specifically those visible to the naked eye (macroorganisms). Of the nine proposed planetary boundaries, representing the limits of conditions within which humans can safely live on Earth, seven have been exceeded due to anthropogenic activity.¹⁷ Yet, there has been lesser theoretic and concrete attention given to relationships between human modes and social relations of production, the Anthropocene, and microorganisms, including those associated with epidemics in humans.

Microorganisms are ubiquitous in all ecosystems and environments.¹⁸ They have their own materiality and corporeal structures. There are more microorganisms than there are all macroorganisms combined.¹⁹ Microorganisms, along with cycles of nitrogen and other chemicals, are essential for the health of soil, which in turn is essential for all agriculture and for human life; some, such as coral polyps and algae, are essential parts of oceanic ecosystems. While microorganisms are affected by climate change, they also affect it.²⁰ A recent scientific consensus statement addressed “microorganisms and climate change” and “put humanity on notice that the *microscopic majority* can no longer be the unseen elephant in the room.”²¹

As Joseph Fracchia has highlighted, Marx wrote that “the first fact to be established for the study of history is the corporeal organization of human beings and their consequent relation to the rest of nature.”²² While each individual human consists of about 30 trillion human cells, there are also an additional estimated 39 trillion bacteria alone (not including viruses) in and on each of us.²³ This understanding that humans, and all multicellular species, have intrinsically associated microorganisms has led to the concepts of both a *microbiome* (the sum of microorganisms associated with a larger host organism and their combined genetic material) and of a *metaorganism* (the interacting aggregate of the host organism and the associated microorganisms that are functionally relevant to the host organism as a process). These microorganisms have coevolved with and serve important functions for host organisms, including contributing to metabolism, immunity, adaptation, environmental sensing, reproduction, and other systems.²⁴

Language, Framing, and Representation of Epidemics

Many theories and representations of human epidemics have appropriately considered their demographic impacts (for example, on the power of labor) and spread via “trade,” but have under-considered the links to production and, more generally, to modes and social relations of production and to the social metabolism, and specifically to their origin and spread “along circuits of capital.”²⁵ There has been a dominant, and appropriate, focus on *zoonoses*, best understood as “infections associated with microorganisms encountered through human interactions with nonhuman animals.”²⁶ Over 60 percent of infectious diseases among humans are linked to microorganisms associated with wild or domesticated nonhuman land animals.²⁷ Currently, *zoonoses* account for over two billion cases of human disease and over two million deaths a year, with the greatest combined burden of zoonotic infections falling unevenly on one billion rural and urban very poor people, constituting forms of unequal ecological exchange and ecological imperialism.²⁸

The “zoonosis” frame inappropriately suggests a dyadic relationship of humans and nonhuman animals abstractly interacting as the sole living entities. This obscures modes of transmission: mediating processes involving at least one other organism, usually a microorganism that infects nonhuman animals and humans via various modes of contact (often mediated via vectors such as fleas, mosquitoes, or ticks). Many studies of *zoonoses* focus narrowly on viral or bacterial “causes” and modes of transmission, excluding from consideration the socially created contexts that facilitate transmission and the significant, inequitable variations in human health, which have resulted from the corporeal rifts induced by capitalism.²⁹

Representations of epidemics as “natural” phenomena arising independently of human agency also contribute to erroneous claims that “everyone is at risk” and the idea of pseudo-solidarity that as humans “we are all in this together,” and claims that epidemics have potent leveling effects.³⁰ These are misleading, ideologically driven notions that obscure and deny class and other differences that serve as bases for inequalities and oppressions.

Developing a Dialectical Historical-Materialist Understanding of Epidemics

A historical-materialist, Marxist (ecosocialist) analysis of epidemics yields richer and more accurate insights. Ecosocialism understands that humans are part of nature, and that how humans appropriate from nature and produce and distribute products shape our interactions with the rest of nature. It also understands that nonhuman nature is affected by what humans do, influencing how other species interact with each other and with humans.

This occurs in contexts that are created, shaped, and reproduced by the sum of living organisms, by the impacts of previously living organisms, and through abiotic processes of nature such as nitrogen and carbon cycles.

An epidemic, by definition, is the significant increase in the occurrence of disease and is not driven entirely by a microorganism.³¹ For an epidemic to occur, a definite number of individuals need to be in specific kinds of contact, within certain distances, over discrete time periods. Further, the likelihood that any given individual may become infected and develop disease will also be driven by each individual's own prior health conditions. These are themselves driven by history and context, and can include manifestations of corporeal rifts induced by alienated, often forced, labor under capitalism. Therefore, while specific organisms may "cause" disease (in the dialectical sense of an asymmetry in the balance of reciprocal forces), the causes and processes of an epidemic are much more complicated phenomena that arise in specific social and historical contexts. It is reductive and one-sided to represent an organism as *the* cause of an epidemic. Rather, epidemics arise in the context of specific processes and relationships of a social metabolism in distinct times and places, which are themselves fundamental causes and dialectically related processes.³²

Some frameworks of public health theory provide a broader focus that includes consideration of factors beyond a host organism and a "pathogen," or beyond these two and sometimes a mediating vector, to include "environment." Some of these frameworks add further clarity to the concept of what constitutes relevant components of environment (referred to as "social determinants of health" models).³³ Most such models (1) limit consideration to the current environment, which is considered static and ahistoric, and often treat socially constructed processes (for example, race, ethnicity, or poverty) as "unmodifiable risk factors," ignoring their social construction and historical trajectories; (2) under-consider the manifold interactions constituting the specifics of the social metabolism, such as human relationships with land, terraqueous environments, and nonhuman animals; and (3) ignore the capitalist social metabolism, with its alienated production and high-velocity circulation driven by exchange value and accumulation.³⁴

Levels of Abstraction, the Dialectics of Nature, and Epidemics

Levins highlights that "what makes science materialist is that the process of abstraction is explicit and recognized as historically contingent within the science."³⁵ An understanding of epidemics and their relationship to the social metabolism similarly requires use of appropriate levels of abstraction

that reflect the dialectics of nature broadly, and of biology specifically, as they manifest in epidemics. Marx's analysis of capitalism explicitly relied on multiple levels of abstraction, and we apply those Marx used and additional levels to epidemics: (1) external, nonhuman nature broadly; (2) both nonhuman abiotic nature and biotic nature; (3) nonhuman biotic nature including both macroorganisms and microorganisms; and (4) microorganisms capable of enacting pathogenic processes in humans.³⁶ Incorporating these levels of abstraction in analyses in no way posits or implies either a fixed human-nature dichotomy or a fixed human-nonhuman animal dualism or dichotomy, but understands these levels as dialectical, as consistent with Marx's writings, and, as Christian Stache put it, as a "sustainable concept of the human-[nonhuman] animal differentiation that stands in contrast to the dualist Western philosophical tradition."³⁷

At higher levels of abstraction, these distinctions can become less clear, as there are processes key to the dialectics of nature in which living organisms create abiotic nature, as well as depend on it. There are examples of long-established and long-sustained cycles of material and energy in nature demonstrating dialectical interconnections among biotic and abiotic aspects of the environment as a *totalizing process*. One example is the symbiotic relationship among coral polyps (which are tiny animals) and certain marine algae. These algae live inside the coral polyps and are photosynthetic, capturing energy from the sun.³⁸ The coral polyp-algae complexes live in colonies and secrete forms of calcium that produce hard coral reefs. Parrot fish bite pieces of coral reef, derive energy and nutrients from the coral polyps and algae, and then defecate calcium-containing particulate matter that becomes the sand of many sea floors and beaches.

This is both an example of production by the cooperation of populations of organisms of two or more species, and an example of living organisms creating abiotic nature.³⁹ Further, in this ecosystem, coral, algae, and parrot fish are each effectively metaorganisms that each have their associated microorganisms.⁴⁰ The Earth System cycle of production of coral reefs, which involves populations of more than one species, is important in capturing solar energy, creating habitats for countless species, increasing biodiversity, and serving as sources of sustenance for countless species, including humans. This ecosystem cycle has continued, with gradual evolutionary changes, for over 400,000 years.⁴¹ Another key dialectic of biotic and abiotic nature is that organisms directly or indirectly capture energy from the sun, and ultimately die, undergo decomposition and physical pressures, and become abiotic fossil fuels. Further, it should be noted that these are examples of the dialectics of nature that do not, of necessity, require the mediation of humans.⁴²

These cycles of interacting organisms are component processes of the dialectical universal metabolism of nature as an active power, which Foster describes as “a kind of agency, even if this is unconscious agency.”⁴³ As Richard Lewontin and Levins have highlighted, “the isolated community [of a single species] is an abstraction in that no real collection of species exists that interacts solely with its own members and that receives no propagules [critical inputs] from outside.”⁴⁴ Understanding these interspecies interactions, and biotic and abiotic nature interactions, together as an ecosystem process (that is, as the universal metabolism of nature) is essential to understanding how perturbations in such long-sustained relations can produce epidemics and *epizootics* (epidemics among nonhuman animals).⁴⁵

Dialectics of Epidemics

Frederick Engels emphasized the importance of the dialectics of nature in understanding nature in its “complexity, nonlinearity and change.”⁴⁶ For many years, the application of dialectics to nature (rather than only to social processes) was actively or obliquely denied by Western Marxism. However, there is increasing recognition of its importance. Foster referred to this as the “return of nature” and, along with the recognition of the centrality of the concept of the social metabolism to Marx’s work, as the “second foundation of Marxism.”⁴⁷

Dialectics allows us to understand epidemics as linked to the social metabolism, and how the mode and social relations of production, which under capitalism are based on exchange values rather than use values is antagonistic to sustainable ecosystem cycles. Under capitalism, commodities circulate throughout the world market at increasing velocities (faster circulation times), stimulating more expansive human-human contact, human-nonhuman animal contact, and contact with a wider range of microorganisms capable of being pathogenic in specific contexts. At each moment of the circuit of capital accumulation and alienated production, humans interact with other species as part of the capitalist social metabolism.⁴⁸ Through repetitions and increasing speed, this circuit produces metabolic and corporeal rifts that can drive epidemics.

To develop a fuller historical-materialist theory of epidemics, we explicitly link specific processes of epidemics to specific dialectical relations.⁴⁹

Appearance/Essence

A key ideological distortion and misrepresentation is that “pathogens cause epidemics.” While certain microorganisms may *appear* to cause epi-

demics because their involvement is often the most proximal (and detectable) aspect, this ignores that the pathogenicity of many microorganisms is contingent upon context. Therefore, a distorted, mystified image of epidemics is produced through a narrow level of abstraction that excludes relevant relations and context. Taking appearance as essence is, in fact, a fetishization of the microorganism.⁵⁰

With respect to epidemics, certain microorganisms, such as Ebola virus or *Yersinia pestis* (*Y. pestis*, the bacteria associated with the plague), may almost always function as pathogens to “cause” (as the most proximal step) disease in that individual.⁵¹ Yet, a dialectical understanding highlights that interactions among individuals and a virus or bacteria are bidirectional and reciprocal, with outcomes influenced by host processes, microorganism processes, evolution, and the specifics of the social metabolism. Compared with the Ebola virus, which almost always functions pathogenically, there is much more variability and contingency in most human-microorganism interactions with less determinism of outcomes, even in a single host.

Contradiction

The increasing extent and velocity of capitalist production and circulation leads to the unintended production (via interaction with existing microorganisms or via anthropogenic evolution) and circulation of microorganisms potentially capable of being associated with epidemics in populations made socially vulnerable to sustaining epidemics.⁵² Further, capitalism’s alienated, high-intensity production by expropriation stands in contradiction to the long-sustained processes of organisms interacting in cycles of their respective metabolisms with nature, producing rifts.⁵³

Interpenetration of Opposites

Humans may consider bacteria such as the *Y. pestis* bacterium as a “pathogen.” However, it is important to acknowledge dialectically that for such microorganisms, their “pathogenicity” is their mode of subsistence, reproduction, and habitat (that is, their metabolism with nature). This is an aspect of what Roy Bhaskar referred to as the ways nonhuman “nature reappropriates human beings.”⁵⁴ With respect to the dialectic relation of interpenetration of opposites, this is a one-sided perspective that only considers how a microorganism functions with respect to a host organism, ignoring the constant change and mutual interaction that exist between all processes in nature and constitute the universal metabolism of nature.⁵⁵

Identity/Difference and Quality/Quantity

For epidemics, the relationships of identify/difference and quality/quantity are reflected in the biology of differences within and between populations that might function in sustainable interspecies relationships in ecosystems, including as host, “pathogen,” predator, or prey, as well as being reflected in the quantitative accumulation of differences that can lead to qualitative shifts from sustainable to “disharmonious” relationships, that is, rifts.⁵⁶ These shifts can be driven by anthropogenic forces, and, as Foster notes with respect to inorganic nature, “the *quantitative* expansion of global production and of resource extraction...led to a *qualitative* transformation in the human relation to the Earth System as a whole,” which can drive species evolution and context changes.⁵⁷ Further, the accumulation of a sufficient *quantity* of relevant genetic changes (through random mutations and natural or anthropogenic selection) can lead to the *qualitative* change of one species to new species or to changes in an existing species that can increase its pathogenic potential leading to epidemics.⁵⁸

Negation of the Negation

The dialectical relation of the negation of the negation is reflected in the ways one organism may evolve to derive energy and nutrients from organisms of another species (for example, by eating them or using them as labor, or through infection and pathogenicity), followed by evolution of that second species in response to selection pressures induced by the first species, and then subsequent evolution of the initial species in response to selection pressures induced by the second species. The evolutionary development of antimicrobial resistance and of new viral variants escaping the protective effects of vaccines are relevant examples of this.⁵⁹

The Commons as an Ecosystem

Marx focused on both labor and land as sources of wealth, on land enclosures as pivotal in the transition to proletarianized wage labor in capitalism, and on the robbery of the soil as an early manifestation of the metabolic rift induced by capitalism.⁶⁰ Marx highlighted that land enclosures thwarted and prompted struggle over an aspect of the social metabolism, specifically the appropriation of what had been a communal resource, the ability to glean fallen wood.⁶¹ Ian Angus and others have further highlighted that analogous processes of struggle over land and land-based biotic nature are ongoing, in both the Global South, as well as in regions of the North.⁶² The expropriation and dispossession of workers from the land that is essential to the creation of the economic coercion necessitating the sale of labor power and establishing capitalist control of

land do not eliminate the social metabolism with land or with nonhuman land animals (and the microorganisms associated with both), but merely change specific aspects of it.⁶³ Hence, a change in mode of production is associated with a change in the social metabolism.

Dialectics also helps us to understand capitalism as a process attacking “the commons.” While this is quite accurate at one level of abstraction, drawing attention to the (real) need for nonhierarchical, non-class-based, nonantagonistic social metabolism, it might also bring a somewhat anthropocentric perspective in framing humans as *in*, rather than as *of*, nature.⁶⁴ The frame of a commons for humans may sometimes inadvertently suggest an exclusive focus on the communal *human* appropriation of nature, obscuring that all other organisms also have a metabolism with nature and that it is the totalizing process of all species’ metabolism with nature and all cycles of the abiotic environment that constitutes the universal metabolism of nature, and of which the social metabolism is one interacting part.⁶⁵

This is not an argument for a flat ontology in which all species, human and nonhuman, and all matter are “on the same physical or moral plane as a human individual living in society” or have historical or moral “agency,” which, as is the case with some forms of post-humanist ecology, close “off the philosophy of praxis.”⁶⁶ Rather, we argue that there are no moments when species do not meet and interact as part of their respective metabolisms with nature, and that a dialectical-materialist understanding of the social metabolism requires attention to human interactions with the ecosystem cycles.

Corporeal Rifts: Embodied, Microbiome, and Interspecies Dimensions

The adverse effects of the capitalist social metabolism should be understood to include both *metabolic* rifts in abiotic chemical and energy cycles, and *corporeal* rifts, which result in human mortality and morbidity through labor, famine, and disease (an embodied dimension of the corporeal rift). Engels described these corporeal impacts in *The Condition of the Working Class in England*, Marx did so in *Capital*, and Rudolph Virchow did so in his analysis of the 1848 typhus epidemic among Silesian workers.⁶⁷ More recently, building on Marx, Foster and Clark, Mauricio Betancourt, and others have done so explicitly using the corporeal rift construct in analyses of the adverse impacts on guano laborers in Peru, a trade constituted as an attempt to respond to the metabolic rift of the robbery of European soil fertility by capitalist agriculture.⁶⁸

Further, Michael Friedman has also highlighted that the adverse effects of the capitalist social metabolism should be understood as including those

on humans as metaorganisms. The human microbiome can be adversely affected by low fiber, high fat, or high sugar foods (such as those marketed by capitalist food industries) as well as by antibiotics used both in health care and in capitalist livestock industries.⁶⁹ These “industrial diets” and antibiotic exposures alter the numbers and distributions – the biodiversity – of the microorganisms in the human microbiome (referred to as *dysbiosis*). These perturbations have been implicated in a range of noncommunicable human diseases. These dysbioses constitute rifts in previously sustained interactions between humans and the other species constituting the human microbiome, induced by the capitalist mode of production and by the specifics of the overall social metabolism, ultimately representing a *microbiome dimension of the corporeal rift*. Understood in this way, these are one-sided impacts on humans; from the perspective of the microorganisms of the microbiome, these dysbioses also constitute changes in the microorganisms’ metabolism with nature. Impacts in both directions have potential evolutionary significance for each involved organism species.

Perturbed relations between humans and other species, including microorganisms, that are part of the broader environment with which humans interact, are also important and key to epidemics. This broader environment includes the microbiomes of other species and the microbiomes of soil and terraqueous environments. At a different level of abstraction, the specifics of the human-microorganism interactions are linked to changes in modes of production and the spheres of production, circulation, and reproduction. The capitalist social metabolism produces both metabolic and corporeal rifts that can perturb sustainable interspecies interactions, potentially manifesting as epidemics, epizootics, and extinctions.⁷⁰ We propose that these perturbed human-microorganism relationships can be understood as the *interspecies dimension of the corporeal rift*.⁷¹ Further, the perturbation of these interactions is linked to capital’s inherent and continuous drive for accumulation, which “reproduces the *separation* and independent existence of material wealth as against labour on an ever increasing scale,” while reproducing metabolic and corporeal rifts and the alienation of humanity from the rest of nature.⁷²

Historical Materialism, Transitions to Capitalist Social Metabolism, and Epidemics

Epidemics have impacted human populations for fifty or more millennia.⁷³ Therefore, an important consideration for a historical-materialist analysis of epidemics is to understand what is different about the relationship between epidemics and the social metabolisms among different modes of production, and, specifically, under capitalism.

Some human infectious diseases, including measles and smallpox, seem to have appeared first with transitions in modes of production and in the social metabolism. These transitions have included those from hunter-gatherer to agricultural modes of production, the origins of Eurasian large land animal domestication, possibly the Islamic Agricultural Revolution, and the Mongol unification of much of Eurasia.⁷⁴ That is, there have been human diseases and epidemics linked to changes from one precapitalist mode of production and from one social metabolism to another.

The social metabolism of necessity includes specific ways humans interact with nonhuman animals, whether for their appropriation as resources (e.g., food, silk, or fiber) or for their services (e.g., protection, hunting, transportation, or companionship). Historically, different populations developed very distinct sets of human-nonhuman animal relations as part of their social metabolism.⁷⁵ Variations in the manner of human-nonhuman animal interactions have been referred to by historian Marcy Norton as *modes of interaction*. This concept is broader than that of species domestication.⁷⁶

Individual organisms and populations of different species can interact in ways that are beneficial to one and harmless to the other (*commensalism*), beneficial to both (*mutualism*), harmful to both (*competition*), or harmful to one and beneficial to the other (predation/hunting and *parasitism*). Of course, the dialectical other side of a microorganism being capable of enacting pathogenic processes is the nonhuman animal being susceptible to a microorganism's potentially pathogenic processes. Under the capitalist social metabolism, the dialectical net balance of these processes produces embodied, microbiome, and interspecies corporeal rifts.

Domestication, for instance, is a coevolutionary process, arising from mutualistic or commensal interspecies interactions. Domestication has often been taken inappropriately as a sign of the stage of development of societies, with the Eurasian style of animal domestication (specifically animal husbandry and the use of appropriated nonhuman animals for hunting and other labor) taken as "a natural and inevitable component of progress," and societies that did not adopt Eurasian modes of interaction taken to be more primitive and underdeveloped.⁷⁷ Such Eurocentric conceptions have the effect of reinforcing assertions of European cultural superiority over the cultures and societies of Africa, Australia, and pre-1492 Americas. Additionally, these notions normalize the alienation of humans from nonhuman animals, reinforcing their objectification and commodification. Last, these Eurocentric conceptions wrongly posit that there are no alternative modes of interacting with nonhuman animals that might be more sustainable and that might be less likely to contribute to epidemics.

In transitions from precapitalist toward capitalist modes of and social relations of production, there are linked transitions toward the capitalist social metabolism. One specific aspect of this is transitions in modes of interactions with nonhuman animals. An understanding of these human-nonhuman animal interactions, recognizing their historical development and variation, and, therefore, their potential for modification within “circumstances existing already, given and transmitted from the past,” is essential to understanding epidemics and to conceptualizing and implementing nonantagonistic, sustainable modes of interaction that minimize, rather than raise, the risk of epidemics.⁷⁸

Colonialism, Slavery, the Commodification of Nonhuman Animals, and Anthrax Epidemics

Anthrax is an infectious disease associated with the bacterium, *Bacillus anthracis* (*B. anthracis*). This microorganism can produce *spores*, a microscopic spherical bacterial form with a thick wall that allows the bacteria to remain dormant but viable despite adverse environmental conditions. *B. anthracis* spores persist in soil around the world and are part of the community of organisms that make soil a dynamic process rather than an inert thing or solely abiotic matter. When environmental conditions are more favorable to bacterial growth, spores can appropriate nutrients and energy from the environment, germinate, and multiply. Herbivores, such as sheep, cattle, reindeer, and others, can ingest *Bacillus* spores while grazing; spores can then germinate within the infected animal, producing toxins that drive severe, often lethal, septicemia. When infected animals die, they return nutrients, energy, and bacteria, including viable *B. anthracis* spores, to the soil, which then can serve as a source of subsequent infection as a cycle.⁷⁹ Large anthrax epizootics have occurred among grazing herbivores and these epizootics have contributed to human famines, to human anthrax cases, and, in some instances, to epidemics.⁸⁰

Anthrax spores can also become attached to animal fur and hides. As humans have long appropriated animals for subsistence, there has long been a risk of human acquisition of anthrax disease associated with this mode of interaction and specific aspect of the social metabolism.⁸¹ Humans can develop anthrax disease either by skin contact with animal tissue that contains *B. anthracis* spores (causing cutaneous anthrax, which can sometimes progress to severe disease), by ingesting infected animal tissue (causing gastrointestinal anthrax, which is usually severe), or by spores that can become aerosolized and are then inhaled (causing very severe, highly lethal pulmonary anthrax).⁸² Cutaneous anthrax is the most common form among humans, and is specifically linked to the appropri-

ation of animal fur and hides, and, more recently, to their commodification in capitalism for surplus value production and accumulation.

Anthrax has been referred to as “wool handlers’ disease” potentially affecting over 64 million livestock handlers and over a billion livestock (and unknown numbers of wildlife) in endemic risk settings.⁸³ For example, in 1770, an anthrax epizootic of livestock cattle occurred in Haiti, then a French plantation colony reliant on the labor of enslaved Africans, which induced a corporeal rift. This epizootic began shortly after an earthquake, which was followed by a tsunami, a rebellion and the escape of enslaved people, increased struggles between French and Spanish colonialists, and human famine. In the human anthrax epidemic that followed, an estimated 15,000 people died in a six-week period due to handling hides, disposing of corpses, and eating infected meat.⁸⁴

Phylogenetic analyses have identified several strains of *B. anthracis* in different distributions around the globe in patterns shaped by human activity. One specific strain is distributed in France, Haiti, Senegal, Gambia, and the region of Canada that was previously a French colony, suggesting strongly that this distribution was linked to French colonialism, enslavement, and trade of West African people, and to the circulation of commodified, infected textiles and fur in the seventeenth and eighteenth centuries.⁸⁵ Human contact with *B. anthracis* then can be understood as being driven by evolutionarily and historically developed “ecological dynamics at the wildlife-livestock interface,” and anthrax epidemics as being linked to colonialism and rifts induced by the specifics of the emerging capitalist modes of interaction, production, and capitalist social metabolism.⁸⁶

Imperialism, Transitions to Capitalist Social Metabolism, and Plague Epidemics in Manchuria (1910-1911)

The end of the nineteenth century and early years of the twentieth century were an era in which imperialism was a key source of ongoing expropriation, capitalist expansion, and accumulation globally. Imperialist wars were fought on all inhabited continents for control of aspects of the abiotic environment (for example, land and its underlying geologic matter for mining), and the biotic environment (for instance, humans as labor power and for the extraction of surplus value). Wars increasingly served as outlets for the absorption of surplus capital and for temporarily ameliorating crises of overaccumulation.⁸⁷ In 1916, V. I. Lenin wrote that “the ‘semi-colonial states’ provide an example of the transitional forms which are to be found in all spheres of *nature and society*. Finance capital...is capable of subordinating to itself, and actually does subordinate to itself, even states enjoying complete political independence.”⁸⁸ Commenting on Lenin’s theory of imperialism,

Georg Lukács wrote that “in its developed form capitalist exploitation does not just criminally exploit the colonial peoples...it simultaneously transforms their whole social structure and draws them into the capitalist system.”⁸⁹

Colonialism and imperialism not only draw precapitalist and transitional societies and areas into capitalist commodity relations, they entangle them in capitalist social metabolism. Supranational aspects of capitalism have been highly relevant not only to the emergence of capitalism, but also to the spread of the capitalist social metabolism, which includes the accelerating cross-national border movement of commodities, people, and nonhuman animals, and the emergence (production) and spread (circulation) of those microorganisms capable of functioning pathogenically.⁹⁰

Large plague epidemics occurred in Manchuria in the early twentieth century. These plague epidemics occurred in the context of several capitalist, imperialism-driven crises in Manchuria. Much of the Russo-Japanese War of 1904–1905 was fought in Manchuria over competing imperialist goals involving mineral and other resources, land, ports, railroads, markets, and more, followed by several years of struggles between Russia, Japan, and China. The 1910–1911 plague epidemic started in modestly populated transitional rural (largely precapitalist agricultural, but increasingly extractivist mining) areas undergoing changing land use patterns and shifts to waged, rather than subsistence, labor. New railway lines were built with exploitative, corporeal rift-inducing labor to support the expanding land enclosures (expropriation and dispossession) for coal and iron mining, and for increasingly capitalist hunting and capitalist agriculture.⁹¹

Y. pestis bacteria can live and not cause diseases in some species; some flea, tick, and lice species can carry the bacteria after biting infected rodents thus becoming vectors capable of transmitting *Y. pestis* to new hosts. Humans can acquire *Y. pestis* infection and plague disease from exposure to infected rodent tissue, mediating insect vectors, or directly from other humans. Plague disease can be bubonic (swollen lymph nodes) or pneumonic (in lungs and contagious person-to-person); both can become septicemic (in blood), leading to death.

Marmots are large burrowing rodents that can carry and sometimes become ill from *Y. pestis*.⁹² These rodents are endemic to many wooded regions, including Manchuria. Indigenous people in Manchuria had specific, historically developed, sustainable modes of interaction with marmots since at least the thirteenth century, and probably since the Neolithic period. Marmots provided food and clothing for humans. The human-marmot relationship was not fully commodified; marmots were appropriated for their use value but not for exchange value, and thus were not commodified. Recent studies have suggested that marmots in

China were the likely reservoir for the *Y. pestis* strain that was associated with the fourteenth-century plague pandemic.⁹³

Through the nineteenth century, marmot hunting among the Indigenous was seasonal in Manchuria, occurring once per year and based on local understandings that the marmot was a curious animal whose natural predator was the wolf.⁹⁴ Hunters sometimes used a trained hunting dog (a domesticated animal), and typically dressed in a traditional costume with a hat made of fabric cut to ambiguously resemble the ears of other mammals such as a (nonthreatening) hare or a wolf (the marmot's natural predator), prompting the curious marmot to pause long enough to allow the hunter to shoot or trap the animal. These Indigenous hunting practices reflect an understanding of marmots as part of the sustainable ecosystem in which the Indigenous people lived, and, as seen in a range of Indigenous cultures, reflect some degree of respect for and identification with their prey as part of their social metabolism.⁹⁵

According to C. Summers, "traditional [marmot] hunting methods have been interpreted...as aimed at avoiding animals infected with plague."⁹⁶ The hunters cut into the sole of a paw of a just-captured or shot marmot to see if their blood was coagulated (as can happen in *Y. pestis* infected animals, including humans), and, if so, the animals were not skinned for their fur or eaten. Instead, they were given to the dogs to eat (as neither dogs nor wolves are susceptible to plague disease). "The rather ritualized hunting may have had the effect of taking only healthy animals," and these longstanding, culturally embedded hunting practices likely originated in empirical observations.⁹⁷ Such observations represent a form of bottom-up science – of knowledge produced by a combination of mental and manual labor by Indigenous hunter-workers. It was transmitted geographically and intergenerationally across centuries as congealed Indigenous labor through oral traditions, facilitating a sustainable social metabolism.⁹⁸

By the early twentieth century, two trends converged to change the balance of the human-marmot interaction in Manchuria, representing a shift from a previously long sustained aspect of the social metabolism, to one that, in the inexorable capitalist pursuit of surplus value and accumulation, led to new corporeal rifts with nature. First, the populations of other species hunted by humans for their fur, such as sable, beaver, and mink, were being significantly depleted through capitalist hunting and agribusiness, reflecting capitalism-induced losses of biodiversity.⁹⁹ Second, there were simultaneous so-called advances in the extractivist and environmentally destructive chemical industry, especially in aniline dyes, which allowed industrial dyeing of marmot furs so that they could then profitably be sold as imitation sable, beaver, or mink fur. There was an influx of more than 12,000 Chinese and

Russian migrant laborer hunters organized by capitalist fur companies for hunting year-round, and who were equipped by employers with traps and implements to dig out marmot burrows, including specifically seeking out even sick animals. Fur dyeing industries developed and rapidly expanded in England and Leipzig, Germany. Russian companies hunting Manchurian marmots exported two million pelts annually, and, in London in 1905, there were 1.6 million marmot pelts sold, as opposed to only 80,000 beaver skins.¹⁰⁰

In the Manchurian plague epidemic, hunter-workers handling *Y. pestis* infected marmots acquired infection directly from marmot tissue, indirectly from fleas that bit marmots and then people, and directly from other people who developed pneumonic plague, especially in socially constructed contexts such as crowded housing and trains that amplify airborne person-to-person transmission. As now commodified marmot pelts and infected workers and soldiers were moved via railway lines from rural areas to cities, the plague epidemic spread to multiple cities, including Beijing, and led to approximately 60,000 deaths. These Manchurian plague epidemics have been attributed to Indigenous Manchurians hunting marmots or to a lack of hunting skills among migrant laborers, rather than to changes in the mode of interaction with marmots as part of transitions to the capitalist social metabolism, with its high-intensity alienated production and high-velocity circulation. Blaming stigmatized or other “otherized” populations for epidemics, such as pointing to Indigenous people for “curious” eating or hunting practices, are mystifications that have occurred repeatedly, as highlighted by Wallace regarding wet markets and COVID-19 and elsewhere with respect to Ebola outbreaks.¹⁰¹ Wallace has written that “Capital weaponizes...disease investigations. Blaming smallholders is now a standard agribusiness crisis management practice, but clearly diseases are a matter of systems of production over time and space and mode, not just specific actors between whom we can juggle blame.”¹⁰²

Interspecies Dimension of the Corporeal Rift and Epidemics in the Anthropocene

Numerous global-scale environmental changes have occurred since the Industrial Revolution. Many of these changes increased slowly and then much more rapidly, becoming drivers of changes in the Earth System since the mid-twentieth century in a rapid acceleration that has been referred to as the “most rapid transformation of the human relationship with the natural world in the history of humankind.”¹⁰³ This acceleration of adverse changes in the Earth System includes changes in nitrogen cycles in soil and reductions in soil fertility, along with increases in erosion and deforestation, and in global increases in the temperature of the at-

mosphere and oceans, contributing to reductions in land and sea species population sizes, extinctions, and overall biodiversity.¹⁰⁴

This rapid and profound transformation in the social metabolism cannot but impact the relationship and metabolism of human and other species, and hence increase the risk of epidemics. The rapid acceleration of changes in the social metabolism, and specifically the capitalist forms of production, circulation, and distribution that drive adverse changes in the climate and abiotic environment impact the relationships among human and nonhuman organisms, producing interspecies corporeal rifts that drive epidemics. Human-nonhuman organism interactions take place in environments that are themselves created or altered by human agency, and specifically by capitalist social relations and the social metabolism. These interactions manifest among human populations whose pre-existing health has been adversely affected (as manifestations of embodied corporeal rifts) by already existing capitalist social relations, exploitation, and related oppressions through combined and uneven development. This is especially true in regard to the extraction of value from the Global South.

Rifts causing the breaching of planetary boundaries, such as global warming and the melting of glaciers and permafrost in Arctic and sub-Arctic regions, can also lead to increases in zoonoses by multiple pathways and to the re-emergence of long absent organisms.

Plague and Anthrax in the Anthropocene

Plague case rates increase in warmer weather, seasonally, in cycles related to large-scale climate phenomena, and, increasingly, due to rising global temperatures. This is mediated through increases in rodent populations, rodent-associated flea populations, and in *risk environments*, such as areas of increasing population density and underdeveloped sanitation, as well as in areas where changes in land use facilitate increasing rodent and associated flea populations.¹⁰⁵ Land-use changes can create new rodent habitats, alter predator/prey balances, and lead rats to migrate to new areas with more human contact. Rising global temperatures (projected to be more intense in urban areas) and increasing population density are leading to increased rat and rat flea populations in most cities.¹⁰⁶ Plague outbreaks in wildlife are expected to increase due to rising global temperatures, flooding, and possibly biodiversity loss, with risk to humans. Similar processes may increase rates of other rodent- and rodent-flea-associated infections and epidemics (for example, leptospirosis).

B. anthracis spores are so resistant to environmental fluctuation that they can withstand being frozen in soil for centuries. Extensive regions of the Arctic and sub-Arctic are underlain by permafrost, which contains soil, rock,

water, other chemicals, and entrapped biotic matter. Permafrost is frozen to depths ranging from several feet to several thousand feet, with the latter zones having been frozen for up to several hundred thousand years. In the Anthropocene, rising air and water temperatures due to anthropogenic climate destruction are driving the melting of polar ice caps, glaciers, and permafrost, leading to numerous adverse consequences, including rising sea levels that threaten coastal and island populations.¹⁰⁷ Permafrost contains stored carbon dioxide and methane, which are released as ice melts, further driving global warming. As ice in glaciers and permafrost melts, the remains of long extinct species and ancient specimens of some existing species of animals, plants, bacteria, and viruses – including the influenza strain associated with the 1918 flu pandemic – can be released.¹⁰⁸

Animals are metaorganisms with normally present bacteria and viruses. Some frozen animals may contain potentially viable microorganisms in their microbiomes, and may have died of diseases in which microorganisms functioned pathogenically. The melting of long frozen glacial and permafrost ice has already led to the identification of specimens of ancient organisms, including frozen cave lion cubs, mammoths, plants, and microorganisms, among them multiple viral, bacterial, and fungal species.¹⁰⁹ The melting of long frozen permafrost has been referred to as a “real chemical and biological...[threat that] may well become a full disaster for humanity.”¹¹⁰

Numerous epizootics of anthrax have occurred since the seventeenth-century colonization of the Yamal region of Northwest Siberia, causing over a million reindeer deaths. In the 1940s, Russia began vaccinating reindeer livestock with a vaccine that provides herbivores with protection from anthrax, ending a centuries-long series of anthrax epizootics and sporadic (but nonepidemic) human cases. In 2007, vaccination was discontinued. In 2016, after a heat wave – itself related to anthropogenic climate destruction – people encountered a thawed, previously frozen reindeer carcass. As a result, seventy-two people developed anthrax and one child died. In the same year, an anthrax epizootic occurred, with over 2,300 reindeer deaths. Anthrax had not been reported in the region for over seventy-five years.¹¹¹

The 2016 human anthrax outbreak and reindeer anthrax epizootic was associated with a *B. anthracis* strain that had been frozen for centuries in permafrost. As permafrost melted due to anthropogenic climate destruction, spores were released from the ice, then adhered to or were ingested by unvaccinated reindeer, and people became infected from contact with an infected reindeer carcass. Phylogenetic analysis of the *B. anthracis* strains showed that they dated from and had evolved in the thirteenth

century, at the time of Mongol expansion across the breadth of Eurasia, which is also linked to the origins of the 1300s plague pandemic.¹¹²

Colonialism, the trade in commodified enslaved African people, the commodification of animal fur and hides, and the rise of capitalist commodity relations on the world market for surplus value production and accumulation have led to the global spread and current distribution of microorganisms, including potentially pathogenic microorganisms, with anthrax and plague being just two examples. While vaccination of livestock and wildlife can interrupt cycles of transmission, if vaccination is discontinued and sources of an associated potentially pathogenic organism remain, epizootics can reoccur. The same issue arises with the discontinuation of vaccination programs against other human infections, if reservoirs of that infection remain.¹¹³ Further, rising global temperatures due to the alienated social metabolism of capital actively promoting and relying on fossil fuel production and consumption can, through melting permafrost, lead to the resurgence of previously eliminated epidemics. This has the potential to unearth and release other recognized and unrecognized organisms and new epidemics.

Conclusion

All organisms, including humans, interact dialectically with abiotic and biotic nature in cycles of energy and chemicals as part of the universal metabolism of nature, a totalizing process. Humans interact with microorganisms as part of our existence as metaorganisms, and as part of the social metabolism. Distinct modes of production generate specific social metabolisms influencing interchanges throughout the biophysical world, and the conditions of sustainability or rifts. The modes of interactions with nonhuman animals and microorganisms in cycles of energy and of species coevolution are linked to their respective appropriation of nature for subsistence and reproduction, in contexts continually recreated by these processes. Transitions in human modes of production and social metabolism have been associated with new or re-emerging epidemics throughout human history. However, primary and ongoing expropriation and the development of capitalism have led to changes in the quality, intensity, extent, and speed of increasingly alienated production and interactions with the rest of nature, and an increased velocity of exchange, driven by production and circulation for exchange value and accumulation, rather than for use values or as part of a sustainable social metabolism. These accelerating changes are unique to fully developed industrial capitalism and late capitalism and are especially and specifically relevant to the Anthropocene.¹¹⁴

Marx wrote that “capital comes [into the world] dripping from head to foot, from every pore, with blood and dirt.”¹¹⁵ It also does so, we would add, by unleashing epidemics in its wake. Under capitalism, the rapid acceleration of alienated production interactions with nature and increased velocity of exchange lead to increasing interspecies corporeal rifts perturbing previously long sustained, yet evolving, ecosystems. This occurs in ways that increase human contacts with already existing pathogenic microorganisms and can also give rise to new, potentially pathogenic microorganisms, both of which can be associated with epidemics in contexts that enhance vulnerability.

Both Engels and Marx highlighted ways in which capitalism leads to corporeal rifts, including social murder, and that these corporeal rifts are unequally distributed, with differential adverse impacts on workers, the poor, and the oppressed.¹¹⁶ Through its historical processes of development, capitalism has shaped the social creation of contexts and niches in which aspects of the abiotic and biotic environment (including housing, air, sources of water or food, nonhuman animals, and other humans) come to constitute risk environments. In these contexts, humans and nonhuman species come into forms of asymmetric contact and reciprocal interactions that further interact with these socially created embodied corporeal rifts and can drive epidemics.

Combined, but uneven, class-race-gender inequalities give rise to differentially vulnerable populations. In capitalism-generated corporeal rifts and risk environments, epidemics emerge that do not result in leveling, but rather in further disproportionately adverse impacts on workers, the poor, and the oppressed.¹¹⁷ Interspecies and embodied dimensions of corporeal rifts interact as corporeal rifts on top of corporeal rifts, and constitute combined and uneven intersectional oppressions.

Capital may then respond to epidemics as either new markets or as forms of competition between capitals.¹¹⁸ Capital’s state system of social metabolic control may attempt to ameliorate the impacts of epidemics (while more often merely transiently controlling or merely displacing them) and may also actively contribute to the emergence of epidemics by its support for capitalist production and accumulation, by denial or delay, and, at times, through direct action.

A dialectical historical-materialist understanding of epidemics requires a perspective that recognizes the necessary coexistence and interdependence of all species, including bacteria and viruses, and the interdependence of the biotic and abiotic world as a totalizing process but not a flat ontology. Human agency drives the social metabolism.

The specifics of the social metabolism, while historically contingent, are and must be a focus of praxis.

Yet, similar to the ways capitalism creates its own gravediggers, capitalism can create a potential “environmental proletariat,” which, given epidemics arising from rifts in the social metabolism, can include an analogous “epidemic proletariat” which can be an important source of solidarity.¹¹⁹ As Mészáros wrote, “a historically sustainable solution” to the antagonisms of the capitalist social metabolism driving the emergence of metabolic and corporeal rifts cannot be found and sustainably overcome “without the *eradication of the state itself from the antagonistic social metabolism*” and the “radical restructuring of the social metabolism itself in a *non-antagonistic way*.”¹²⁰ Doing so will require a transition out of capitalism, and toward a sustainable social metabolism with nature and an ecological civilization.¹²¹

Notes

1. Prior notions of an “epidemiologic transition,” meaning a decline in infectious diseases, as Richard Levins noted three decades ago, should now clearly be understood to be some mix of wishful thinking and intentional mystification, as epidemics have in fact been accelerating in number, geographic range, and size of the affected populations now for decades. Richard Lewontin and Richard Levins, *Biology Under the Influence* (New York: Monthly Review Press, 2007), 199–217, 345–46; Rob Wallace et al., “Covid-19 and the Circuits of Capital,” *Monthly Review* 71, no. 1 (May 2020): 1–15; Chris Kenyon, “Emergence of Zoonoses Such as Covid-19 Reveals the Need for Health Sciences to Embrace an Explicit Eco-Social Conceptual Framework of Health and Disease,” *Epidemics* 33 (2020): 100410; James O. Lloyd-Smith et al., “Epidemic Dynamics at the Human-Animal Interface,” *Science* 326, no. 5958 (2009): 1362–67.
2. As Levins wrote: “With any major change in the way of life of a population (such as population density, patterns of residence, *means of production*), there will also be a change in our relations with pathogens, their reservoirs, and with the vectors of disease.” Richard Levins, “Is Capitalism a Disease?,” *Monthly Review* 52, no. 4 (September 2020): 11, emphasis added; E. Ray Lankester, *The Kingdom of Man* (New York: Henry Holt, 1911), 159–91; John Bellamy Foster, Brett Clark, and Hannah Holleman, “Capital and the Ecology of Disease,” *Monthly Review* 73, no. 2 (June 2022): 1–23.
3. Lewontin and Levins, *Biology Under the Influence*, 27–30.
4. Christopher Hill, *Reformation to Industrial Revolution: 1530–1780* (New York: Verso, 2018), 54.
5. Isolated populations and species are historically contingent abstractions but, as Levins says, we must ask of any model: “Where is the rest of the world?” On the limitations of overly narrow levels of abstraction, see Levins, “Strategies of Abstraction,” in Lewontin and Levins, *Biology Under the Influence*, 149–66.
6. Rob Wallace et al., “The Dawn of Structural One Health,” *Social Science and Medicine* 129 (2015): 68–77.
7. Lewontin and Levins, *Biology Under the Influence*, 297–321; John Bellamy Foster and Brett Clark, “The Dialectical Ecologist: Richard Levins and the Science and Praxis of the Human-Nature Metabolism,” *Monthly Review* 76, no. 8 (January 2025): 1–18.
8. John Bellamy Foster, *Marx’s Ecology* (New York: Monthly Review Press, 2020), 310.
9. Karl Marx, *Capital*, vol. 3 (New York: Penguin, 1990), 949; Karl Marx and Fredrick Engels, *Collected Works* (New York: International Publishers, 1975), vol. 30, 54–66, especially 63.
10. Marx, *Capital*, vol. 1, 283.
11. John Bellamy Foster and Brett Clark, *The Robbery of Nature* (New York: Monthly Review Press, 2020); István Mészáros, *Beyond Capital* (New York: Monthly Review Press, 2000), 938–40.
12. Foster and Clark, *The Robbery of Nature*, 23–32; 78–103; John Bellamy Foster, *The Dialectics of Ecology* (New York: Monthly Review Press, 2024).
13. Marx wrote that “the same blind desire for profit that in the one case exhausted the soil had in the other case seized hold of the vital force of the nation at its roots. *Periodical epidemics* speak as clearly on this point as the diminishing military standard of height in France and Germany.” Marx, *Capital*, vol. 1, 348, emphasis added.
14. On the consistency of germ theory with dialectical ecosocialist understandings of nature and its subsequent reframing as a reductionistic narrowly abstracted, fetishization of microorganisms, see Foster, Clark and Holleman, “Capital and the Ecology of Disease,” 3; Nancy Krieger, *Epidemiology and the People’s Health* (New York: Oxford University Press, 2024), 202–3, 213.
15. Bob Jessop, “Every Beginning Is Difficult, Holds in All Sciences: Marx on the Economic Cell Form of *Capital* and the Analysis of Capitalist Social Formations,”

- in *Marx's Capital After 150 Years*, Marcello Musto, ed., (New York: Routledge, 2019), 54–82. Jessop also highlights that Marx explicitly wrote that “in the analysis of economic forms neither microscopes nor chemical reagents are of assistance. The power of abstraction must replace them both.” Marx, *Capital*, vol. 1, 90.
16. Pieter Johnson, “Linking Environmental Nutrient Enrichment and Disease Emergence in Humans and Wildlife,” *Ecological Applications* 20, no. 1 (2010): 16–29; Valerie J. McKenzie and Alan R. Townsend, “Parasitic and Infectious Disease Responses to Changing Global Nutrient Cycles,” *EcoHealth*, 4, no. 4 (2007): 384–96.
17. “Executive Summary,” *Planetary Health Check 2025* (Potsdam Institute for Climate Research, 2025); Stockholm Resilience Centre, “Seven of Nine Planetary Boundaries Now Breached,” September 24, 2025; Foster, Clark, and Holleman, “Capital and the Ecology of Disease,” 12.
18. Kenneth J. Loyce and Jay T. Lennon, “Scaling Laws Predict Global Microbial Diversity,” *Proceedings of the National Academy of Sciences* 113, no. 21 (2016): 5970–75.
19. Yinon M. Bar-On et al., “The Biomass Distribution on Earth,” *Proceedings of the National Academy of Sciences* 115, no. 25 (2018): 6506–11.
20. Daniel J. Wiczynski et al., “Linking Species Traits and Demography to Explain Complex Temperature Responses across Levels of Organization,” *Proceedings of the National Academy of Sciences* 118, no. 42 (2021).
21. Ricardo Cavicchioli et al., “Scientists’ Warning to Humanity: Microorganisms and Climate Change,” *Nature Reviews Microbiology* 17, no. 9 (2019): 569–86. Thomas W. Crowther et al., “Biotic Interactions Mediate Soil Microbial Feedbacks to Climate Change,” *Proceedings of the National Academy of Sciences* 112, no. 22 (2015): 7033–38.
22. Joseph Fracchia, “Organisms and Objectifications: A Historical-Materialist Inquiry into the ‘Human and Animal,’” *Monthly Review* 68, no. 10 (2017): 1–16.
23. Ian Angus, “Superbugs in the Anthropocene,” *Monthly Review* 71, no. 2 (2019): 1–28; Ron Sender et al., “Revised Estimates for the Number of Human and Bacteria Cells in the Body,” *PLOS Biology* 14, no. 8 (2016).
24. Michael Friedman, “Metabolic Rift and the Human Biome,” *Monthly Review* 70, no. 3 (2018): 70–104; Angus, “Superbugs in the Anthropocene”; Cornelia Jaspers et al., “Resolving Structure and Function of Metaorganisms through a Holistic Framework Combining Reductionist and Integrative Approaches,” *Zoology* 133 (2019): 81–87.
25. As examples, see Emmanuel Le Roy Ladurie, “Reply to Robert Brenner,” R. H. Hilton, “A Crisis of Feudalism,” and Robert Brenner, “The Agrarian Roots of European Capitalism,” 103, 131, 267–69, respectively, in *The Brenner Debate*, T. H. Aston and C. H. E. Philpin, eds. (Cambridge: Cambridge University Press, 1987); Alexander Anievas and Kerem Nisancioglu, *How the West Came to Rule* (London: Pluto Press, 2015). Marx notes that the construction of railroads involved “nomadic labor” noting that it was a “flying column of pestilence, it carries smallpox, typhus, cholera and scarlet fever into the places in whose neighborhoods it pitches camp” (Marx, *Capital*, vol. 1, 818). E. Ray Lankester linked epidemics with human interactions with nature, and specifically with “reckless” and “disharmonious” interactions that disrupt the “harmonious interaction of the units of the living world.” Lankester, *The Kingdom of Man*, 159–91. See also Rob Wallace, *Dead Epidemiologists* (New York: Monthly Review Press, 2020), 42–57; Wallace et al., “The Dawn of Structural One Health,” 68–77.
26. Johan Giesecke, *Modern Infectious Disease Epidemiology* (Baton Raton, Florida: CRC Press, 2017); A. J. McMichael, “Environmental and Social Influences on Emerging Infectious Diseases,” *Philosophical Transactions of the Royal Society of Britain: Biological Sciences* 359, no. 1447 (2004): 1049–58; Nathan D. Wolfe et al., “Origins of Major Human Infectious Diseases,” *Nature* 447, no. 7142 (2007): 279–83.
27. William B. Karesh et al., “Ecology of Zoonoses,” *Lancet* 380, no. 9857 (2012): 1936–45.
28. Delia Grace et al., *Mapping of Poverty and Likely Zoonoses Hotspots* (UK: Department of International Development, 2012).
29. The framing of epidemics as due to “spillover” of microorganisms from nonhuman animals to humans is misleading; it implies passive diffusion (unlinked to human agency) and a pre-existing “pathogen” that simply sits in the environment until an unfortunate and random event occurs. See, for example, David Quammen, *Spillover* (London: Vintage, 2020). Similarly, notions that potentially pathogenic viruses or bacteria “jump” from one species to another ascribe agency to the microorganism and falsely portray humans as passive “victims” of actions of other species. See Mark E. J. Woolhouse et al., “Emerging Pathogens,” *Trends in Ecology and Evolution* 20, no. 5 (2005): 238–44; Rob Wallace, *Big Farms, Big Flu* (New York: Monthly Review Press, 2016), 456.
30. Walter Scheidel, *The Great Leveler* (Princeton: Princeton University Press, 2018). Scheidel argues that epidemics have historically led to economic leveling of income, wages, and wealth, but with such a “violent cost” to human life that the goal of inequality should be abandoned. He wrote “that substantial reductions in resource inequality depended on violent disaster,” that “although generic infections such as influenza today may more severely affect the poor, we cannot simply conjecture a class-specific mortality crisis that would drive up the value of low-skilled labor even as the economy as a whole remained largely intact.” He concludes by saying that “All of us who prize greater economic equality would do well to remember that with the rarest exceptions, it was only ever brought forth in sorrow. Be careful what you wish for.” Scheidel, *The Great Leveler*, 291–342, 442. See also Lisa Bowleg, “We’re Not All in This Together,” *American Journal of Public Health* 110, no. 7 (2020): 917.
31. This argument is linked to Marx’s point in *Capital* when critiquing the Robinson Crusoe stories and frames used by David Ricardo and most orthodox capitalist political economists as wrongly positing isolated individuals abstracted from others and from all preceding history. There can be no real understanding of epidemics without consideration of interrelations among humans and other species, contexts, history, and evolution. Marx, *Capital*, vol. 1, 170–71.
32. Lewontin and Levins, *Biology Under the Influence*, 110–111. See Bruce G. Link and Jo Phelan, “Social Conditions as Fundamental Causes of Disease,” *Journal of Health and Social Behavior*, extra issue (1995): 80–94; David C. Perlman and Ashly E. Jordan, “The Syndemic of Opioid Misuse, Overdose, HCV, and HIV,” *Current HIV/AIDS Reports* 15, no. 2 (2018): 96–112; Jo C. Phelan, Bruce G. Link, and Parisa Tehranifar, “Social

Conditions as Fundamental Causes of Health Inequalities," *Journal of Health and Social Behavior* 51 Supplement (2010): S28-40.

33. Wade Hampton Frost, "Some Conceptions of Epidemics in General," *American Journal of Epidemiology* 103, no. 3 (1976): 141-51; Karen-Beth G. Scholthof, "The Disease Triangle: Pathogens, the Environment and Society," *Nature Reviews Microbiology* 5 (2007): 152-56; Peter Braveman et al., "The Social Determinants of Health," *Annual Review of Public Health* 38, no. 32 (2011): 381-98.

34. C. Mary Schooling and Heidi E. Jones, "Clarifying Questions about 'Risk Factors,'" *Emerging Themes in Epidemiology* 15, no. 10 (2018); Frederick K. Ho et al., "Modifiable and Non-modifiable Risk Factors for COVID-19, and Comparison to Risk Factors for Influenza and Pneumonia," *BMJ Open* 10, no. 11 (2020): e040402. Some public health theories endeavor to address some of these factors; their relative merits and gaps are beyond the scope of this paper. See: Krieger, *Epidemiology and the People's Health*; Nancy Krieger, *Ecosocial Theory, Embodied Truths and the People's Health* (New York: Oxford University Press 2021); Merrill Singer, *Introduction to Syndemics* (San Francisco: Wiley, 2009); Paul Farmer, *Infections and Inequalities* (Berkeley: University of California Press, 2001); Nason Maani, Mark Petticrew, Sandro Galea, eds., *The Commercial Determinants of Health* (New York: Oxford University Press, 2023); Vicente Navarro, *Crisis, Health, and Medicine* (New York: Tavistock, 1996); Samuel R. Friedman, Diana Rossi, "Dialectical Theory and the Study of HIV/AIDS and Other Epidemics," *Dialectical Anthropology* 35, no. 4 (2011): 403-27; Michael Harvey, "The Political Economy of Health," *American Journal of Public Health* 111 (2021): 293-300; Samuel R. Friedman et al., "Dialectical Processes of Health Framework as an Alternative to Social Determinants of Health Framework," *American Journal of Public Health* 115, no. 11 (2025): 1868-76; Howard Waitzkin, *Health Care Under the Knife* (New York: Monthly Review Press 2018); Wallace et al., "The Dawn of Structural One Health," 68-77; Lankester, *The Kingdom of Man*, 159-91.

35. Richard Lewontin and Richard Levins, *The Dialectical Biologist* (Cambridge: Harvard University Press, 1985), 149.

36. In his analysis of capital, Marx alternates between abstractions at several levels of generality, perspective, and extent including 1) what makes individual humans unique, 2) what is general to people within modern capitalism, 3) capitalism as such, including production as a whole, 4) a wider historical scope of class society, 5) all human societies historically, 6) humans as part of the whole animal world, 7) all of nature. Levins "Strategies of Abstraction" in Lewontin and Levins, *Biology Under the Influence*, 149-166; Katherine Richardson et al., "Earth Beyond Six of Nine Planetary Boundaries," *Science Advances* 9, no. 37 (2023).

37. Christian Stache, "Marx and the Critique of Alienated Speciesism," *Monthly Review* 71, no. 1 (May 2019): 47.

38. Scott F. Gilbert et al., "A Symbiotic View of Life," *Quarterly Review of Biology* 87, no. 4 (2012): 325-41, 327.

39. Before the understanding of the cooperative role of algae and coral polyps in coral reef production, Marx cited coral as an example of cooperative production by a single species. In this example, each coral polyp serves as a "stomach" supplying nutrients to the whole group; this contrasts with Menenius Agrippa's analogy of the body as the class-based state in which the stomach represents elites who extract sustenance from the labor-producing limbs, which represented plebians. Marx, *Capital*, vol. 1, 481-82.

40. Laetitia G. E. Wilkins et al., "Host-Associated Microbiomes Drive Structure and Function of Marine Ecosystems," *PLOS Biology* 17, no. 11 (2019): e3000533. Jaspers et al., "Resolving Structure and Function of Metaorganisms through a Holistic Framework Combining Reductionist and Integrative Approaches," 81-87.

41. Guillem Corbera et al., "Glacio-Eustatic Variations and Sapropel Events as Main Controls on the Middle Pleistocene-Holocene Evolution of the Cabliers Coral Mound Province (W Mediterranean)," *Quaternary Science Reviews* 253 (2021): 106783. There are also long-established cycles in which lichen (combined colonies of fungal species and algae and/or cyanobacteria, in essence, metaorganisms) which live on and degrade solid rock, creating soil on which many species, including humans, depend. Additionally, it remains debated (and perhaps a choice) whether to

consider viruses, a key class of "things" associated with disease and epidemics of other species, as living (they cannot reproduce without other organisms) or as something not well characterized by a level of abstraction that dichotomizes biotic and abiotic, but which, along with coral and lichen, demonstrate and reflect the dialectics of nature. Purificación López-García, "The Place of Viruses in Biology in Light of the Metabolism-versus-replication-first Debate," *History and Philosophy of the Life Sciences* 34, no. 3 (2012): 391-406; Didier Raoult and Patrick Forster, "Redefining Viruses," *Nature Reviews Microbiology* 6, no. 4 (2008): 315-19.

42. For further discussion of the issue, see John Bellamy Foster, "The Return of the Dialectics of Nature," *Monthly Review* 74, no. 7 (December 2022): 1-20. For examples in Marx's writings, see Marx and Engels, *Collected Works*, vol. 6, 163; vol. 42, 385.

43. Foster, "The Return of the Dialectics of Nature," 3, 6.

44. Lewontin and Levins importantly note that "But to be useful as an analytic tool, the idea of community [or a species] does not require that a group or species be totally isolated from other species." Lewontin and Levins, *The Dialectical Biologist*, 151.

45. On the concept of perturbations to ecosystems, see M. Graziano Ceddia and Jacopo Nicola Bergamo, "The Necessity of System Change," *Monthly Review* 71, no. 11 (April 2024): 33-47; John Bellamy Foster and Brett Clark, "The Dialectical Ecologist" *Monthly Review* 76, no. 8 (January 2025): 4-5.

46. Foster, *The Dialectics of Ecology*, 42-64; John Bellamy Foster, *The Return of Nature* (New York: Monthly Review Press, 2020), 216-69; Lewontin and Levins, *Biology Under the Influence*, 124; Marx and Engels, *Collected Works*, vol. 25, 110-32, 313-587.

47. Foster, *Marx's Ecology*, 141-77; Foster, *The Return of Nature*; Foster, *The Dialectics of Ecology*, 82-103; John Bellamy Foster, "Extractivism in the Anthropocene," *Monthly Review* 75, no. 11 (April 2024): 82-103.

48. Marx, *Capital*, vol. 1, 198-228, 247-57; Ceddia and Bergamo, "The Necessity of System Change."

49. Marx and Engels, *Collected Works*, vol. 25, 572-73, 606-8, 120-32; Foster, *The Dialectics of Ecology*, 87-88,

- 297, 572-73; Foster, *The Return of Nature*, 297.
50. This is analogous to the fetishism of commodities, which obscures the relations between people.
51. This is analogous, and linked, to Stephen Jay Gould's argument that in contrast to the broader Aristotelian concept of "causality," in the Cartesian or Newtonian worldview, a narrow definition of "causes" leads to the erroneous inference that genes, rather than organisms, interact with the rest of nature in the process of natural selection. Stephen Jay Gould, *The Structure of Evolutionary Theory* (Cambridge, Massachusetts: Harvard University Press, 2002), 626-27, 1187-89.
52. Foster and Clark, "The Dialectical Ecologist," 4-10.
53. John Bellamy Foster, Brett Clark and Hannah Holleman, "Capitalism and Robbery," *Monthly Review* 71 no. 7 (December 2019): 1-23.
54. Roy Bhaskar, *Reclaiming Reality* (London: Routledge, 2011), 131; Foster, "The Return of the Dialectics of Nature," 3.
55. Karl Marx, *Grundrisse* (New York: Penguin, 1993), 100-11; Marx and Engels, *Collected Works*, vol. 25, 110-34, 313-17, 452-64, 492-521, 572-87; vol. 35, 12-32.
56. Lankester, *The Kingdom of Man*, 159-91.
57. Foster, "Extractivism in the Anthropocene," 1.
58. On speciation by natural and anthropogenic evolution, see Gould, *The Structure of Evolutionary Theory*, 765-84. See also Miguel Baltazar-Soares et al., "Human-Induced Evolution," *Evolutionary Applications* 14, no. 10 (2021): 2335-41; Marx and Engels, *Collected Works*, vol. 25, 116-19, 494.
59. Engels discussed the relevance of negation of the negation in nature, including with respect to the "organic [living] world," citing the development of a grain of barley, its development into a fruit bearing plant, and by implication the repetition of this process, and the evolution through random mutation and natural selection which makes this process simultaneously a negation and a sublation. Marx and Engels, *Collected Works*, vol. 25, 120-32, 572, 604-8.
60. Marx, *Capital*, vol. 1, 637-39, 876-95; vol. 3, 949-50; Foster and Clark, *The Robbery of Nature*; Ian Angus, *The War Against the Commons* (New York: Monthly Review Press, 2023).
61. Marx and Engels, *Collected Works* vol. 1, 224-63.
62. Angus, *The War Against the Commons*; Roxanne Dunbar-Ortiz, *An Indigenous Peoples' History of the United States* (Boston: Beacon Press, 2014); Ksenija Hanaček et al., "On Thin Ice—The Arctic Commodity Extraction Frontier and Environmental Conflicts," *Ecological Economics* 191 (2022): 107247; Massimo De Angelis, "Marx and Primitive Accumulation," *The Commoner* 2 (2001): 1-22.
63. Marx, *Capital*, vol. 1, 283-84, 637-38, 891-95, 931-40.
64. Fracchia, "Human and Animal," *Monthly Review* 68, no. 10 (March 2017): 3.
65. Helena Sheehan, "Totality: Decades of Debate and the Return of Nature," *Monthly Review* 75, no. 4 (September 2023): 21-24.
66. Foster, *The Dialectics of Ecology*, 79-80. See pages 74-81 for Foster's fuller critique of post-humanist ecology and flat ontologies.
67. Frederick Engels, *The Condition of the Working Class in England* (New York: Oxford University Press, 2009), 100-43, 159-86; Marx, *Capital*, vol. 1, 340-416, 481, 517-26, 610-39, 866; Rudolph Virchow, "Report on the Typhus Epidemic in Upper Silesia," *American Journal of Public Health* 96, no. 12 (2006): 2102-5; Howard Waitzkin, "The Social Origins of Illness," *Int J Health Services* 11, no. 1 (1981): 77-103.
68. Marx, *Capital*, vol. 1, 348-49; vol. 3, 949; Foster and Clark, *The Robbery of Nature*, 23-32, 78-103; Foster, Clark, and Holleman, "Capitalism and Robbery," 7-8; Mauricio Betancourt, "The Corporeal Rift: From 19th-Century Guano Diggers to the Present," *Environmental Sociology* 11, no. 3 (2024): 296-305; Lola Loustaunau, Mauricio Betancourt, Brett Clark, and John Bellamy Foster, "Chinese Contract Labor, the Corporeal Rift, and Ecological Imperialism in Peru's Nineteenth-Century Guano Boom," *Journal of Peasant Studies* 49, no. 3 (2022); Brett Clark, Daniel Auerbach, and Karen Xuan Zhang, "The Du Bois Nexus," *Environmental Sociology* 4, no. 1, 54-66.
69. Friedman, "Metabolic Rift and the Human Biome."
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72. Karl Marx, *Theories of Surplus Value*, vol. 3 (Moscow: Progress Publishers, 1971), 315, emphasis added; Karl Marx, *Early Writings* (New York: Penguin, 1992), 332-34; de Angelis, "Marx and Primitive Accumulation," 1-22; Foster, Clark, and Holleman, "Capitalism and Robbery," 1-2.
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- Hearths, and Herds* (Cambridge: MIT Press, 1969), 84–100; William C. Summers, *The Great Manchurian Plague of 1910–1911* (New Haven: Yale University Press, 2012), 116–24.
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77. Purugganan, "What is Domestication?"; 9.
78. Karl Marx, *The Eighteenth Brumaire of Louis Bonaparte* (New York: International Publishers, 1994), 15.
79. Bhaskar, *Reclaiming Reality*.
80. David M. Morena, "Epidemic Anthrax in the Eighteenth Century, the Americas," *Emerging Infectious Diseases* 8, no. 10 (2002): 1160–62; Ian Kracalik et al., "Changing Livestock Vaccination Policy Alters the Epidemiology of Human Anthrax, Georgia, 2000–2013," *Vaccine* 35 (2017): 6283–89.
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90. Marx and Engels *Complete Works*, vol. 34, 187, 221–24, 246; vol. 32, 387–88; Marx, *Capital*, vol. 1, 578, 727, 734, 794; Foster, Clark, and Holleman, "Capitalism and Robbery"; Lucia Pradella, *Globalisation and the Critique of Political Economy* (New York: Routledge, 2015).
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97. Summers, *The Great Manchurian Plague of 1910–1911*, 123.
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112. Timofeev et al., "Insights from Bacillus Anthracis Strains Isolated from Permafrost in the Tundra Zone of Russia"; Green, "The Four Black Deaths."
113. Kracalik et al., "Changing Livestock Vaccination Policy Alters the Epidemiology of Human Anthrax."
114. Here it is important to note that analyses and debates about the historical development of capital relations, and the historical emergence of capitalism as a mode of production, may not exactly map onto the understandings and analyses of changes in the social metabolism that may affect the sustainability of ecosystems and the emergence of epidemics. We suggest that considering these together may contribute to enhanced understandings of the historical development of capital relations and of capitalism as a system of "social metabolic control." Marx, *Capital*, vol. 1, 914-916; John Bellamy Foster, forward to István Mészáros, *The Necessity of Social Control* (New York: Monthly Review Press, 2015); Mészáros, *Beyond Capital*, 40-58.
115. Marx, *Capital*, vol. 1, 926.
116. Marx, *Capital*, vol. 1, 348; Engels, *The Condition of the Working Class in England*, 106-43.
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121. John Bellamy Foster, "Some Preliminary Theses on the Concept of Eco-civilization," *Monthly Review* 76, no. 8 (January 2025): 40-43; Ian Angus, "An Ecological Civilization Will Have to be Socialist," *Monthly Review* 76, no. 8 (January 2025): 31-39.

MONTHLY REVIEW *Fifty Years Ago*

In the mythology of bourgeois social science, capital and technology are the magic that presumably will bring the entire world into the Garden of Eden. Libraries, UN Agencies, various economic institutes around the world are bulging with reports and studies telling us how a country can get out of the stage of underdevelopment, how it can lift itself out of the quagmire of poverty and misery. All sorts of ideas and proposals are contained in these publications, but there is one common thread. If you just put in enough capital, if you just introduce enough modern technology, the underdeveloped societies will be vitalized and will start growing on their own...

The trouble with these simple truths is that when they are abstracted from the concrete, historical circumstances in which they have to be applied, they end up as fetishes – fetishes that tend to obscure the real issues. What these fetishes disguise is the fact that production is a social activity. This means that to get at the heart of the problem of production, we must first and foremost focus on people and the social relations into which they enter. Unless we put people, people as producers and people as consumers, at the center of our analysis, we lose sight what it is all about.

– HARRY MAGDOFF, "Capital, Technology, and Development,"
Monthly Review, January 1976.