

The Point Is to Change It: MICHAEL E. TIGAR

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# capital and the ecology of disease

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# Capital and the Ecology of Disease



**By John Bellamy Foster & Brett Clark**  
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“The old Greek philosophers,” Frederick Engels wrote in *Socialism: Utopian and Scientific*, “were all born natural dialecticians.”<sup>1</sup> Nowhere was this more apparent than in ancient

Greek medical thought, which was distinguished by its strong materialist and ecological basis. This dialectical, materialist, and ecological approach to epidemiology (from the ancient Greek *epi*, meaning *on* or *upon*, and *demos*, the people) was exemplified by the classic Hippocratic text *Airs Waters Places* (c. 400 BCE), which commenced:

Whoever wishes to investigate medicine properly, should proceed thus: in the first place to consider the seasons of the year, and what effects each of them produces, for they are not all alike, but differ from themselves in regard to their changes. Then the winds, the hot and cold, especially such as are common to all countries, and then such as are peculiar to each locality. We must also consider the qualities of the waters, for as they differ from another in taste and weight, so also do they differ much in their qualities. In the same manner, when one comes into a city to which he is a stranger, he ought to consider its situation, how it lies as to the winds and the rising of the sun.... These things one ought to consider most attentively, and concerning the waters which the inhabitants use, whether they be marshy and soft, or hard, and running from elevated rocky situations, and then if saltish and unfit for cooking, and the ground, whether it be naked and deficient in water, or wooded and well-watered, and whether it lies in a hollow or confined situation, or is elevated and cold; and the mode in which the inhabitants live, and what are their pursuits, whether they are fond of drinking and eating to excess, and given to indolence, or are fond of exercise and labor....

For if one knows all these things well, or at least the greater part of them, he cannot miss knowing, when he comes into a strange city, either the diseases peculiar to the place, or the particular nature of common diseases, so that he will not be in doubt as to the treatment of the diseases, or commit mistakes, as is likely to be the case provided one has not previously considered these matters. And in particular, as the season and the year advances,

he can tell what epidemic diseases will attack the city, either in summer or in winter, and what each individual will be in danger of experiencing from the change in regimen.... For with the seasons the digestive organs of men undergo a change.<sup>2</sup>

A key element of this view was the notion of a dialectical relation between the body and the environment, such that the body was situated or embodied in a particular *place* and specific natural conditions (air and water), producing a vision, as historian of medicine Charles E. Rosenberg has indicated, that was “holistic and integrative—one might call it both ecological and sociological.”<sup>3</sup>

To be sure, in ancient Greece, medicine was bifurcated. Slaves had slave doctors and citizens had citizen doctors, who performed under quite different conditions.<sup>4</sup> The Hippocratic author of *Airs Waters Places* was writing specifically for citizen doctors, and thus this treatise reflected the class nature of Greek society. Nevertheless, it stood for a general approach that was to influence the later development of epidemiology for thousands of years.

The great heir of the environmental and dialectical approach to health in the early capitalist era was Bernardino Ramazzini (1633–1714), whose pioneering work on *The Diseases of Workers* was, as Karl Marx stressed in *Capital*, the foundational treatise in “industrial pathology,” or what is now known as the field of occupational and environmental health.<sup>5</sup> Ramazzini explored the occupational diseases associated with miners of metals, gilders, chemists, painters, sulfur workers, blacksmiths, cleaners of privies and cesspits, fullers, oil pressers, tanners, tobacco workers, corpse carriers, midwives, wet nurses, brewers, bakers, millers, stone cutters, laundresses, farmers, workers who stand, sedentary workers, and many other occupational categories and laboring conditions. He consciously incorporated the viewpoint of *Airs*

*Waters Places* by transcending the bifurcation that had existed in Greek medicine between free citizen and slave, and examining the environmental conditions of the most lowly occupations. He wrote: “When a doctor visits a working-class home he should be content to sit on a three-legged stool, if there isn’t a gilded chair, and should take time for his examination; and to the questions recommended by Hippocrates, he should add one more – What is your occupation?”<sup>6</sup>

In the mid-nineteenth century, Marx saw Ramazzini’s work on industrial pathology, which extended epidemiology to working-class occupations, as the key to the development of public health, as formulated by radical nineteenth-century physicians. The wider historical implications of this vis-à-vis the rise of industrial capitalism were presented in the mid-1840s in Engels’s *The Condition of the Working Class in England*. In the mid-1860s, Marx turned to Engels’s work and the most recent investigations into public health when seeking to explore the environmental conditions of the working class in the pages of *Capital*. The early to mid-nineteenth century was the era of the great sanitation reforms, often led by radical doctors. It was also an age of major changes in medicine, with the development of the microscope and the rise of the theory of cell pathology in the work of Rudolf Virchow, who played a formative role in the creation of social epidemiology and helped establish a general environmental approach to epidemics that drew on the work of Engels.

Nevertheless, epidemiological investigations by the late nineteenth and early twentieth centuries were to be dominated by the germ theory of disease and the legendary breakthroughs of “the microbe hunters.”<sup>7</sup> The emphasis was on specific developments in biomedicine in countering epidemics, such as those associated with the development of vaccines and antibiotics. These advances in biomedicine were logically compatible with an

ecosocial approach to epidemiology, as could be seen in the work of E. Ray Lankester—Charles Darwin and Thomas Huxley’s protégé, Marx’s intimate friend, and a close collaborator with Louis Pasteur. However, the general tendency was increasingly to set broad environmental issues aside as inimical to capital.<sup>8</sup> By the mid-twentieth century, a reductionist biomedical model had triumphed over broader, environmental perspectives, thus setting aside the remarkable achievements of ecosocial thinkers such as Engels, Marx, Virchow, and Lankester, along with those of Florence Kelley, W. E. B. Du Bois, Alice Hamilton, Norman Bethune, and Salvador Allende.

The marginalization by the mid-twentieth century of social-environmental approaches to epidemiology was justified in large part by what was portrayed as the complete triumph of modern medicine over infectious disease. In 1971, Abdel R. Omran introduced his theory of “epidemiologic transition,” which argued that infectious diseases were essentially phenomena of the past in developed economies, swept away by the modernization process. While infectious diseases were still present in underdeveloped economies, it was postulated that they would simply disappear with further economic development.<sup>9</sup> Consequently, it was proposed that health concerns should focus on the concomitant increase in degenerative diseases. The epidemiologic transition conception has remained—at least prior to the emergence of COVID-19—the most influential general approach to the evolution of environmental health. However, it began to fray around the edges and came to be increasingly qualified (if not absolutely disproven) due to two sets of critiques: (1) the failure to account for growing health inequalities (particularly class and racial) in the developed capitalist societies, and (2) the enormous expansion of capitalist globalization, leading to the spread of diseases—which were not

simply confined to poor, tropical countries, as they threatened the nations in the capitalist core as well.<sup>10</sup>

As Harvard ecologist Richard Levins declared in “Is Capitalism a Disease?,” the appearance at the end of the twentieth century of a new series of pathogens, including the return of malaria, cholera, dengue fever, tuberculosis, and other classic diseases, coupled with Ebola, AIDS (HIV), Legionnaire’s disease, toxic shock syndrome, and multiple drug resistant tuberculosis – to which we could now add others such as H1N1, H5N1, MERS, SARS, and COVID-19 (SARS-CoV-2) – pointed to the complete failure of the epidemiologic transition theory. In the face of this, Levins insisted that, “instead of a doctrine of the epidemiologic transition, which held that infectious disease would simply disappear as countries developed, we need to substitute an ecological proposal: that 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.”<sup>11</sup> Such changes have occurred as a result of the wave of neoliberal globalization and agribusiness expansion in the half century since the epidemiologic transition was first postulated, leading to a new critical emphasis on the ecology of disease and its relations to the structural crisis of capital.

## **The Epidemiological Rift**

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The leading critics of the conditions of the working class in the nineteenth century consisted of radical physicians who personified many of the most progressive aspects of bourgeois science and culture, often going against the logic of capitalist society, frequently taking on socialist values. It was partly in this context, beyond political economy, that Marx and Engels were to develop much of their critique of capital. Engels’s *The Condition of*

*the Working Class in England*, written in 1844, was based to a considerable extent on his first-hand observations, as he walked the streets of Manchester at all times of day and night, guided at times by his partner, the vivacious, young, Irish proletarian Mary Burns.<sup>12</sup> But Engels also relied heavily on the investigations of radical physicians, such as Manchester's Peter Gaskell, James Phillips Kay, and Thomas Percival. In the 1820s–40s, the English ruling class was motivated to look into the conditions of workers and to carry out sanitary reforms, largely due to the spread of epidemics of cholera, typhus, typhoid, scarlet fever, and other diseases, that, while always worse in the vicinities of the poor, frequently expanded into the domains of the rich. However, the physicians who actually took on the task of remedying these evils were often, like Dr. Lydgate in George Eliot's *Middlemarch*, free thinkers, who saw medicine as “presenting the most perfect interchange between science and art,” pointing to the need for radical social reform and the rejection of the “venal” proclivities of a cash-nexus society.<sup>13</sup>

Significantly, Kay, Gaskell, and London's Southwood Smith, on whom Engels was to rely, were all trained in Edinburgh, which, together with Glasgow, was the fountainhead of the Scottish Enlightenment, sometimes seen as the birthplace of classical sociology. Leading intellectuals in the Scottish Enlightenment such as Adam Ferguson and James Millar, as well as Adam Smith, promoted a broad natural history perspective, which was generally materialist and empiricist in philosophical orientation.<sup>14</sup> Henry Julian Hunter, whom Marx admired, received his medical degree at Aberdeen.<sup>15</sup> Edwin Lankester obtained his medical training in Germany, where he picked up critical perspectives on bourgeois society.<sup>16</sup> Of the leading radical physicians of the day in Britain who were to influence Engels and Marx, John Simon, the medical officer of the privy council, and



Edward Smith, the author of *Health and Disease* (1861), stood out in having received their medical degrees at English universities, the former at King's College, Cambridge University, the latter at the Royal Birmingham Medical School.<sup>17</sup>

Building on his own observations, Chartist literature, and radical physicians of the day, the young Engels in 1844 uncovered the horrific environmental conditions of the working class in England in the midst of the Industrial Revolution, focusing on the factors leading to epidemics as well as occupational diseases and nutritional deficiencies. Among his findings, explored in great detail, was the much higher mortality of the working class as compared to the capitalist class. At one point in his text, he drew on a study of Chorlton-on-Medlock, then a suburb of Manchester (now part of the city), by the physician P. H. Holland, who had divided both the streets and houses into three qualitatively distinct classes, from rich to poor. As Engels explained, the resulting data showed that the mortality in the "streets of the third class [was] 68 per cent greater than in those of the first class," while the mortality in the houses of the third class was "78 per cent greater than in those of the first class."

In Liverpool, as Engels indicated based on parliamentary reports, "the average longevity [i.e., life expectancy at birth] of the upper classes, gentry, professional men, etc., was thirty-five years," while that of the working class was fifteen years. The reason that life expectancy was so abysmally low had to do with the high infant mortality rate. In Manchester, "more than fifty-seven per cent of the children of the working class perish before their fifth year, while but twenty per cent of the children of the higher classes.... Epidemics in Manchester and Liverpool are three times more fatal than in country districts.... Fatal cases of small-pox, measles, scarlet fever, and whooping cough, among small children are four times more frequent."<sup>18</sup> As his analysis showed,

the working classes suffered higher morbidity and mortality at every age and gender, with ethnic minorities (in England at the time mainly Irish) hurting much more massively.<sup>19</sup> Engels contended that these unequal conditions were the product of the system of capital accumulation and constituted in that sense a form of “social murder.”<sup>20</sup>

In Germany, Virchow, the German doctor and pathologist, famous as the author of *Cellular Pathology* (1858), drew on Engels’s *The Condition of the Working Class in England* in his own pioneering work in social epidemiology, utilizing some of the latter’s statistics on class-based mortality. Designating epidemics of cholera and typhus as “crowd diseases,” Virchow played a leading role in sanitary reform in Berlin. In the United States, Engels’s book influenced the leading socialist activist and social reformer Florence Kelley, who was a close friend of and frequent correspondent with Engels and translated *The Condition of the Working Class in England* into English in 1887. She resided for a time at Hull House in Chicago, where she developed maps documenting the impoverished areas of Chicago, color coding neighborhoods for ethnicity and class to reveal specific forms of inequalities. Later, as chief factory inspector for the state of Illinois, she fought sweat houses, tenement houses, child labor, and a smallpox epidemic. She went on to become a leading figure in the battle for reform of the social and environmental conditions of the working class, and particularly women, in the United States. As U.S. Supreme Court justice Felix Frankfurter stated in 1953, Kelley was “a woman who had probably the largest single share in shaping the social history of the United States during the first thirty years of this century,” responding to the conditions of a “hectic industrialization.”<sup>21</sup> In 1900, the death rate from typhoid in the United States, according to the British scientist and socialist Lancelot Hogben, was thirty-six per thousand, but had dropped

to six per thousand by 1932, largely due to sanitary reformers, of which Kelley was one of the foremost practitioners.<sup>22</sup>

Marx took up many of the epidemiological issues addressed in Engels's *Condition of the Working Class in England* a little more than twenty years later in *Capital*. For Marx, the "periodical epidemics" that Engels had explored were as much a manifestation of the "irreparable rift in the interdependent process of social metabolism" as was "the manuring of English fields with guano" from Peru.<sup>23</sup> In this sense, a *corporeal rift* in human morbidity and mortality was to be seen as part of the wider *metabolic rift* in the relation of humanity to nature via social production.<sup>24</sup> In analyzing the ecological/epidemiological rift of capitalism, Marx drew heavily on the work of radical English physicians of the 1860s, particularly Simon, whom he considered one of the great critics of capitalism of the age, along with Hunter, Edward Smith, and Edwin Lankester (with whose work Marx was indirectly acquainted)—all of whom worked in various capacities with Simon.<sup>25</sup> Marx filled numerous pages of *Capital* with treatments of the social and class causes of epidemics, nutritional deficiencies, mortality differentials (including high child mortality), housing, and sanitary conditions. The assessments of radical physicians investigating the state of public health, in Marx's words, teemed "with heterodox onslaughts on 'property and its rights.'" <sup>26</sup>

Next to Simon himself, who, despite his elevated position at the top of the English public health establishment, was a self-styled "socialist" concerned with "proletarian" conditions, the radical doctor Marx most admired was Hunter, who was one of the gifted group of physicians that Simon drew on to investigate the health conditions of workers in England and Wales.<sup>27</sup> Marx characterized Hunter's investigations in the sixth, seventh, and eighth public health reports (1864–66) into infant mortality, nutrition, sanitation, epidemics, and the general living conditions of

workers throughout England as nothing short of “epoch-making,” basing more than a dozen pages of *Capital* on Hunter’s on-the-ground research.<sup>28</sup> With respect to housing, Hunter highlighted the absurdity of a national requirement “of supplying cover [housing] to those who by reason of their having no capital, cannot provide it for themselves, though they can by periodical payments reward those who will provide it to them.” This lack of capital on the part of the working population and the exorbitant rents that had to be paid out of their paltry wages, coupled with frequent expropriations by landlords, led Marx to refer sardonically to the “admirable character of capitalist justice!”<sup>29</sup> Overcrowding, measured in the lack of necessary cubic space for the inhabitants (as well as lack of windows, adequate sanitary facilities, and clean water) was, he indicated, the breeding ground for a host of epidemics, including smallpox, cholera, typhus, typhoid, scarlet fever, and tuberculosis.<sup>30</sup>

Marx provided many of the elements of what is now called an “ecosocial” theory of disease distribution. The commencement of a railway from Lewisham to Tunbridge (now Tonbridge), he explained, had the unintended consequence of spreading a smallpox epidemic to the parish of Seven Oaks around thirty miles from present-day London. Improved transport under capitalist conditions thus could be seen as leading to the more rapid spreading of infectious diseases. Likewise, the gang system of agricultural labor in the countryside relied on migrant laborers consisting in large part of women and children, who were moved from place to place in response to the exigencies of capital, in order to service such construction-related projects as “building and draining works, brick-making, lime-burning, and railway-making.” The result, Marx declared, was “a flying column of pestilence,” carrying “smallpox, typhus, cholera, and scarlet fever

into the places in whose neighborhood it [the migrant work gang] pitches its camp.”<sup>31</sup>

For Marx, all of this of course was related to the metabolic rift generated by capitalism between humanity and nature as a whole—including what can be seen as a corporeal rift (epidemiological rift) in human bodily existence. At all times, it was necessary, he emphasized, to take into account “the cyclical movement of the conditions of human life,” that is, human social metabolism.<sup>32</sup> In the *Seventh Public Health Report*, Hunter had explored the “seigneurial rights” over manure that landed proprietors in Durham exerted over the poor in the region. As Marx, quoting Hunter, explained, “It is curious to observe that the very dung of the hind and bondsman [terms for the agricultural laborers] is the perquisite of the calculating lord...and the lord will allow no privy but his own to exist in the neighborhood, and will rather give a bit of manure here and there for a garden than abate any part of his seigneurial right.”<sup>33</sup> The object of the aristocracy and gentry in imposing these conditions was to capture and monopolize the very manure produced by the laborers, in order to fertilize the fields of the lords’ landed estates.

Similarly, Marx highlighted the wider environmental conditions of miners, who besides working in one of the most dangerous of all occupations, were frequently forced to live on the mine owner’s estate at exorbitant rents charged for decrepit cottages in order simply to be able to work in the mines. Here he quoted Simon’s rather jaundiced view, that “the laborers...have not education enough to know the value of their sanitary rights, [so] that neither obscenest lodging nor foulest drinking water will be appreciable inducements to a ‘strike.’”<sup>34</sup> Capital’s exploitation of miners and their families was in this case directly tied to the expropriation of the very means of life—not only within, but without the mine.

In exploring the epidemiological conditions of workers, Marx paid close attention to their nutritional intake, relying on data from Edward Smith, showing that industrial workers were deficient in both carbohydrates and proteins, as compared with convicts, and in many cases were unable, due to low nutritional intake, to “avert starvation diseases.” Women were generally the most underfed.<sup>35</sup> Working-class women with infant children often had no choice but simply to breastfeed them before they went to work, and then again afterward, with often a period of twelve hours or more in between. As Marx, based on Hunter, recounted, infants, left with elderly “nurses,” were often fed artificial mixtures like Godfrey’s Cordial laced with opium to keep them sedated. For this and other reasons, young children in working-class districts died in huge numbers.<sup>36</sup>

Of no less concern was occupational disease, resulting from extreme forms of exploitation, particularly conditions forced on women in informal work. Marx’s depiction of the condition of overwork and overcrowding in his chapter on “The Working Day” in *Capital* drew on descriptions of the conditions of young women working as seamstresses in mistress houses, published in several London papers in June 1863 based on the *Report of the Medical Officer of Health to the Parish Vestry of St. James* by Edwin Lankester.<sup>37</sup> The 1863 newspaper reports dwelled on the elder Lankester’s account of the death of 20-year-old Mary Ann Walkley, employed in a dressmaking establishment run by Madame Elise, one of London’s better-known millineries. Walkley, along with sixty other young women, had been forced to work twenty-six and a half hours straight without a break, while confined thirty to a room, with only one-third the necessary cubic feet per person to guarantee adequate air intake. For Marx, this was a clear instance of overwork and social and environmental injustice, standing for the conditions in which proletarians in

general were caught, reducing their overall lifespans—if not actually extinguishing their lives in mere hours, as in the case of Walkley.<sup>38</sup>

In considering the epidemiological conditions of the working class, one passage by Simon was so important to Marx that he quoted it in full in both the first and third volumes of *Capital*:

[It is] practically impossible...for the workpeople to insist upon that which in theory is their first sanitary right—the right that, whatever work their employer assembles them to do, shall, so far as depends upon him, be, at his cost, divested of all needlessly unwholesome circumstances.... While workpeople are practically unable to exact that sanitary justice for themselves, they also (notwithstanding the presumed intentions of the law) cannot expect any effectual assistance from the appointed administrators of the Nuisances Removal Acts.... In the interest of myriads of labouring men and women, whose lives are now needlessly afflicted and shortened by the infinite physical suffering which their mere employment engenders, I would venture to express my hope, that universally the sanitary circumstances of labour may, at least so far, be brought within the appropriate provisions of law.<sup>39</sup>

This, along with the other wider issues of the worsening ecological conditions of disease generated by the capital system, required, in Marx's view, nothing less than the revolutionary reconstitution of society at large: not simply for work, but for life as well.

## **“Nature’s Revenges”**

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E. Ray Lankester, the son of Edwin Lankester, was the leading zoologist in England in the generation after Darwin and Huxley. He was an adamant materialist, socialist (of the Fabian type), and environmental critic, who had read Marx's *Capital* and was a frequent guest at Marx's home.<sup>40</sup> Lankester had worked in

Germany with Ernst Haeckel. The first introduction of the word *ecology* or *æcology* (coined by Haeckel in 1866) into English appeared in the 1876 translation of Haeckel's *History of Creation* under Lankester's supervision. Lankester himself coined the term *bionomics*, a category that was commonly used for ecology.<sup>41</sup>

One of the key aspects of Lankester's wide-ranging scientific research was the study of parasitic pathogens. His father had been a founding editor of the *Quarterly Journal of Microscopical Science*, and Ray Lankester subsequently became editor of the publication serving in this capacity for half a century. It was to emerge as a leading British scientific journal dedicated to microbial research. In 1871, Lankester independently rediscovered (its previous discovery in 1843 had gone without notice) *Trypanosoma rotatorum*, the type of spindle or corkscrew-shaped microscopic parasite responsible for various sleeping sicknesses and Chagas disease.<sup>42</sup> In 1882, "it was Lankester who first described a protozoan parasite of the type which was later shown by C. L. A. Laveran to be the causative agent of malaria." The parasite, which Lankester referred to as *Depranidium ranarum*, was renamed *Lankestella* in his honor in 1892.<sup>43</sup>

For Lankester, "apparent 'opposites' are often closely allied in Nature.... The smallest change in the substance administered or the smallest difference in the living substance of an individual...makes all the difference between 'poison' and 'meat.'"<sup>44</sup> Hence, relatively small alterations in ecological conditions resulting from the crossing of critical thresholds due to human-social actions could vastly upend ecological-epidemiological relations, leading to the spread of epidemics. It was this broad dialectical and ecological perspective that was to make his observations on the human role in the spread of



epidemics – beyond the actual pathogenic parasite – unique in his time.

In 1887, Lankester visited the Pasteur Institute in Paris for the first time, becoming a scientific associate of Pasteur's. He also worked closely in later years with Élie Metchnikoff, who succeeded Pasteur as head of the Institute. Lankester was the key figure in organizing the British scientific and political elite to support the Pasteur Institute's research, and in setting the stage for the establishment of the similar Lister Institute in England. As director of the Natural History Museum in London, England's main zoological center, Lankester established major collections of mosquitoes and tsetse flies for research.<sup>45</sup>

With the expansion of colonialism and imperialism in the late nineteenth century, there was an enormous increase in tropical diseases, most notably African sleeping sickness (trypanosomiasis), which devastated populations in Central and East Africa, killing hundreds of thousands. The parasitic pathogen was spread by the tsetse fly. Once the parasite crossed the blood-brain barrier and affected the central nervous system, the patient became lethargic, insane, fell into a coma, and then died.<sup>46</sup> The European powers had partitioned Africa in 1884–85, leading to a massive extension of colonialism and the plundering of the continent. As the British colonized Uganda, an epidemic of sleeping sickness broke out, killing a third of the population in just a few years. Trypanosoma epidemics also broke out in the French Congo, Belgian Congo, and the colonies of Germany and Portugal.<sup>47</sup>

As chair of the Royal Society's Tropical Diseases Committee, as well as in his capacity as director of the British Museum of Natural History, Lankester devoted much of his efforts at the turn of the century to searching out the sources of tropical diseases,

particularly sleeping sickness. Trypanosomes were first discovered in human blood in 1902. Lankester worked closely with the microbiologist David Bruce, who was the first to determine scientifically that sleeping sickness was spread by the tsetse fly, which also passed on the particular variants of the parasitic pathogen affecting humans (*Trypanosoma brucei gambiense* and *Trypanosoma brucei rhodesiense*).<sup>48</sup>

What was most remarkable about Lankester's own work in this area was his ecosocial approach to epidemiology. Bruce had originally discovered the species of protozoan trypanosome (*Trypanosome brucei*) infecting domestic cattle, causing the deadly nagana disease. This trypanosome species had long existed in a benign relation to wild animals, such as buffalo, antelope, and wild cattle. It became deadly only when crossing over into domestic cattle and to humans. Although sleeping sickness had apparently been present to some degree from time immemorial, African populations had established a rough equilibrium between the natural/wild ecosystems and the human/domesticated animals one.<sup>49</sup> Colonialism broke all of this down.

Lankester, writing in "Nature's Revenges: The Sleeping Sickness," included in his *The Kingdom of Man*, concluded that sleeping sickness "crept up the newly opened trade-routes to the Congo basin" created by the colonial powers. "The appalling mortality produced by this disease in Central Africa," he wrote, "naturally caused the greatest anxiety" to the British government, "which had but just completed the railway from the East Coast to the shores of lake Victoria Nyanza."<sup>50</sup>

In writing about "Man and Disease" in *The Kingdom of Man*, Lankester introduced the hypothesis that,

in the extra-human system of Nature there is no disease and there is no conjunction of incompatible forms of life, such as Man has

brought about on the surface of the globe.... It is a remarkable thing—which possibly may be less generally true than our present knowledge seems to suggest—that the adjustment of organisms to their surroundings is so severely complete in Nature apart from Man, that diseases are unknown as constant and normal phenomena under those conditions.... It seems to be a legitimate view that every disease to which animals (and probably plants also) are liable, excepting as a transient and very exceptional occurrence, is due to Man's interference. The diseases of cattle, sheep, pigs, and horses are not known except in domesticated herds and those wild creatures to which Man's domesticated productions have communicated them....

Anything like the epidemic diseases of parasitic origin with which civilised man is unhappily familiar seems to be due either to his own restless and ignorant activity or, in his absence, to great and probably somewhat sudden geological changes—changes of the connections, and therefore communications, of great land areas.... Man has played havoc with himself and all sorts of his fellow beings by mixing up the products of one area with those of another.... In his greedy efforts to produce large quantities of animals and plants convenient for his purpose, and in his eagerness to mass and organise his own race for defence and conquest, man has accumulated natural swarms of one species in field and ranch and unnatural crowds of his own kind in towns and fortresses. Such undiluted masses of one organism serve as a ready field for the propagation of previously rare and unimportant parasites from individual to individual. Human epidemic diseases as well as those of cattle and crops, are largely due to this unguarded action of the unscientific man.<sup>51</sup>

Epidemics in humans (as well as in their domesticated animals and plants) thus resulted from ecological destruction and the vast agglomerations of human species and their domesticated animals, including monocultures and animal feedlots, that created

pathways for pathogens. Such diseases commonly arose from the spillover of pathogens from natural hosts, entering domesticated animals and humans, due to the disruptions caused by human actions.<sup>52</sup> And with biodiversity decreased and, in many cases, eliminated, the spread of diseases occurred much more readily. Moreover, there were definite socioeconomic causes engendering these changes, related to the colonial expansion and globalization of capitalism, and having to do with a system dominated by “markets” and “cosmopolitan dealers in finance.”<sup>53</sup>

As Lankester wrote in “Nature’s Revenges: The Sleeping Sickness”:

We are justified in believing that until man introduced his artificially selected and transported breeds of cattle and horses into Africa there was no nagana disease [trypanosome-infected domestic animals]. The *Trypanosoma Brucei* lived in the blood of the big game in perfect harmony with its host. So, too, it is probable that the sleeping-sickness parasite flourished innocently in a state of adjustment due to tolerance on the part of aboriginal men and animals of West Africa. It was not until the Arab slave raiders, European explorers, and india-rubber thieves stirred up the quiet populations of Central Africa, and mixed by their violence the susceptible with the tolerant races, that the sleeping-sickness parasite became a deadly scourge—a “disharmony” to use the suggestive term introduced by my friend [Élie Metchnikoff].<sup>54</sup>

Lankester went on to insist on the need for the expansion of public health in the tradition of Simon, transcending the capitalist tendency to organize medicine “as a fee-based profession.”<sup>55</sup> Only with coordinated state involvement could the health and security of the human population be secured.

## The Second Sickness

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Despite the dominance of the biomedical model, with its narrow focus on private individual health, a broader conception of socialized medicine, rooted in a holistic understanding of the socioeconomic and physical environment, persisted. Significant contributors to this environmental approach include Du Bois, Hamilton, Bethune, and Allende, each of whom explored how the organization and operations of the political economy contributed both to inequality and the spread of disease. Bethune described this aspect as the “second sickness,” which needed to be recognized as a “social crime,” similar to Engels’s concept of social murder.<sup>56</sup>

In *The Health and Physique of the Negro American* (1906), Du Bois demonstrated how tackling epidemiological concerns involved confronting racial conceptions, especially in regard to biological notions about innate abilities and dispositions. He surveyed the most recent studies in anthropology and various biological sciences, which determined that it was “impossible to draw a color line between black and other races” in regard to “physical characteristics,” so Black people “cannot be set off...as absolutely different.”<sup>57</sup> In particular, he was challenging cranial anthropometry studies, such as those associated with French physician Paul Broca in the mid-to-late 1800s, which measured and weighed human brains in an effort to proclaim distinct evolutionary origins among the world’s peoples. Du Bois highlighted the various problems with these studies, such as the insufficient number of brains from Black people, in comparison to those from whites, and the failure to consider sociodemographic characteristics, such as age, class, occupation, and nutrition.

In order to demonstrate the social causes of disease, Du Bois put forward a series of comparative cases and situations to illuminate

differences in health and sickness. This revealed the weakness of the position that “Negroes are inherently inferior in physique to whites.”<sup>58</sup> He detailed how the death rate of Black people in Philadelphia, though high in relation to whites, was lower than the death rates of whites in many other areas of the country, indicating that other factors were involved than so-called biological race, particularly the social relations of race and class. In order to hammer this home, Du Bois pointed out that at the start of the twentieth century in Russia, where the divide between the aristocracy/bourgeoisie and peasants/proletarians was especially stark, “poverty’s death rate” revealed “a much greater divergence from the rate among the well-to-do than the difference between Negroes and whites of America.” Similar results were present in relation to Britain, Sweden, and Germany, where the death rate for the poor was twice as high as that of the rich, with the “well-to-do” between the two groups. Whites working in the Chicago stockyards had a higher death rate than Black people within the city.

In highlighting these facts, Du Bois was arguing against determinist arguments rooted in biological race. In response, he pointed to interlocking forms of oppressions. High infant mortality, disease, and the wider death rate were reflective of an overall “social condition,” encompassing poor housing, contaminated water, lack of ventilation, inadequate nutrition, air pollution, and dangerous jobs—all of which were linked to inequalities of race (as a cultural category) and class.<sup>59</sup> “Consumption [tuberculosis],” he insisted, “is not a racial disease but a social disease.”<sup>60</sup>

Decades later, in 1947, the leading British biologist and Marxist theorist J. B. S. Haldane wrote that tuberculosis was closely connected to economic factors, primarily real earnings, “with the two curves” for the real earnings of young women in England and

their death rates from tuberculosis “almost identical with one another turned upside down”—a relationship that could be expected to apply to other oppressed groups.<sup>61</sup>

Looking at the fact that Black/white health disparities were in no way fixed, but differed along lines of class and locality, Du Bois provided a definitive refutation of the racial inferiority thesis in relation to Black Americans propounded by eugenicist Frederick Hoffman in his *Race Traits and Tendencies in the American Negro* (1896). Hoffman claimed that health statistics demonstrated that the susceptibility of Black people “to consumption alone would suffice to seal its fate as a race.”<sup>62</sup> To which Du Bois responded:

The undeniable fact is...that in certain diseases the Negroes have a much higher rate than whites, and especially in consumption, pneumonia and infantile diseases.

The question is: Is this racial [in terms of biological race]? Mr. Hoffman would lead us to say yes, and to infer that it means that Negroes are inherently inferior in physique to whites.

But the difference in Philadelphia can be explained on other grounds than upon race. The high death rate of Philadelphia Negroes is yet lower than the whites of Savannah, Charleston, New Orleans and Atlanta.<sup>63</sup>

Du Bois’s trenchant critique of the “mismeasure of man” with respect to the health of the Black population in the United States seemingly had a powerful effect. John William Trask, assistant surgeon general in the U.S. Public Health Service, wrote an article in 1916 for the *American Journal of Public Health* on race and health that was in diametrical opposition to the special issue on “The Health of the Negro” in the same journal the year before, focusing like Du Bois on the role of class and economic factors, and

rejecting an interpretation of health outcomes based on biological race.<sup>64</sup>

In the early twentieth century, physician and (like Kelley) Hull House resident Alice Hamilton provided pathbreaking work investigating what Marx, in the spirit of Ramazzini, had called “industrial pathology,” or occupational and environmental health. At the time, industrial medicine was not well established within the United States. Little data existed. Company doctors and bosses blamed poor health, illnesses, and injuries on individual workers, suggesting that they had weak constitutions and lacked hygiene. Hamilton systematically dismantled these arguments through her extensive investigations of working conditions. She conducted detailed studies of the labor process within countless factories, examining the conditions, chemicals, and materials used in production, the points of exposure, and the ailments experienced by workers.<sup>65</sup>

In 1908, Hamilton noted that the United States was so obsessed with expanding industrial production that it had failed to “take stock of the killed and wounded” within these operations.<sup>66</sup> She made a distinction between trades that are inherently dangerous because they involved poisonous substances and those that are hazardous due to poor working conditions. Both realms demanded special attention, as they contributed in distinct ways to the corporeal rift in human bodies and between populations divided by class, race, and gender.

Through inspecting factories, extensive interviews, and collecting data regarding poisoning, Hamilton documented toxic disorders associated with, but not limited to, mercury, arsenic, phosphorus, aniline dyes, benzene, radium, and lead. She revealed how lead was used widely throughout industry, resulting in lead poisoning among workers, negatively affecting the nervous system. In



women, this exposure was linked to miscarriages. She explained that the symptoms of lead poisoning generally did not manifest until the situation was quite severe. Additionally, exposure could take place on multiple fronts. In factories that used lead salts, workers inhaled this material as it was part of the dust in the air. Thus, it was necessary to account for the temporal aspects and the various pathways of the ecology of disease.<sup>67</sup> Based on her research regarding the dangers of exposure to lead, she warned in 1925 against the use of lead in gasoline, noting that it presented a danger to the public and the environment.

In her investigation of the rubber industry, which was still in its early stages, Hamilton stated: "It has not been easy to secure the information desired, since the nature of the chemicals used in rubber compounding and reclaiming is carefully guarded as a valuable trade secret, while occupational disease among rubber workers often comes to the notice of the company doctor only and he regards it as a duty to his employers to keep such occurrences secret."<sup>68</sup> These trade secrets led to a delay in diagnosing why workers were developing cyanosis, causing their lips to turn blue. Eventually, it was discovered that all these workers handled aniline. She also highlighted a solvent, carbon disulfide, used in rubber manufacturing, which affected the central nervous system. Workers inhaled and absorbed it through their skin. Afflicted people developed extreme headaches, fatigue, depression, and problems walking. Given the exposure to so many different toxic chemicals, Hamilton stressed that hospitals, including asylums, needed to document the occupation of patients in order to determine the potential source of diseases, rather than treating these situations as isolated cases.<sup>69</sup>

Due to the gendered division of labor, women experienced various ailments associated with their specific working conditions. Hamilton noted that, within textile factories, workers

suffered from lung diseases from inhaling particles of cotton and wool. Together with John B. Andrews, she detailed how women working in match factories were suffering from phosphorus necrosis due to exposure to white phosphorus. Hamilton demonstrated that it was the social conditions that concentrated specific illnesses and diseases among the population. Social inequalities, such as those associated with the division of labor in regard to women and immigrants, resulted in different exposures to poisons and hazardous work.

Bethune, a Canadian physician, who served as a surgeon in the Spanish Civil War and later in the Chinese Revolution, argued in 1936, at the Montreal Medico-Chirurgical Society conference, that capitalism “produces ill health” and that its medical system is dominated by “rapacious individualism,” whereby doctors “enrich themselves at the expense of the miseries of our fellow men.”<sup>70</sup> He had managed early on to recover from tuberculosis. When talking with radical doctors who were part of the liberation forces in China in 1939, he declared: “As a doctor I suffered from two very difficult diseases. I was only beginning to make my way as a surgeon when I came down with a bad case of tuberculosis.... My ‘second sickness’...well, that wasn’t so simple.... I came to understand that tuberculosis was not merely a disease but a social crime.... I have learned what must be done to cure this second sickness.”<sup>71</sup>

The majority of the public in a capitalist society, Bethune remarked, received little or no health care each year, simply because they were not able to afford it. Medicine had become a luxury commodity, in which doctors “*are selling bread at the price of jewels.*”<sup>72</sup> People needlessly suffered and died under this arrangement. He declared that private health did not make sense under industrial capitalism. Instead, “all health is public health.”<sup>73</sup> He went on to insist that “socialized medicine” was

necessary, meaning that “health protection becomes public property,” “it is supported by public funds,” the “service is available to all,” the “workers are to be paid by the State,” and there is a “democratic self-government by the health workers themselves.”<sup>74</sup> As part of this transformation, he put forward an understanding of the ecology of disease:

Any scheme to cure this disease which does not consider man as a whole, as the resultant of environmental strain and stress, is bound to fail. Tuberculosis is not merely a disease of the lungs; it is a profound change of the entire body which occurs when man, regarded as an organism acting under the dictation of, and the product of, his environment, fails to circumnavigate or subjugate certain injurious forces acting on his body and mind. Let him persist in continuing in such an environment and he will die. Change these factors, both external and internal, readjust the scene, if not the stage, and he, in the majority of instances, will recover.<sup>75</sup>

Bethune illustrated how environmental changes were already being practiced by the wealthy who had tuberculosis, as they went to sanatoriums to rest, eat nourishing food, and enjoy fresh air. The poor, in contrast, in the current system, died, due to lack of treatment and proper care. With socialized medicine and a socioeconomic system predicated on meeting and servicing human needs, the broader range of socioecological relations could be attended to, as part of eradicating the second sickness: the social murder instituted by capitalist relations of production.

In line with this view, Bethune devoted his life to fighting for such a future. Following his death from blood poisoning in 1939, after operating on a wounded Chinese soldier, Mao Zedong movingly wrote, “Comrade Bethune was a doctor, the art of healing was his profession and he was constantly perfecting his skill,” he embodied a “true communist spirit,” and he demonstrated a

complete “devotion to others.... I am deeply grieved over his death.” He was “a man of...value to the people.”<sup>76</sup>

In 1939, the same year as Bethune’s death in China, Allende wrote his classic epidemiological work, *The Chilean Medico-Social Reality*, while serving as minister of health in the Popular Front government headed by Pedro Aguirre Cerda. Allende explained: “The individual in society is not an abstract entity; one is born, develops, lives, works, reproduces, falls ill, and dies in strict subjection to the surrounding environment, whose different modalities create diverse modes of reaction, in the face of the etiologic agents of disease. The material environment is determined by wages, nutrition, housing, clothing, culture, and additional concrete and historical factors.”<sup>77</sup> Allende, like Du Bois and Bethune, characterized tuberculosis as a “social disease” because of its much greater incidence in working-class populations. He saw diseases such as typhus as manifestations of proletarianization and pauperization. As Howard Waitzkin has written, “Allende’s exposition of social factors in the etiology of infectious diseases antedated many emphases of modern epidemiology. His arguments transcended the search for specific etiologic agents and treatments—the dominant perspective of Western medicine at the time Allende was writing.”<sup>78</sup>

Like Marx, Allende referred to occupational diseases as a “social pathology” promoted by capitalist industrialization. He underscored the deficiencies in Western medicine, which had caused it to ignore almost completely the role of occupational disease, resulting in a dearth of information on the subject.<sup>79</sup>

Allende was particularly concerned with the effects of imperialism in limiting social medicine in Latin America and throughout the third world. He was perhaps the earliest critic of big pharma as representing the domination of health by

monopoly capital and imperialist forces. He highlighted the much higher prices for brand name pharmaceuticals and the misleading commercial propaganda of the leading multinational drug companies. After being elected president of Chile in the Popular Unity government in 1970, he promoted the nationalization of the pharmaceutical industry, which was controlled by foreign internationals, and sought the control of drug prices.<sup>80</sup>

## **Capitalism versus Ecosocialist Epidemiology**

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The death of Allende in 1973, during the Chilean coup launched by Augusto Pinochet and supported by the United States, marked, simultaneously, not only the demise of one of the great socialist experiments, and the launching of neoliberalism by Pinochet's military dictatorship in cooperation with Chicago economists led by Milton Friedman; it also represented the loss in Allende of one of the great figures in social medicine. Nowhere has neoliberalism had more devastating effects than in the destruction of public health and social medicine initiatives throughout the world.<sup>81</sup>

The radical upsurge of the 1970s, however, led to important breakthroughs in social epidemiology, which continued into the '80s and merged in the '90s with ecological perspectives. This served to reinvigorate and expand the dialectical *Airs Waters Places* perspective on humanity's *embodiment* within its larger environment, long promoted by materialist and socialist thinkers. Thus, the dominant capitalist epidemiological perspective of biomedical plus lifestyle factors was increasingly challenged beginning in the 1970s by an approach that emphasized "the ecosocial theory of disease distribution: embodying societal and ecologic context."<sup>82</sup> These years saw the rise of dialectical historical materialism in the work of radical figures, such as Hilary and Steven Rose, engaged in the "science for the people"

movements in the United States and the United Kingdom, incorporating notions of “materialist epidemiology,” “the political economy of health,” and the “social etiology of disease.”<sup>83</sup> Illustrative of these revolutionary new developments, Barbara and John Ehrenreich published *The American Health Empire* in 1970; Vicente Navarro founded the major critical organ in social medicine, *The International Journal of Health Services*, in 1971; Barbara Ehrenreich and Deirdre English completed *Witches, Midwives, and Nurses* in 1973; Lesley Doyal wrote *The Political Economy of Health* in 1979; Waitzkin finished *The Second Sickness* in 1983; Levins and Richard Lewontin issued *The Dialectical Biologist* in 1985; and David Himmelstein and Steffie Woolhandler cofounded Physicians for a National Health Program in 1987 (a year after coediting a special issue of *Monthly Review* on “Science, Technology, and Capitalism”).<sup>84</sup>

In the 1990s, these critical perspectives on medicine, health, and disease merged into the new ecologically oriented approaches, marked especially by Nancy Krieger’s “ecosocial theory of disease distribution,” in which she incorporated “constructs pertaining to political economy, political ecology, ecosystems, spatiotemporal scales and levels, biological pathways of embodiment, and the social production of scientific knowledge” in order to transcend the narrow capital-friendly biomedical model of health and disease.<sup>85</sup> This ecosocial approach is in line with a long history of human ecology, reflected in the work of the historical-materialist biologist Lancelot Hogben in the 1930s, with his holistic emphasis on “the ecological system of man.”<sup>86</sup>

In *Biology Under the Influence* (2007), Lewontin and Levins expressly criticized the extreme reductionism of the human genome project that assumes that disease can be fought with designer genes, without accounting for the “triple helix” represented by the dialectic of gene, organism, and

environment.<sup>87</sup> Similar reductionist fantasies arose with those who believed that antibiotics could cure all bacterial infections, failing to understand that bacteria, as living organisms, evolve and mutate, negating the actions of specific antibiotics. The overuse of antibiotics under capitalism, particularly in large-scale agribusiness feedlots and chicken factories, where antibiotics are used to counter bacterial diseases associated with overcrowding, have resulted in the rapid evolution of antibiotic-resistant bacteria, or “superbugs,” threatening the human population—producing still another instance of what Lankester (after Engels) referred to as “Nature’s Revenges.”<sup>88</sup>

For Levins, writing in “Is Capitalism a Disease?,” the five primary social responses to the modern health crisis require focusing on: (1) ecosystem health, (2) environmental justice, (3) the social determination of health, (4) health care for all, and (5) alternative medicine.<sup>89</sup> To these should be added, where possible, an ecosocial approach to scientific research in medicine. The country that best exemplifies such a social approach to health care is Cuba, where all of these factors are taken into account. Despite being a small, poor country confronted by an economic blockade instituted by the United States, Cuba has emerged as a world leader in biotechnology; for example, it is the only country in Latin America to develop COVID-19 vaccines.<sup>90</sup> This is due to its socialist and ecological approach, which sees health as a basic productive factor, in which total “human capital” counts, rather than being designated simply as an attribute of individuals, mediated by class position. Cuba has thus adopted an entirely different mode of scientific research, which is based on a notion of knowledge as collective, interdisciplinary, concrete, local, and frequently tacit. This, as explained by Agustín Lage Dávila, director of the Center for Molecular Immunology in Havana, goes against the dominant individualistic, reductionistic, nonlocalized,

and extra-environmental approaches characteristic of the dominant capitalist model of scientific inquiry.<sup>91</sup>

With the onset of the COVID-19 pandemic, the importance of historical-materialist epidemiology has become increasingly evident, as in the work of Rob Wallace, author of *Big Farms Make Big Flu* and *Dead Epidemiologists*.<sup>92</sup> For Wallace and the epidemiologists associated with Structural One Health (a more critical, ecosocial variant of the now-dominant One Health approach adopted by the World Health Organization), the key is understanding how the new wave of deadly epidemics is connected not to “absolute geographies,” but to the circuits of capital introduced by neoliberal globalization. This includes the destruction of ecosystems and the agglomeration of vast monocultures of single species, particularly in animal feedlots. All of this encourages the spillover of zoonotic diseases into domesticated animals and humans, transmitted along the circuits of capital, generating what has been called “ecological blowback.” The extension of capitalist commodity chains and the neoliberal demolition of public health systems have increased the speed with which diseases spread globally while making populations – particularly the poor and racially oppressed – more vulnerable.<sup>93</sup>

As explained by Wallace, “capitalism is not just about producing metabolic rifts between our economies and ecologies along the way to profits, destroying our capacity to reproduce as a civilization. It’s also about producing new ecologies that reproduce capital alienating the web of life.”<sup>94</sup> A similar view is advanced by Marxian and Kaleckian economist Riccardo Bellofiore, who has forcefully stated: “The subterranean root” of the current coronavirus crisis, in its manifold economic, epidemiological, and ecological aspects, lies in “the systematic robbery and destruction of what is ‘other’ to capital.... Both ‘external’ nature and human beings as part of nature, in their



dialectical interaction,” are now subject to this system of universal alienation. This has led in the present moment to “a particularly dramatic and explicit instance of losing control of the metabolism between nature and human intervention.”<sup>95</sup>

Today the notion that human beings can be conceived apart from their wider environment has been shown to be one of the most fatal errors in the long history of humanity. The return to a dialectical perspective on humanity and nature, traceable back to the ancient Greeks and the notion of *Airs Waters Places*, and preserved and enhanced over millennia in the work of materialist, socialist, and ecological thinkers, is an existential requirement of living ecologically in the Anthropocene in a world beyond capital.

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## Notes

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1. Frederick Engels, *Socialism: Utopian and Scientific* (New York: International Publishers, 1978), 45.
2. Hippocratic author, *Airs, Waters, and Places*, available at classics.mit.edu. See also *Hippocratic Writings* (London: Penguin, 1950). In the text, we follow Benjamin Farrington, in referring to the title as *Airs Waters Places*. See Benjamin Farrington, *Head and Hand in Ancient Greece* (London: Watts and Co., 1947), 39.
3. Charles E. Rosenberg, “Epilogue: Airs, Waters, Places,” *Bulletin of the History of Medicine* 86 (2012): 661; Nancy Krieger, *Epidemiology and the People’s Health* (Oxford: Oxford University Press, 2011), vii–xi.
4. Farrington, *Head and Hand in Ancient Greece*, 35.
5. Karl Marx, *Capital*, vol. 1 (London: Penguin, 1976), 484–85.
6. Ramazzini quoted in Farrington, *Head and Hand in Ancient Greece*, 38; J. S. Felton, “The Heritage of Bernardino Ramazzini,” *Occupational Medicine* 47, no. 3 (1997): 167–79. For a latter translation, see Bernardino Ramazzini, *Diseases of Workers* (Thunder Bay, Ontario: OH&S Press, 1993), 42.
7. Paul de Kruif, *The Microbe Hunters* (San Diego: Harvest, 1996).
8. Nancy Krieger introduced the specific concept *ecosocial* into the health sciences in 1994 as part of her “ecosocial theory of disease distribution,” giving particular salience to this term. Krieger, *Epidemiology and the People’s Health*, 202–3, 213.
9. Abdel R. Omran, “The Epidemiologic Transition,” *Milbank Quarterly* 49, no. 4, part 1 (1971): 509–38. The notion of an epidemiologic transition of course had a longer history, prior to the actual formulation of the term. See, for example, H. G. Wells, Julian S. Huxley, and G. P. Wells, *The Science of Life* (New York: Literary Guild, 1934), 1089–90.
10. John W. Sanders, Greg S. Fuhrer, Mark D. Jonson, and Mark S. Riddle, “The Epidemiological Transition: The Current Status of Infectious Diseases in the Developed World *versus* the Developing World,” *Science Progress* 9, no. 2 (2008): 1–38; M. H. Wahdan, “The Epidemiological Transition,” *La Revue de Santé de la Méditerranée Orientale* 2, no. 1 (1996): 8–20; Frank M. Snowden, “Emerging and Reemerging Diseases: A Historical Perspective,” *Immunological Review* 225, no. 1 (2008): 9–26.
11. Richard Levins, “Is Capitalism a Disease?,” *Monthly Review* 52, no. 4 (September 2000): 11. Also included as a chapter in Richard Lewontin and Richard Levins, *Biology Under the Influence* (New York: Monthly Review Press, 2007): 297–319.

12. John Bellamy Foster, *The Return of Nature* (New York: Monthly Review Press, 2020), 173–74, 183–84.
13. George Eliot, *Middlemarch* (New York: Signet, 1981), 143–44.
14. Michael E. Rose, “The Doctor in the Industrial Revolution,” *British Journal of Industrial Medicine* 28 (1971): 22–26; Ronald Meek, *Economics, Ideology, and Other Essays* (London: Chapman and Hall, 1967), 34–50.
15. Foster, *The Return of Nature*, 28–29.
16. Edward Smith, *Health and Disease* (London: Walton and Maberly, 1861); Encyclopedia.com, s.v. “Smith, Edward,” accessed April 27, 2021.
17. Karl Marx and Frederick Engels, *Collected Works*, vol. 4 (New York: International Publishers, 1975), 403–6.
18. Marx and Engels, *Collected Works*, vol. 4, 361–62, 389–92.
19. Marx and Engels, *Collected Works*, vol. 4, 394, 407; Foster, *The Return of Nature*, 184, 196.
20. Howard Waitzkin, *The Second Sickness* (New York: Free Press, 1983), 60–63; Foster, *The Return of Nature*, 212–15; Brett Clark and John Bellamy Foster, “Florence Kelley and the Struggle Against the Degradation of Life,” *Organization & Environment* 19, no. 2 (2006): 251–63.
21. Lancelot Hogben, *Science for the Citizen* (New York: Alfred A. Knopf, 1938), 875.
22. Marx, *Capital*, vol. 1, 348–49; Karl Marx, *Capital*, vol. 3 (London: Penguin, 1981), 949. Marx’s observation connecting the guano trade and periodical epidemics as equally representative of the metabolic rift prefigured the analysis of Lancelot Hogben, who ended a chapter on “The Microbe Hunters” in *Science for the Citizen* with a discussion of the guano trade as an example of the disruption of the nitrogen cycle and the implications for agriculture, clearly seeing these disturbances of natural substances as “the follies of a young civilization.” See Hogben, *Science for the Citizen*, 877–79.
23. On the concept of corporeal rift, see John Bellamy Foster and Brett Clark, *The Robbery of Nature* (New York: Monthly Review Press, 2020), 23–32.
24. On John Simon and his influence on Marx and Engels, see Foster, *The Return of Nature*, 199–212.
25. Marx, *Capital*, vol. 1, 812.
26. John Simon, *English Sanitary Institutions* (London: Smith, Elder, Co., 1897), 437–39, 443–45, 455–58, 480–81; Foster, *The Return of Nature*, 199–204, 208, 211–12, 573.
27. Marx, *Capital*, vol. 1, 812–13, 834–35.
28. Henry Julian Hunter, appendix 2 to “Report on the Housing of the Poorer Parts of the Population in Towns,” in *Medical Officer of the Privy Council, Eighth Public Health Report, 1865* (London: Her Majesty’s Government, 1866), 89. Marx and Engels, *Collected Works*, vol. 35, 654; Marx, *Capital*, vol. 1, 814–15.

- The Penguin edition of *Capital* is deficient here as a crucial part of Hunter’s sentence, relating to capital, is missing.
29. Marx, *Capital*, vol. 1, 635–36, 818.
  30. Marx, *Capital*, vol. 1, 818–20.
  31. Marx, *Capital*, vol. 1, 846.
  32. Marx, *Capital*, 1, 723–24.
  33. Marx, *Capital*, vol. 1, 822.
  34. Edward Smith, appendix 6 to *Medical Officer of the Privy Council, Sixth Public Health Report, 1863* (London: Her Majesty’s Government, 1864), 238, 249, 261–62; Karl Marx, *On the First International* (New York: McGraw-Hill, 1973), 5–7; Marx, *Capital*, vol. 1, 834–35; Foster and Clark, *The Robbery of Nature*, 107–8.
  35. Henry Julian Hunter, appendix 14 to “Report on the Excessive Mortality of Infants in Some Districts of England,” in *Sixth Public Health Report, 1863*, 453–59; Marx, *Capital*, vol. 1, 520–22, 835–36; Foster and Clark, *The Robbery of Nature*, 84–85.
  36. A decade earlier, Edwin Lankester, as the medical officer of St. James parish, together with Dr. John Snow and Reverend Henry Whitehead, had famously discovered the source of the 1854 cholera epidemic in London to be the Broad Street water pump in the vicinity, demonstrating that cholera was a water-borne disease—a major discovery leading to the germ theory of disease. See Foster, *The Return of Nature*, 29–31, 37.
  37. Marx, *Capital*, vol. 1, 364–67.
  38. John Simon in *Sixth Public Health Report, 1863*, 29–31; Marx, *Capital*, vol. 1, 594; Marx, *Capital*, vol. 3, 190. This passage from John Simon is full of misquotes in all English-language editions of *Capital*. It appears to have been translated back to English from the German, rather than using the original English. It is quoted here from the original.
  39. Marx and Lankester were close friends in the last few years of the former’s life. Marx was interested in Lankester’s work *Degeneration*, which dealt with parasitism. See E. Ray Lankester, *Degeneration* (London: Macmillan and Co., 1880). Lankester received his copy of *Capital* from Marx directly. See Foster, *The Return of Nature*, 27, 35–40.
  40. For assessments of Lankester’s achievements, see Foster, *The Return of Nature*, 24–72; Joseph Lester, *Ray Lankester and the Making of Modern British Biology* (Oxford: British Society for the History of Science, 1995).
  41. Ray Lankester, “On Undulina, the Type of a New Group of Infusoria,” *Quarterly Journal of Microscopical Science* 11 (1971): 387–89; Lester, *E. Ray Lankester*, 149; E. Ray Lankester, *The Kingdom of Man* (New York: Henry Holt and Co, 1911), 173–74.

42. Ray Lankester, "On Drepanidium Ranarum, the Cell-Parasite of the Frog's Blood and Spleen," *Quarterly Journal of Microscopic Science* XXII (1882): 53–65; Lester, *E. Ray Lankester*, 147–48.
43. Ray Lankester, *Science from an Easy Chair: Second Series* (London: Methuen and Co., 2015), 353.
44. Ray Lankester, preface to Olga Metchnikoff, *Life of Elie Metchnikoff, 1845–1916* (Boston: Houghton Mifflin, 1921), vii–viii; E. Ray Lankester, *The Advancement of Science* (London: Macmillan and Co., 1890), 148, 150, 164–65.
45. Lankester, *The Kingdom of Man*, 161, 166–67; Daniel R. Headrick, "Sleeping Sickness Epidemics and Colonial Responses in East and Central Africa, 1900–1940," *PLOS Neglected Tropical Diseases* 8, no. 4 (2014); Maryinez Lyons, "Sleeping Sickness in the History of the Northeast Congo (Zaire)," *Canadian Journal of African Studies* 19, no. 3 (1985): 627–33; Gerasimos Langousis and Kent L. Hill, "Motility and More: The Flagellum of *Trypanosoma brucei*," *Nature Reviews Microbiology* 12, no. 7 (2014): 505–18.
46. Headrick, "Sleeping Sickness Epidemics."
47. Lankester, *The Kingdom of Man*, 165–66, 175, 189; Lester, *Ray Lankester*, 148–50.
48. Lankester, *The Kingdom of Man*, 145, 165–71; Headrick, "Sleeping Sickness Epidemics."
49. Lankester, *The Kingdom of Man*, 160–61.
50. Lankester, *The Kingdom of Man*, 32–33, 185–87.
51. Lankester, *Science from an Easy Chair*, 343–44.
52. Lankester, *The Kingdom of Man*, 31–33; Lester, *Ray Lankester*, 190.
53. Lankester, *The Kingdom of Man*, 189.
54. Lankester, *The Kingdom of Man*, 191.
55. Norman Bethune quoted in *The Scalpel, The Sword*, by Sydney Gordon and Ted Allan (New York: Monthly Review Press, 1973), 250.
56. E. B. Du Bois, *The Health and Physique of the Negro American* (Atlanta: Atlanta University Press, 1906), 16. See Stephen Jay Gould, *The Mismeasure of Man* (New York: W. W. Norton & Company, 1996) for an important critique of the various biases, both conscious and unconscious, that influenced Broca and others. The parallel between Du Bois's and Gould's critique is quite fascinating.
57. Du Bois, *The Health and Physique of the Negro American*, 24–25, 89.
58. Du Bois, *The Health and Physique of the Negro American*, 89–90; W. E. B. Du Bois, *The Philadelphia Negro* (Philadelphia: Ginn & Co., 1899), 147–63.
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