

Engels's *Dialectics of Nature* in the Anthropocene

JOHN BELLAMY FOSTER

In “The Part Played by Labour in the Transition from Ape to Man” from his *Dialectics of Nature*, Frederick Engels declared: “Everything affects and is affected by every other thing.”¹ Today, two hundred years after his birth, Engels can be seen as one of the foundational ecological thinkers of modern times. If Karl Marx’s theory of the metabolic rift is at the heart of historical-materialist ecology today, it nonetheless remains true that Engels’s contributions to our understanding of the overall ecological problem remain indispensable, rooted in his own deep inquiries into nature’s universal metabolism, which reinforced and extended Marx’s analysis. As Paul Blackledge has stated in a recent study of Engels’s thought, “Engels’s conception of a dialectics of nature opens a place through which ecological crises” can be understood as rooted in “the alienated nature of capitalist social relations.”² It is because of the very comprehensiveness of his approach to the dialectic of nature and society that Engels’s work can help clarify the momentous challenges facing humanity in the Anthropocene epoch and the current age of planetary ecological crisis.

Racing to Ruin

Some intimation of the contemporary significance of Engels’s ecological critique can be gained by commencing with Walter Benjamin’s celebrated 1940 aside, often quoted by ecosocialists, from the “Paralipomena” (or side notes) to his “On the Concept of History.” There, Benjamin stated: “Marx says that revolutions are the locomotive of world history. But perhaps it is quite otherwise. Perhaps revolutions are an attempt by passengers on this train – namely, the human race – to activate the emergency brake.” In Michael Löwy’s well-known interpretation of Benjamin’s statement: “The image suggests implicitly that if humanity were to allow the train to follow its course – already mapped out by the steel structure of the rails – and if nothing halted its headlong dash, we would be heading straight for disaster, for a crash or a plunge into the abyss.”³

Benjamin’s dramatic image of a runaway locomotive and, hence, the necessity of conceiving of revolution as a pulling of the emergency brake,

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recalled a similar passage in Engels's *Anti-Dühring*, written in the late 1870s, a work with which Benjamin, like all socialists in his day, was familiar. Here, Engels had indicated that the capitalist class was "a class under whose leadership society is racing to ruin like a locomotive whose jammed safety-valve the driver is too weak to open." It was precisely capital's inability to control "the productive forces, which have grown beyond its power," including the destructive effects imposed on its natural and social "environs," that was "driving the whole of bourgeois society towards ruin, or revolution." Hence, "if the whole of modern society is not to perish," Engels argued, "a revolution in the mode of production and distribution must take place."⁴

Engels's earlier metaphor differed slightly from Benjamin's later one, in that the object was to open the safety valve in order to prevent a boiler explosion and crash – a fairly common cause of train wrecks in the mid-to-late nineteenth century.⁵ If the system can be seen as "racing to ruin," revolution here is less about simply stopping the forward momentum than exerting control over the out-of-control forces of production. Indeed, Engels's ecological and economic argument was not predicated, as would be the case today, on the notion that there was too much production in relation to the overall carrying capacity of the earth, a perspective that was scarcely present at the time he was writing. Instead, his chief ecological concern had to do with the wanton destruction wrought by capitalism on local and regional environments – even if on an increasingly global basis. The visible effects of this were evident in industrial pollution, deforestation, the degradation of the soil, and the general deterioration of the environmental conditions (including periodic epidemics) of the working class. Engels also pointed to the devastation of whole environments (and their climates), as in the ecological destruction that played such a big role in the fall of ancient civilizations, due mainly to desertification, and the environmental damage imposed by colonialism on traditional cultures and modes of production.⁶ Like Marx, Engels was deeply concerned with British colonialism's "Victorian Holocausts," including the generation of famine in India through the destruction of its ecology and hydrological infrastructure, and the ruinous expropriation and extermination inflicted on Ireland's ecology and people.⁷

It is true that we can also find in these same pages, in which the question "ruin or revolution" is raised, the most productivist (and, in this sense, seemingly Promethean) passage to be found anywhere in Marx and Engels's works.⁸ Thus, Engels declared in *Anti-Dühring* that the advent of socialism would make possible the "constantly accelerated development of the productive forces, and...a practically unlimited increase of pro-

duction itself.”⁹ However, in the context in which Engels was writing, this presents no particular contradiction. The view that a future society, released from the irrationality of capitalist production would allow for what, by nineteenth-century standards, would have seemed like an almost unlimited development of production was of course practically universal among radical thinkers at the time. This was a natural reflection of the still low level of material development in most of the world at the time of the Industrial Revolution, when set against the still immeasurably vast scale of the earth itself. World manufacturing production was to increase by “about 1,730 times” in the hundred and fifty years between 1820, when Engels was born, at the time of the early nineteenth-century Industrial Revolution, and 1970, when the modern ecological movement was born, at the time of the first Earth Day.¹⁰ Moreover, in Engels’s analysis (as in Marx’s), production was never viewed as an end in itself, but rather as a mere means to the creation of a freer and more equal society, dedicated to a process of sustainable human development.¹¹

Two centuries after his birth, the depth of Engels’s understanding of the systematic nature of capitalism’s destruction of the natural and social environment, together with his development of a dialectical naturalist perspective, makes it, along with Marx’s work, a starting point for a revolutionary ecosocialist critique today. As Marxist anthropologist Eleanor Leacock noted, Engels, in the *Dialectics of Nature*, sought to develop the conceptual basis for understanding “the complete interdependence of human social relations and human relations to nature.”¹²

The Revenge of Nature

Ecological problems are the product of the interrelation of system and scale. In Engels’s analysis, it is system that is emphasized above all. In his great work, *The Condition of the Working Class in England*, written while he was still in his early twenties, he focused on the destructive environmental and epidemiological conditions of the Industrial Revolution in the large manufacturing towns, particularly Manchester. He highlighted the horrendous ecological conditions imposed on workers by the new industrial factory system, evident in pollution, toxic contamination, physical deterioration, periodic epidemics, poor nutrition, and high working-class mortality, all associated with extreme economic exploitation. *The Condition of the Working Class in England* remains unique in its powerful indictment of the “social murder” inflicted by capitalism on the underlying population at the time of the Industrial Revolution.¹³ Marx, for whom Engels’s book was the starting point for his own epidemiological studies in *Capital*, was on this basis to designate “periodical epidemics,” along

with the destruction of the soil, as evidence of capitalism's metabolic rift. In Germany, Engels's treatment of the etiology of disease in *The Condition of the Working Class in England* exercised an influence that extended well beyond socialist circles. Rudolf Virchow, the German doctor and pathologist, famous as the author of *Cellular Pathology*, referred favorably to Engels's book in his own pioneering work in social epidemiology.¹⁴

This understanding of the material conditions of capitalist class society as environmental, as well as economic, was evident in all of Engels's work. Moreover, in constantly seeking to merge materialist and dialectical perspectives of nature and society, Engels eventually arrived at the thesis that "nature," of which human beings were an emergent part, was the "proof of dialectics" – a statement that today is better understood if we say that *ecology is the proof of dialectics*.¹⁵

In Engels's developed evolutionary-ecological perspective, evident in his mature works such as *The Dialectics of Nature* and *Anti-Dühring*, what distinguished human beings from nonhuman animals was the role of labor in transforming and mastering the environment, making it possible for "man" to become the "real, conscious, lord of nature, because he now [in a future society] becomes master of his own social organisation."¹⁶ Nevertheless, along with this tendency toward greater mastery of nature in some respects, already exhibited under capitalism, was concealed a systematic tendency toward expanding ecological crises, since all attempts at the conquest of nature in defiance of natural laws of limits could only lead, in the end, to ecological catastrophes. This could be seen first and foremost in the mid-nineteenth century in the ecological devastation unleashed by colonialism. As he exclaimed:

What cared the Spanish planters in Cuba, who burned down forests on the slopes of mountains and obtained from the ashes sufficient fertilizer for *one* generation of very profitable coffee trees – what cared they that the heavy tropical rain afterwards washed away the unprotected upper stratum of the soil, leaving behind only bare rock! In relation to nature, as to society, the present mode of production is predominantly concerned only with the immediate, the most tangible result; and then surprise is expressed that the often remote effects of actions to this end turn out to be quite different, are mostly quite the opposite in character.¹⁷

For Engels, the starting point for a rational approach to the environment was to be found in Francis Bacon's famous maxim that "nature is only overcome by obeying her" – that is, by discovering and conforming to her laws.¹⁸ Yet, in Marx and Engels's view, the Baconian principle, to the extent that it was applied in bourgeois society, was primarily treated as a "ruse" for conquering nature so as to bring it under capi-

tal's laws of accumulation and competition.¹⁹ Science was made into a mere appendage of profit making, viewing nature's boundaries as mere barriers to be surmounted. Instead, the rational application of science in society as a whole was only possible in a system in which the associated producers regulated the human metabolic relation to nature on an unalienated basis, in accordance with genuine human needs and potentials and the requirements of long-term reproduction. This pointed to the contradiction between, on the one hand, science's own dialectic, which more and more recognized our "oneness with nature" and the associated need for social control, and, on the other hand, capitalism's myopic drive to accumulation *ad infinitum*, with its innate uncontrollability and neglect of environmental consequences.²⁰

It was this deep, critical-materialist perspective that led Engels to stress the senselessness of the prevailing notion of the *conquest of nature* – as if nature were a foreign territory to be subjected at will, and as if humanity did not exist in the midst of the earth's metabolism. Such an attempt to conquer the earth could only lead to what he referred to, metaphorically, as the "revenge" of nature, as various critical thresholds (or tipping points) were crossed:

Let us not, however, flatter ourselves overmuch on account of our human victories over nature. For each such victory nature takes its revenge on us. Each victory, it is true, in the first place brings about the results we expected, but in the second and third places it has quite different, unforeseen effects which only too often cancel out the first. The people who, in Mesopotamia, Greece, Asia Minor, and elsewhere, destroyed the forests to obtain cultivable land, never dreamed that by removing along with the forests the collecting centres and reservoirs of moisture they were laying the basis for the present forlorn state of those countries. When the Italians of the Alps used up the pine forests on the southern slopes, so carefully cherished on the northern slopes, they had no inkling that by doing so they were cutting at the roots of the dairy industry in their region; they had still less inkling that they were thereby depriving their mountain springs of water for the greater part of the year, and making it possible for them to pour still more furious torrents on the plains during the rainy seasons.... Thus at every step we are reminded that we by no means rule over nature like a conqueror over a foreign people, like someone standing outside nature – but that we, with flesh, blood and brain, belong to nature, and exist in its midst, and that all our mastery of it consists in the fact that we have the advantage over all other creatures of being able to learn its laws and apply them correctly.²¹

Through conscious action in accord with rational science, human beings were capable of rising to a considerable extent above "the influence of unforeseen effects and uncontrolled forces," perceiving "the more re-

mote consequences of our interference with the traditional course of nature.” Yet, even with respect to “the most developed peoples of the present day,” there could be seen to be “a colossal disproportion between the proposed aims and the results arrived at,” such “that unforeseen effects predominate and...the uncontrolled forces are more powerful than those set in motion according to plan.” Class-based commodity economies achieved “the desired end only by way of exception,” more often producing “the exact opposite.” Hence, a rational, scientific, and sustainable approach to the human relation to nature and society under capitalism was impossible.²²

It is significant that this same general standpoint on capitalism and ecology articulated by Engels was to be echoed a few decades later by Ray Lankester, who was Charles Darwin and Thomas Huxley’s protégé, Marx’s close friend (and Engel’s acquaintance), and the leading British biologist in the generation after Darwin. Lankester was a Fabian-style socialist who had read and been influenced by Marx’s *Capital*. In his 1911 book, *The Kingdom of Man* – which brought together his 1905 Romanes lecture at Oxford, “Nature’s Insurgent Son,” his 1906 presidential address to the British Association for the Advancement of Science, and his article “Nature’s Revenges” focusing on the African sleeping sickness – Lankester insisted that the growing human dominion over the earth was giving rise, in contradictory fashion, to an increased potential for planetary-scale ecological disasters. Thus, in his chapter on “Nature’s Revenges,” he referred to humanity as the “disturber of Nature” and thus as the creator of periodic epidemic diseases threatening humanity along with other species. “It seems to be a legitimate view,” Lankester wrote, “that every disease to which animals [including the human animal] (and probably plants also), are liable, excepting as a transient and very exceptional occurrence, is due to Man’s interference.”²³ Moreover, this could be traced to a system dominated by “markets” and “cosmopolitan dealers in finance” who undermined any rational and scientific approach to reconcile nature and human production.²⁴ Lankester was later to develop this argument further, writing systematically on “The Effacement of Nature by Man.”²⁵

Like the later Marx and Engels, Lankester saw the “Kingdom of Man” as ushering in a permanent ecological knife-edge state for humanity, engendered by capitalism, that would, if natural conditions were trampled over by rapacious capital accumulation, lead to catastrophic human environmental decline. If it were not to destroy the very bases of its existence, humanity therefore had no choice but to control its production, superseding the narrow dictates of capital accumulation and adopting the dictates of a rational science in line with coevolutionary development.

The Dialectics of Nature and History

Engels's ecological insights are inseparable from his inquiries into the dialectics of nature from which they arose. Yet, the very first principle of what came to be known as the philosophical tradition of Western Marxism was that the dialectic could not be said to apply to external nature, that is, there was no such thing as what Engels referred to as "so-called *objective* dialectics" beyond the active realm of the human subject.²⁶ Dialectical relations, and even the objects of dialectical reasoning, were thus confined to the human-historical sphere, where the identical subject-object could be said to apply, since all nonreflexive (transfactual) reality outside of human consciousness and human action was excluded from the analysis.²⁷ But with the complete rejection of the dialectics of nature within the Western Marxist tradition, the extraordinary power of Engels's explorations in this area and the enormous influence they exerted on evolutionary and ecological thought within the natural sciences and on Marxism were lost, except to a relatively small number of left scientists and dialectical materialists. Unable to see dialectics as related to material nature, the Western Marxist philosophical tradition tended to relegate both natural science and external nature itself to the realm of mechanism and positivism. The result was to create a deep chasm between the dominant post-Second World War conception of Marxian philosophy in the West and natural science (and between Western Marxism and the materialist conception of nature) at the very moment, ironically, that the ecological movement was emerging as a major political force.²⁸

Restoring the insights of classical historical materialism in this area thus requires the recovery, at some level, of Engels's conception of the dialectics of nature.²⁹ This requires, in turn, rejecting superficial and often poorly conceived summary dismissals of Engels's approach to the dialectics of nature, usually polemicizing against his three broad dialectical "laws" that he derived from G. W. F. Hegel and to which he gave new *materialist* significance: (1) the transformation of quantity into quality and vice versa, (2) the identity or unity of opposites, and (3) the negation of the negation.³⁰ In writing on "Engels's Philosophy of Science," Peter T. Manicas, for example, has complained of the "very nearly vacuous" nature of these laws.³¹ Yet, in Engels's analysis, these were not meant as narrow, fixed laws in the positivistic sense, but, rather, in today's terminology, as broad, dialectically conceived "ontological principles," equivalent to such basic propositions as the principle of the uniformity of nature, the principle of the perpetuity of substance, and the principle of causality. In fact, Engels's approach to dialectics challenged in various ways the understanding of these very same principles as they were advanced by the science of his day.³²

Perhaps the most succinct and penetrating assessment of Engels's contributions to the dialectics of nature provided by a natural scientist can be found in a 1936 pamphlet entitled *Engels as a Scientist* by the celebrated Marxist scientist J. D. Bernal, professor of physics and x-ray crystallography at Birkbeck College, University of London. Bernal depicted Engels as a philosopher and historian of science, one who could not "be said to have been an amateur" given the range of the scientific contacts he had developed in Manchester, and who had reached a level of analysis that far exceeded that of the professional philosophers of science of his day, such as Herbert Spencer and William Whewell in England and Friedrich Lange in Germany.³³ Behind Engels's deep understanding of the historical development of science in his time, according to Bernal, was a dialectical perception in which the "concept of nature was always as a whole and as a process."³⁴ In this, Engels had borrowed critically from Hegel, recognizing that behind the latter's idealist presentation of dialectical change in his *Logic* were processes that could be said to inhere objectively in nature, as captured in human cognition.

In addressing the first of the three dialectical "laws" or ontological principles that Engels had drawn from Hegel—how changes in quantity can lead to qualitative transformations and its opposite—Bernal emphasized its essential character for natural scientific thought. "With remarkable insight, Engels says:—'The so-called constants of physics are for the most part nothing but designations of nodal points where quantitative addition or withdrawal of motion calls forth a qualitative change in the state of the body in question'.... We are only now beginning to appreciate the essential justice of these remarks and the significance of such nodal points." In this regard, Bernal stressed Engels's reference to Dmitri Mendeleev's periodic table as exemplary of qualitative transformations arising from continuous quantitative changes, as well as the relation of Engels's basic notions to discoveries associated with the rise of quantum theory.³⁵ Engels's approach, as the British Marxist mathematician Hyman Levy indicated, pointed to the concept of "phase change" as employed in modern physics.³⁶

Today, we know that this dialectical principle holds for biology as well. For example, increasing population density of microorganisms (a quantitative increase) can cause a change in genetic expression, leading to the formation of something new (a qualitative change). As bacterial populations increase, the signals (chemicals) emitted by each organism accumulate to a level that activates genes, leading to the production of a mucilaginous biofilm phase in which the organisms become embedded. Biofilms may be composed of a number of organisms and attach organisms to almost any surface, from water pipes to rocks in streams to teeth to soil roots.³⁷

Engels's second law, the interpenetration of opposites, was more difficult to define in an operational sense, but still of supreme importance for scientific inquiry. In Bernal's explanation, this stood for two related principles: (1) "everything implies its opposite" and (2) there were "no hard and fast lines in nature." Engels illustrated the latter point by referring to Lankester's famous discovery that the horseshoe crab (*Limulus*) was an arachnid, part of the spider and scorpion family, a revelation that had startled the scientific world and threw previous biological classifications askew.³⁸ In his application of this dialectical principle to physics and to the question of matter and movement (or energy), Bernal contended, "Engels approached very close to the modern ideas of relativity."³⁹ Engels's notion of the unity of opposites is often seen in today's Marxian dialectics in terms of the role of internal relations, in which at least one of the *relata* is dependent on the other.⁴⁰ As Engels himself observed, the recognition that mechanical relations with "their imagined rigidity and absolute validity have been introduced into nature only by our reflective minds...is the kernel of the dialectical conception of nature."⁴¹

The negation of the negation, Engel's third informal dialectical law, which, as Bernal noted, seemed so paradoxical in mere words, was meant to convey that, in the course of its historical development or evolution over time, anything within the objective world is bound to generate something different, a new emergent reality, representing new material relations and emergent levels, often through the action of recessive factors or residual elements, previously overcome, that still inhere in the present. Material existence as a whole could be seen as leading to a hierarchy of organizational levels, while transformative change often meant the shift from one organizational level to another, as in the seed to the plant.⁴²

The development of what are called "emergent properties" is now considered a basic biological and ecological concept. In an ecological context, it occurs when communities of species interact in ways that produce new characteristics, mostly unpredicted, arising from the behavior of the individual species in the community.⁴³ A four-acre farm field with a mixture of four different species (a polyculture) may lead to higher total yield than four acres devoted to only growing each of the individual species separately. This can occur for a variety of reasons: for example, better use of sunlight and water, and decreased insect damage in the polyculture field.

Coevolution of organisms also produces new properties. For example, over evolutionary time, insects feeding on plant leaves lead to the development of numerous defense mechanisms in plants. These include producing chemicals that inhibit the insect's feeding and emitting chemicals that recruit organisms (frequently small wasps) that lay their eggs in the

insect, which is then killed as the eggs develop. But the back and forth continues. In at least one instance, that of the tomato hornworm caterpillar, the wasp has also to inject a virus that deactivates the caterpillar's immune system to enable the wasp's eggs to develop. Evolution is constantly creating something different, sometimes dramatically, as *organisms* interact. In some cases, this leads to fundamental changes in whole ecosystems and the rise of new dominant species in particular environments. As Engels wrote, emergence, in the sense of "the negation of the negation, *really does take place* in both [plant and animal] kingdoms of the natural world."⁴⁴

As a historian of science, Engels, according to Bernal, was remarkable in his insights into the three great scientific revolutions of the nineteenth century: (1) thermodynamics – the laws of the conservation and interchangeability of forms of energy, and of entropy; (2) the analysis of the organic cell and the development of physiology; and (3) Darwin's theory of evolution based on natural selection by innate variation.⁴⁵ As Ilya Prigogine, winner of the 1977 Nobel Prize in Chemistry was later to observe, Engels's great insight was to recognize that these three revolutions in physical science "rejected the mechanistic worldview" and drew "closer to the idea of an historical development of nature."⁴⁶

In Bernal's account, among Engels's concerns was the pursuit of "the synthesis of all the processes affecting life, animal ecology, and [biological] distribution."⁴⁷ What made this synthesis possible was his conception of dialectical movement and change, emphasizing the complexity of material interactions and the introduction of new emergent powers, in a process of origin, development, and decline. "The central idea in Dialectical Materialism," Bernal declared, "is that of transformation.... The essential task of the materialist dialectic is the explanation of the qualitatively new," uncovering the conditions governing the emergence of a new "organizational hierarchy."⁴⁸

In this respect, Engels's pioneering achievement was to utilize his dialectical conception of nature to throw light on all four materialist problems of "origin" that remained after Darwin: (1) *the origin of the universe* (which Engels insisted was a self-origin as envisioned in the nebular hypothesis of Immanuel Kant and Pierre-Simon Laplace); (2) *the origin of life* (in which Engels refuted Justus von Liebig's and Hermann Helmholtz's notion of the eternity of life and pointed instead to a chemical origin focusing on the complex of chemicals underlying the protoplasm, particularly proteins); (3) *the origin of human society* (in which Engels went further than any other thinker of his time in explaining the evolution of the hand and tools through labor, and with them the brain and language, anticipating later discoveries in paleoanthropology); and (4) *the origin of the*

family (in which he explained the original matrilineal basis of the family and the rise of the patriarchal family with private property).⁴⁹

In this way, Engels, Bernal insisted, had anticipated or prefigured many of the developments in materialist science. “Engels, who welcomed the principle of the conversion of one form of energy into another, would equally have welcomed the transformation of matter into energy. Motion as the mode of existence of matter [Engels’s great postulate] would here acquire its final truth.”⁵⁰ As Bernal noted elsewhere, Engels “saw more clearly than most distinguished physicists of his time the importance of energy and its inseparability from matter. No change in matter, he declared, could occur without a change in energy, and vice versa.... [The] substitution of motion for force which Engels battles for throughout was the starting-point of Einstein’s own criticism of mechanics.”⁵¹

Yet, it was the broad perspective on ecology emanating from Engels’s dialectics that constituted the most critical insight of the *Dialectics of Nature* and is the reason why a return to Engels’s way of reasoning remains so important. As Bernal argued, one of Engels’s crucial contributions was his critique of notions of the absolute human conquest of nature. Engels had powerfully diagnosed the failure of human society, and particularly of the capitalist mode of production, to foresee the ecological consequences of its actions, tracing “the effects of undesired physical consequences of human interference with nature such as cutting down forests and the spreading of deserts.”⁵²

Other leading British socialist scientists of the 1930s and ’40s were equally impressed by Engels’s ecological warnings. For the great biochemist and science historian Joseph Needham, Engels could be described as someone for “whom nothing escaped.” Engels thus pointed out that, in Needham’s words, “a time may some day come when the struggle of mankind against the adverse conditions of life on our planet will have become so severe that further social evolution will become impossible,” referring to the eventual extinction of the human species.⁵³ For Needham, such a critical standpoint, which rejected the crude hypothesis of linear progress, also served to illuminate the extraordinary waste and ecological destruction of capitalist society—where coffee was grown to feed locomotive fireboxes. This raised the question of a “thermodynamic interpretation of justice” since the alienation of nature (including the alienation of energy), as Engels had intimated, was “squandering” real human possibilities in the present and future.⁵⁴

Biologist J. B. S. Haldane—one of the two leading British figures (along with R. A. Fisher) in the neo-Darwinian synthesis, reconciling Darwinian biology with the revolution in genetics—saw Engels as “the chief source” of materialist dialectics. Comparing Engels to Charles Dickens in relation to the Industrial Revolution, Haldane emphasized that Engels saw deeper

and further. “Dickens had a first-hand knowledge of these conditions [of poverty and pollution]. He described them with burning indignation and in great detail. But his attitude was one of pity rather than hope. Engels saw the misery and the degradation of the workers, but he saw through it. Dickens never suggested that if they were to be saved they must save themselves. Engels saw that this was not only desirable but inevitable.”⁵⁵

The recognition of the importance of Engels’s dialectics of nature has extended into our own times. Harvard biologists Richard Levins and Richard Lewontin were to dedicate their now classic work *The Dialectical Biologist* to Engels, drawing heavily, if somewhat critically at points, on his analysis.⁵⁶ Levins and Lewontin’s Harvard colleague, paleontologist and evolutionary theorist Stephen Jay Gould, was to observe that Engels provided the best nineteenth-century case for gene-culture coevolution – that is, the best explanation of human evolution in Darwin’s own lifetime, given that gene-culture coevolution is the form that all coherent theories of human evolution must take.⁵⁷

It was Engels’s development of a dialectics of emergence that was ultimately to prove most revolutionary. The significance of this perspective – ontologically, epistemologically, methodologically – was captured by Needham in his own pathbreaking analysis of “integrative levels” (or emergence) in *Time, the Refreshing River* (a title that referred back to the great ancient materialist, Heraclitus):

Marx and Engels were bold enough to assert that it [the dialectical process] happens actually in evolving nature itself, and that the undoubted fact that it happens in our thought about nature is because we and our thought are part of nature. We cannot consider nature otherwise than as a series of levels of organisation, a series of dialectical syntheses. From the ultimate particle to atom, from atom to molecule, from molecule to colloidal aggregate, from aggregate to living cell, from cell to organ, from organ to body, from animal body to social association, the series of organisational levels is complete. Nothing but energy (as we now call matter and motion) and the levels of organisation (or the stabilised dialectical syntheses) at different levels have been required for the building of our world.⁵⁸

Engels in the Anthropocene

It is widely recognized in contemporary science (though not yet official) that the Holocene epoch in geological time, extending back almost twelve thousand years, has come to an end, beginning in the 1950s, displaced by the current Anthropocene epoch. The onset of the Anthropocene was brought about by a Great Acceleration in the anthropogenic impacts on the environment, such that the scale of the human economy has now come to rival the major biogeochemical cycles of the planet it-

self, resulting in rifts in the planetary boundaries that define the Earth System as a safe home for humanity.⁵⁹ The Anthropocene thus stands for what Lankester had earlier called the “Kingdom of Man,” in the critical sense in which this was meant: that is, humanity was increasingly the “disturber” of the natural environment on a planetary scale. Hence, society had no choice but to seek the rational application of science, and thus the overturning of a social order in which science has been relegated to a mere means by which “treasure and luxury are opened to capitalists.”⁶⁰ What this meant, in Engels’s (and Marx’s) more forceful terms, was that the condition for the rational regulation of the metabolism between humanity and nature, and hence the rational application of science, was the transformation of the mode of production and distribution. Any other course invited the accumulation of catastrophe.⁶¹

It is in the Anthropocene that Engels’s dialectic of ecology can be seen as finally coming into its own. It is here that his emphasis on the interdependence of everything in existence, the unity of opposites, internal relations, discontinuous change, emergent evolution, the reality of ecosystem and climate destruction, and the critique of linear notions of progress can all be seen as essential to the very future of humanity and the earth as we know it. Engels was acutely aware that in modern scientific conceptions “the whole of nature also is now merged in history, and history is only differentiated from natural history as the evolutionary process of *self-conscious* organisms.”⁶² Insofar as humanity was alienated from its own labor and production process, and therefore from its metabolism with nature, this could only mean the destruction of nature as well as society. The quantitative growth of capital led to a qualitative transformation of the human relation to the earth itself, which only a society of associated producers could rationally address. This was related to the fact that a particular qualitative mode of production (such as capitalism) was associated with a specific matrix of quantitative demands, while a qualitatively transformed mode of production (as in socialism) could lead to a very different quantitative matrix.

Engels argued that capitalism was “squandering” the world’s natural resources, including fossil fuels.⁶³ He indicated that urban pollution, desertification, deforestation, exhaustion of the soil, and (regional) climate change were all the result of unplanned, uncontrolled, destructive forms of production, most evident in the capitalist commodity economy. In line with Marx, and Liebig, he pointed to London’s enormous sewage problem as a manifestation of the metabolic rift, which removed the nutrients from the soil and shipped them one-way to the overcrowded cities where they became a source of pollution.⁶⁴ He underscored the class basis of the spread

of the periodic epidemics of smallpox, cholera, typhus, typhoid, tuberculosis, scarlet fever, whooping cough, and other contagious diseases that were affecting the environmental conditions of the working class, along with poor nutrition, overwork, exposure to toxics at work, and workplace injuries of all kinds. He highlighted, based on the new science of thermodynamics, that historical ecological change was irreversible and that humanity's own survival was ultimately in question.⁶⁵ In terms of the current relations of production and the environment, he wrote of a society faced with *ruin or revolution*. The social murder of workers in urban environments and the famines in colonial Ireland and India were seen as indications of the extreme exploitation, ecological degradation, and even wholesale extermination of populations just below the surface of capitalist society.⁶⁶

On all these bases, Engels, like Marx, argued that the human metabolism with nature should be regulated by associated producers in conformity to (or in coevolution with) nature's laws as understood by science, while fulfilling individual and collective needs. Such a rational application of science, however, was impossible under capitalism. Nor was development itself controllable under capitalism, since it was based on immediate, individual gain. To implement a comprehensive, rational scientific approach in line with human needs and sustainable environmental conditions required a society in which a system of long-term planning in the interest of the chain of human generations could be put into operation.⁶⁷

Implicit in Engels's analysis from the very beginning was a notion of what we can call the *environmental proletariat*. Thus, while capitalism was concerned with the "political economy of capital," the working class in its most oppressed and also in its most radical phases was concerned with the entirety of existence, always starting from elemental needs. To call the objectives of workers a "political economy of the working class," as Marx once did, may not be wrong, but it would be more correct in today's terminology to say that workers, in their more revolutionary struggles, are primarily striving to create a new *political ecology of the working class*, concerned with their whole environment and basic living conditions, which can only be achieved on a communal basis.⁶⁸ It was this that was captured so well in Engels's *Condition of the Working Class in England*, where he systematically exposed the pollution of air and water, the contaminated sewers, the adulterated food, the lack of nutrition, the toxics at work, the frequent injuries, and the high morbidity and mortality of the working class – and saw the struggle for socialism as the only genuine way forward.

Indeed, *The Condition of the Working Class in England* raised issues that are now once again coming to the fore in the Anthropocene. For Marx, Engels's youthful work was to exert an enduring influence leading him to

designate “periodical epidemics” as a manifestation of the metabolic rift alongside the destruction of the soil. Many pages of *Capital* were devoted simply to attempting to update Engels’s epidemiological analysis decades later.⁶⁹ Today, in the context of the pandemic represented by COVID-19, these insights take on a renewed importance as a place from which to begin in the long revolution for an ecosocialist world.⁷⁰ Yet, to bring such analyses forward, it is necessary to explore a dialectical science (and art) rooted in a conception of the complex “oneness” of humanity and nature.

All Things Are Sold

Engels admired the poetry of Percy Bysshe Shelley, whom he considered a “genius.” He wrote in his youth of “a tenderness and originality in the depiction of nature such as only Shelley can achieve.”⁷¹ In the opening stanzas of Shelley’s *Mont Blanc*, we find a materialist dialectics of nature and mind not unlike Engels’s own:

The everlasting universe of things
Flows through the mind, and rolls its rapid waves,
Now dark – now glittering – now reflecting gloom –
Now lending splendour, where from secret springs
The source of human thought its tribute brings
Of waters – with a sound but half its own⁷²

Like Shelley, who in *Queen Mab* wrote of bourgeois society’s alienation of nature along with love – “All things are sold: the very light of Heaven / Is venal; earth’s unsparing gifts of love” – Engels saw the deep need for the reconciliation of humanity with nature, which only a revolution could bring.⁷³

Notes

1. Karl Marx and Frederick Engels, *Collected Works*, vol. 25 (New York: International Publishers, 1975), 459.
2. Paul Blackledge, *Friedrich Engels and Modern Social and Political Theory* (Albany: State University of New York Press, 2019), 16.
3. Walter Benjamin, *Selected Writings*, vol. 4, 1938–1940 (Cambridge, MA: Harvard University Press, 2003), 402; Michael Löwy, *Fire Alarm: Reading Walter Benjamin’s “On the Concept of History”* (London: Verso, 2001), 66–67.
4. Marx and Engels, *Collected Works*, vol. 25, 145–46, 153, 270; Karl Marx and Frederick Engels, *Ireland and the Irish Question* (Moscow: Progress Publishers, 1971), 142.
5. Locomotive boiler explosions due to defective and maladjusted safety valves were common in the mid-nineteenth century. Locomotive engineers under time pressures often wedged or fastened down the safety valves, thereby jamming the safety valves on the train, which did not open, or which they were unable physically to open in time. See Christian H. Hewison, *Locomotive Boiler Explosions* (Newton Abbot: David & Charles, 1983), 11, 18–19, 36, 49, 54–56, 82, 85, 110.
6. Marx and Engels, *Collected Works*, vol. 25, 459; John Bellamy Foster, “Capitalism and the Accumulation of Catastrophe,” *Monthly Review* 63, no. 7 (December 2011): 5–7; Karl Marx and Friedrich Engels, *Marx-Engels Gesamtausgabe (MEGA) IV/31* (Amsterdam: Akademie Verlag, 1999), 512–15.
7. Marx and Engels, *Collected Works*, vol. 25, 167; Karl Marx and Friedrich Engels, *Marx-Engels Gesamtausgabe (MEGA) IV/18* (Berlin: Walter de Gruyter, 2019), 670–74, 731 (excerpts by Marx); Mike Davis, *Late Victorian Holocausts: El Niño Famines and the Making of the Third World* (London: Verso, 2001); Marx and Engels, *Ireland and the Irish Question*.
8. On the notion of extreme productivism and, in this sense, Prometheanism, as well as its almost complete absence in Marx and Engels’s thought, see John Bellamy Foster, *The Ecological Revolution* (New York: Monthly Review Press, 2009), 226–29.
9. Marx and Engels, *Collected Works*, vol. 25, 269. For Marx and Engels, it should be noted, productive forces refer to more than simply technology. Thus, Marx insisted that the most important instrument or force of production was

- human beings themselves. Hence, expansion of the forces of production meant the expansion of human productive skills and powers. See Marx and Engels, *Collected Works*, vol. 6, 211; Paul A. Baran, *The Longer View* (New York: Monthly Review Press, 1969), 59.
10. Walt Rostow, *The World Economy* (Austin: University of Texas Press, 1978), 47-48, 659-62.
11. On sustainable human development as a framework governing both Marx's and Engels's thought, see Paul Burkett, "Marx's Vision of Sustainable Human Development," *Monthly Review* 57, no. 5 (October 2005): 34-62.
12. Eleanor Leacock, introduction to *The Origin of the Family, Private Property and the State*, by Frederick Engels (New York: International Publishers, 1972), 245.
13. Marx and Engels, *Collected Works*, vol. 4, 394, 407; Ian Angus, "Cesspools, Sewage, and Social Murder," *Monthly Review* 70, no. 3 (July-August 2018): 38; John Bellamy Foster, *The Return of Nature* (New York: Monthly Review Press, 2020), 182-95.
14. Howard Waitzkin, *The Second Sickness* (New York: Free Press, 1983), 71-72.
15. Marx and Engels, *Collected Works*, vol. 25, 23; Foster, *The Return of Nature*, 254.
16. Marx and Engels, *Collected Works*, vol. 25, 270.
17. Marx and Engels, *Collected Works*, vol. 25, 463-64.
18. Francis Bacon, *Novum Organum* (Chicago: Open Court, 1994), 29, 43.
19. Marx and Engels, *Collected Works*, vol. 25, 461; Karl Marx, *Grundrisse* (London: Penguin, 1973), 409-10.
20. Marx and Engels, *Collected Works*, vol. 25, 461.
21. Marx and Engels, *Collected Works*, vol. 25, 460-61.
22. Marx and Engels, *Collected Works*, vol. 25, 330-31, 461.
23. E. Ray Lankester, *The Kingdom of Man* (New York: Henry Holt and Co., 1911), 1-4, 26, 31-33; Foster, *The Return of Nature*, 61-64.
24. Lankester, *The Kingdom of Man*, 31; Joseph Lester, E. Ray Lankester and the Making of Modern British Biology (Oxford: British Society for the History of Science, 1995), 163-64.
25. E. Ray Lankester, *Science from an Easy Chair* (New York: Henry Holt and Co., 1913), 365-69.
26. Marx and Engels, *Collected Works*, vol. 25, 492. The criticism of Engels on the dialectics of nature had its origins in footnote 6 of Georg Lukács's *History and Class Consciousness*, though Lukács, as he later explained, never fully abandoned the notion of a "merely objective dialectics" and was to promote such a naturalistic dialectic, based on Marx more than Engels, in his later thought. Nevertheless, the rejection of the dialectics of nature became axiomatic for Western Marxism beginning in the 1920s, taking a stronger hold in the post-Second World War period. Georg Lukács, *History and Class Consciousness* (Cambridge, MA: MIT Press, 1971), 24, 207. See also Russell Jacoby, "Western Marxism," in *A Dictionary of Marxist Thought*, ed. Tom Bottomore (Oxford: Blackwell, 1983), 523-26; Foster, *The Return of Nature*, 11-22. On the general conflict regarding Engels within contemporary Marxism, see Blackledge, *Frederick Engels and Modern Social and Political Theory*, 1-20.
27. As Roy Bhaskar has argued, the necessity to consider the intransitive or the realm of transfactuality establishes the distinction between the epistemological and the ontological, against the tendency within much of contemporary philosophy, including the Western Marxist philosophical tradition, to promote the epistemological fallacy, characteristic of idealism, in which ontology is subsumed within epistemology. Adherence to the epistemological fallacy would make any consistent materialism or natural science impossible. Roy Bhaskar, *Dialectic: The Pulse of Freedom* (London: Verso, 1993), 397, 399-400, 405.
28. This can be seen in Alfred Schmidt's *The Concept of Nature in Marx*, published in 1962, the same year as Rachel Carson's *Silent Spring*. Schmidt's work, a product of the Frankfurt School (influenced particularly by his mentors Max Horkheimer and Theodor Adorno) for the most part denied the dialectics of nature and any reconciliation of humanity with nature on the very cusp of the emergence of the modern environmental movement. Alfred Schmidt, *The Concept of Nature in Marx* (London: Verso, 1970).
29. This and the following six paragraphs are adapted from Foster, *The Return of Nature*, 379-81.
30. Marx and Engels, *Collected Works*, vol. 25, 356.
31. Peter T. Manicas, "Engels's Philosophy of Science," in *Engels After Marx*, ed. Manfred B. Steger and Terrell Carver (University Park: Pennsylvania University Press, 1999), 77.
32. Craig Dilworth, "Principles, Laws, Theories, and the Metaphysics of Science," *Synthese* 101, no. 2 (1994): 223-47. The principle of uniformity (or uniformitarianism), most closely associated with Charles Lyell, was challenged by Darwin's concept of evolution, though Darwin's gradualism downplayed the conflict. Stephen Jay Gould and paleontologist Niles Eldredge were to challenge uniformitarianism much more radically in their theory of punctuated equilibrium in the 1980s. See Richard York and Brett Clark, *The Science and Humanism of Stephen Jay Gould* (New York: Monthly Review Press, 2011), 28, 40-42. The traditional notion of the perpetuation of substance was challenged in Engels's day by the development of the concept of energy in physics. In relation to both of these ontological principles and the principle of causality, where he addressed the complex interchange of cause and effect, Engels's dialectical "laws" or ontological principles not only captured the revolutionary changes taking place in the science of his day, but in various ways prefigured later discoveries. On Engels's views of causality, see Marx and Engels, *Collected Works*, vol. 25, 510.
33. J. D. Bernal, *Engels and Science* (London: Labour Monthly Pamphlets, 1936), 1-2.
34. Bernal, *Engels and Science*, 5.
35. Bernal, *Engels and Science*, 5-7; Marx and Engels, *Collected Works*, vol. 25, 359 (translation follows Bernal).
36. Hyman Levy, *A Philosophy for a Modern Man* (New York: Alfred A. Knopf, 1938), 30-32, 117, 227-28.
37. This paragraph was written by Fred Magdoff. See also Fred Magdoff and Chris Williams, *Creating an Ecological Society* (New York: Monthly Review Press, 2017), 215.
38. Marx and Engels, *Collected Works*, vol. 25, 326, 507; E. Ray Lankester, "Limulus an Arachnid," *Quarterly Journal of Microscopical Science* 2 (1881):

504–48, 609–49; Foster, *The Return of Nature*, 56, 249.

39. Bernal, *Engels and Science*, 7–8, J. D. Bernal, "Dialectical Materialism," in *Aspects of Dialectical Materialism*, by Hyman Levy et al. (London: Watts and Co., 1934), 107–8.

40. Bernal, *Engels and Science*, 7; Foster, *The Return of Nature*, 242.

41. Bernal, *Engels and Science*, 7; Marx and Engels, *Collected Works*, vol. 25, 14.

42. All three of Engels's informal laws of dialectics can be seen as related to emergence, particularly the first and the third. Engels's third informal law, negation of the negation, as Roy Bhaskar argued in *Dialectics: Pulse of Freedom*, "raises the issue of *absenting absences* and the reassertion of lost or negated elements of reality. Bernal developed an analysis of the negation of the negation in terms of the role of residuals that reemerge and transform relations through complex evolutionary processes." Roy Bhaskar, *Dialectic: The Pulse of Freedom* (London: Verso, 1993), 150–52, 377–78; Bernal, "Dialectical Materialism," 103–4.

43. This and the following paragraph were drafted nearly in their entirety by Fred Magdoff.

44. Marx and Engels, *Collected Works*, vol. 25, 126.

45. Bernal, *Engels and Science*, 8–10; Friedrich Engels, *Ludwig Feuerbach and the Outcome of Classical German Philosophy* (New York: International Publishers, 1941), 65–69.

46. Ilya Prigogine and Isabelle Stengers, *Order Out of Chaos* (New York: Bantam, 1984), 252–53.

47. Bernal, *Engels and Science*, 4.

48. Bernal, "Dialectical Materialism," 90, 102, 107, 112–17.

49. Bernal, *Engels and Science*, 10–12. With respect to Engels on the origins of life, Richard Levins and Richard Lewontin wrote that "dialectical materialism has focused [necessarily] mostly on some selected aspects of reality. At times we have emphasized the materiality of life against vitalism, as when Engels said that life was the motion of 'albuminous bodies' (i.e. proteins; now we might say macro-molecules). This seems to be in contradiction to our rejection of molecular reductionism, but simply reflects different moments in an ongoing debate

where the main adversaries were first the vitalist emphasis on the discontinuity between the inorganic and living realms, and then the reductionist erasure of the real leaps of levels." Richard Lewontin and Richard Levins, *Biology Under the Influence* (New York: Monthly Review Press, 2007), 103.

50. Bernal, *Engels and Science*, 13–14.

51. J. D. Bernal, *The Freedom of Necessity* (London: Routledge and Kegan Paul, 1949), 362.

52. Bernal, *The Freedom of Necessity*, 364–65.

53. Joseph Needham, *Time, the Refreshing River* (London: George Allen, and Unwin, 1943), 214–15; Engels, *Ludwig Feuerbach*, 12.

54. Needham, *Time, the Refreshing River*, 214–15; Marx and Engels, *Collected Works*, vol. 46, 411.

55. J. B. S. Haldane, *The Marxist Philosophy and the Sciences* (New York: Random House, 1939), 199–200; Foster, *The Return of Nature*, 391.

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

57. Stephen Jay Gould, *An Urchin in the Storm* (New York: W. W. Norton, 1987), 111–12.

58. Needham, *Time, the Refreshing River*, 14–15. Engels wrote: "It is precisely the *alteration of nature by men*, not solely nature as such, which is the most essential and immediate basis of human thought." Marx and Engels, *Collected Works*, vol. 25, 511.

59. See John Bellamy Foster, Brett Clark, and Richard York, *The Ecological Rift* (New York: Monthly Review Press, 2010), 13–18; Ian Angus, *Facing the Anthropocene* (New York: Monthly Review Press, 2016); Clive Hamilton, *Defiant Earth* (Cambridge: Polity, 2017).

60. Lester, *E. Ray Lankester*, 164.

61. John Bellamy Foster, "Capitalism and the Accumulation of Catastrophe," 1–2, 15–16. Foster, *The Return of Nature*, 64, 286–87.

62. Marx and Engels, *Collected Works*, vol. 25, 516.

63. Marx and Engels, *Collected Works*, vol. 46, 411.

64. Frederick Engels, *The Housing Question* (Moscow: Progress Publishers, 1975), 92.

65. On Engels's approach to thermodynamics, see John Bellamy Foster and Paul Burkett, *Marx and the Earth* (Chicago: Haymarket, 2016), 137–203.

66. On Marx and Engels on ecological degradation and extermination in colonial Ireland, see John Bellamy Foster and Brett Clark, *The Robbery of Nature* (New York: Monthly Review Press, 2020), 64–77.

67. Engels made it clear that the rational regulation of the human relation to nature, and thus a rational application of science, was only possible with "a complete revolution in our hitherto existing mode of production." Marx and Engels, *Collected Works*, vol. 25, 462. On the alienation of science under capitalism, see István Mészáros, *Marx's Theory of Alienation* (London: Merlin, 1975), 101–2. The role of science under capitalism is further clarified in Richard Levins's notion of the "dual nature of science." Richard Levins, "Ten Propositions on Science and Antiscience," *Social Text* 46–47 (1996): 103–4. The uncontrollability of capital is theorized in István Mészáros, *Beyond Capital* (New York: Monthly Review Press, 1995), 713.

68. Karl Marx, *On the First International*, ed. Saul Padover (New York: McGraw-Hill, 1973), 10.

69. See Foster, *The Return of Nature*, 197–204.

70. John Bellamy Foster and István Suwandi, "COVID-19 and Catastrophe Capitalism," *Monthly Review* 72, no. 2 (June 2020): 3–4.

71. Marx and Engels, *Collected Works*, vol. 2, 95–101, 497; vol. 4, 528. Engels's admiration for Shelley led him to attempt to translate *Queen Mab*, along with *The Sensitive Plant*, into German. See John Green, *Engels: A Revolutionary Life* (London: Artery, 2008) 28–29, 59. For a fascinating treatment of Shelley's revolutionary poetry and politics, see Annette Rubinstein, *The Great Tradition in English Literature* (New York: Monthly Review Press, 1953), 516–64.

72. Percy Bysshe Shelley, *The Complete Poetical Works* (Oxford: Oxford University Press, 1914), 528.

73. Shelley, *Complete Poetical Works*, 773. Marx depicted Shelley as "essentially a revolutionist," a view that Engels shared. Edward Aveling and Eleanor Marx Aveling, *Shelley's Socialism* (London: The Journeyman, 1975), 4.