Paving the Way for Pandemics: Proximate and Remote Causes of COVID-19

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ABSTRACT

This paper investigates how the historians Donald Worster and Dipesh Chakrabarty, independently, employ the concept of remote causes in their assessment of causes of the COVID-19 pandemic. After introducing these two categories within the sphere of the evolutionary theory, we will try to show that both historians argue that evolutionary theory is necessary, but certainly not sufficient, to understand how humans interact with other species, especially animals (wild and domesticated), which is related to the spillover of pathogenic species. They note that the human impulse to control and manipulate natural phenomena for our own benefit is an evolutionary adaptation that has gotten out of control and was one of the fundamental remote causes of the pandemic. We conclude with a call for closer ties between medicine informed by evolutionary theory and the social sciences in an attempt to combine proximate and remote causes and better understand humankind's place in nature, along with the politic e societal risks of utilizing natural resources without taking this into account.

Keywords: COVID-19; evolution; remote cause; worster; chakrabarty; politics.

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> We bemoaned the impersonality of the modern world, but that was a lie, it seemed to him; it had never been impersonal at all. There had always been a massive delicate infrastructure of people, all of them working unnoticed around us, and when people stop going to work, the entire operation grinds to a halt. No one delivers fuel to the gas stations or the airports. Cars are stranded. Airplanes cannot fly. Trucks remain at their points of origin. Food never reaches the cities; grocery stores close. Businesses are locked and then looted. No one comes to work at the power plants or the substations, no one removes allen trees from electrical lines (Emily St. John Mandel, *Station Eleven*).

Desgovernos

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In April 2020, a few short months after the COVID-19 pandemic first emerged, the environmental historian Donald Worster published a text in the online journal *Critical Inquiry* which he speculated about the causes of this global health tragedy (Worster, 2020). The factors he listed as having contributed to the emergence and spread of the disease naturally included the coronavirus SARS-CoV-2, along with human overpopulation, large-scale industrialization of agriculture (agrobusiness), and corporate greed and arrogance in general. All these elements could be considered proximate causes of the pandemic. But surprisingly, Worster also refers to the remote causes of this disaster that transformed deep-rooted habits, resulted in political conflicts, and clearly illuminated the crossroads at which we found ourselves. A few months later, the postcolonial historian Dipesh Chakrabarty raised critical and dangerous questions about the idea that the capitalist system was the only remote cause of COVID-19 (Chakrabarty, 2020). In works prior to the pandemic, Chakrabarty questioned whether this same system was the exclusive remote cause of ongoing phenomena related to global climate change (Chakrabarty, 2009; Silva & Lopes, 2021); his answer was no.

Donald Worster´s academic research covers a wide range of topics related to environmental history, agricultural history, the history of the American West, and global history. He examines how environmental changes influence society and how society shapes the environment. Some of Worster's most well-known works include

Nature's Economy: A *History of Ecological Ideas* (1994), which examines the evolution of ecological ideas and theories throughout history; and *Shrinking the Earth: The Rise and Decline of American Abundance* (2016), wich test the theory, in the context of the United State history, that there are no limits to what can be extracted from and expected of the natural world. His work has helped shape understanding of the complex relationship between society and the environment and has highlighted the importance of addressing environmental issues, including health problems, in a historical and interdisciplinary manner. Dipesh Chakrabarty is a historian and scholar known for his contributions to postcolonial studies and global history. While he is not primarily an environmental historian, he has expressed interest in environmental history and its intersections with broader historical and social issues. In his influential paper "The Climate of History: Four Theses," Chakrabarty explores the relationship between human history and the concept of climate change. He argues that climate change has the potential to transform our understanding of historical narratives and calls for a reconsideration of how we think about the human impact on the environment. Chakrabarty highlights the dimension of the ecological crisis as not just global, but planetary, and includes in his reflections the consequences of human action, particularly political actions, on health (Chakrabarty, 2021).

The ideas of Worster and Chakrabarty, expressed in the texts published in 2020 about COVID-19, reflect a trend in the field, exemplified by the special issue of the journal *Environmental History*, from October 2020, titled *History Reflections: in the Era of* COVID-19 (Alagona et al, 2020). Although none of the authors in this publication refers to the remote causes of the COVID-19, they deal with the interaction between social and biological factors that are necessarily involved in any explanation of the pandemic. Some examples: “Environmental historians often stress the deep connections between humans and other animals. This pandemic offers our field a rare opportunity to highlight these indelible connection” (Alagona, 2020, p. 597); “People soon facilitated evolution in SARS-CoV-2 populations. By behaving like bats and birds - flying and living in dense populations - people quickly spread SARS-CoV-2” (Russell, 2020, p. 659); “They both [Rachel Carson and Aldo Leopold]

recognized the animal side of humans and the co-evolution and vulnerability that we share with the rest of nature, and we should too" (Hou, 2020, p.625).

The present study investigates how Worster e Chakrabarty employ the concept of remote causes in their assessment of causes of the COVID-19 pandemic. Here we discuss remote causes in terms of proximate and remote (ultimate) causation as defined by Ernst Mayr (1961). Both Worster and Chakrabarty explicitly identify the theory of evolution by natural selection as part of a causal explanation for the pandemic, referring to the "ultimate causes" of the pandemic, which for stylistic reasons will be considered "remote causes" in the present text.

The issue of causes of a thing or phenomenon was contemplated by Aristotle, who differentiated four types of causes: formal, material, efficient, and final (Ferrater-Mora, 1994, pp. 423-432; Hladký and Havlíček, 2013). In a classic example: the formal cause of a house is the very *idea* or *form* of the house; the material cause is the *material* of which it is built; the efficient cause is *what made its existence possible*, the agents involved in *processes* that utilized materials and an idea of form to transform these materials into the intended object (in this case, a house). The final cause of a house is the *purpose* for which it is intended. History shows us that the emancipation and progress of science, especially starting in the Renaissance, was the result of a deep dive into the efficient causes of objects and phenomena (Richards, 1998; Waizbort, 2004). How does the solar system work? What forces are involved in keeping the planets in orbit? How does the Earth attract objects? How does blood flow? How can the eye see a rose? All mechanicism (since Descartes) and all empiricism (since the English such as Hume and Lock) have been based on the search for efficient or proximate causes of the apparent mysteries of nature. More often than not, the final causes have been relegated to a kind of metaphysical limbo.

However, the obvious purpose of biological structures and behaviors (eyes to see, hearts to pump blood, long legs to escape predators, wings to fly, fingers to grasp) has drawn attention from naturalists and imposed severe limits on more stringent mechanicisms and physicalisms. During the late eighteenth and early nineteenth century, authors such as Kant, Goethe, and later the ones associated to *Naturphiloshophen*, assumed that some guiding force existed and directed living

matter, for example from the egg to the embryo to the adult individual (Gould, 1977; Lenoir, 1982; Richards, 1992; Zammitto, 2000). Later, the theory of evolution by natural selection found a response by explaining (without reference to any non-natural entities or guiding forces) how structures and behaviors with vital physiological significance arise. To this end, Darwin promoted a combination of efficient/proximate causes with remote/evolutionary causes; in other words, Darwin identified a process, which he called natural selection, that over generations modeled structures and behaviors of complex physiology and beauty which could result in generating new species. The reasoning for this process was based on the small advantages that individual random variations introduce into populations that are live using limited resources: the process would favor individuals for which such variations would result in increased survivorship and ability to reproduce; over time, these variations, however small, would tend to accumulate, and over eons would result in the production of new (evolutionary) adaptations and, especially for Darwin, new species. As we will attempt to demonstrate here, Worster and Chakrabarty also combine causes in a similar manner to explain the COVID-19 pandemic.

Science seeks to explain facts that are not immediately knowable. Explaining a thing or a phenomenon involves seeking its cause or causes. In the twentieth century, majoritarialy, the causal explanation was identified in what is known as the deductive-nomological model (DNM) (Hempel, 1942; Hull, 1974; Popper, 1985; Brandon, 1997; Richards, 1998; Fitzhugh, 2010; Caponi, 2014a). In this sense, an explanation of anything should obey a logical-linguistic structure: a natural law conjugated with a particular observation, called an initial condition, explains what is in question. A scientific law is the description of a supposed rule of nature, like “all swans are white” or “the sun rises all day”, inductively discovered. According to the DNM, for example, if a person wanted to explain the death of a rat, it would not be enough to say that the rat died because it ate a poison. The DNM demands that along with this singular statement (“the rat ate poison”), a nomological proposition must be added, a law (*nomos* means law) that provides an support for the singular proposition referring to the rat consuming a supposedly fatal substance. The proposition “all rat that eats poison dies,” because of its universal character (as expressed by the term “all”), works

in the deductive structure of explanation as a kind of umbrella law: it covers particular propositions, singular statements, and along with them explains the death of the rat. This explanatory structure opens up a range of empirical possibilities for testing the idea that ingesting poison is the cause of death. The framework of testing scientific hypotheses according to this model admits the existence of other propositions and laws that also count as assumptions: previous empirical observations of poisoned rats, treatises on toxicology, etc.

Similarly, the death of a person with an acute respiratory syndrome could be explained by the initial condition, expressed in the singular statement, "this person contracted the coronavirus SARS-CoV-2", conjugated with the law "all person who contracts the coronavirus SARS-CoV-2 dies." Despite the evident empirical falsehood of this inductive generalization, a supposed law, which we know to be mistaken (not all person who is infected by the virus dies), the structure as a whole is deductively valid, and is also testable. Perhaps scientific research on the disease, on viruses and their human and non-human hosts, and on the environmental, social, and political situations that led to the emergence and maintenance of the disease can give us information (in the form of a combination of hypotheses, laws, theories, particular propositions) to build a valid deduction that can explain why some people who contract SARS-CoV-2 dies from COVID-19 and others do not. But in one way or another, any deductive inference will always fall short of providing a good understanding of the death or survival of an infected person during a pandemic in the twenty-first century. In the philosophy of the life sciences, especially when it comes to the process of biological evolution, there are many philosophical and logical discussions (which are often quite technical) about whether there are true laws that govern evolutionary biology phenomena, and about the causal explanation model for this field of knowledge that investigates the organic world, including human behaviors and societies (Hull, 1974; Brandon, 1997; Caponi, 2014a). In addition, there is extensive discussion of models of causal explanation other than the DNM (for reviews see Woodward, 2003; von Wright, 1971; Thagard, 1999; Aguiar, 2008). It is not our objective here to discuss and deepen any models of causal explanation, but to point out how

two authors in the area of History articulate proximate and remote causes to equate the scenario that allowed the emergence of the pandemic.

Explaining and understanding are not synonymous. Explaining is said to be an attribute of the natural sciences and understanding a task of the social sciences: *explaining* phenomena that are alien and external to the human mind (the apparent movement of the stars and planets; the reproduction of animals and plants) and *understanding* the life, the action, and the mind of specific humans in specific societies (Gadamer, 1994; Harrington, 2001; Waizbort, 2004). In order to understand the COVID-19 pandemic in depth, we need to immerse ourselves in the historical, environmental, social, economic, and political motivations that allowed or paved the way for the emergence of this new disease (de Waal 2020, 2021). That is what Worster and Chakrabarty have done, in our view, as we will attempt to demonstrate below. Both go beyond pointing out the most immediate causes of the pandemic to call for the integration of the human species into a more remote history.

PROXIMATE AND REMOTE CAUSES IN EVOLUTIONARY MEDICINE

In biology, proximate or efficient causes are the set of factors mobilized to explain how an organic structure or system works physiologically, at the level of organs (lungs, heart, brain) and systems (respiratory, cardiovascular, neuronal) as well as at the level of cells, molecules, and also genes (Mayr 1961, 1982; Perlman, 2013; Stearns & Medzhitov, 2016; Gluckman et al., 2016). They are closely related to biophysical and biochemical physiological processes. Explanations for proximate causes can contribute to the discovery of flaws and failures of the organismal systems and their components; for example, the aging of the body, the evolution of a genetic disease, or when parasites infect the body with often unforeseen and devastating consequences. Proximate causes are also involved in the search for explanations to the process of embryological development. Some authors argue that proximate causes should also incorporate environmental and ecological phenomena or factors, including social and political decisions, which are related to the phenomenon in question, since they influence the course of certain phenomena such as human diseases (Livi-Bacci, 2003, 2011; Jones, 2003, 2016; Sánchez-Albornoz, 2003; Waizbort,

2019; de Waal, 2020, 2021). Proximate causes characterize the level at which physicians from all training backgrounds usually work. We note here in passing, for future explorations, that what in the human sciences are called social determinants of health (Buss & Pellegrini Filho 2007) can and should be treated as both proximate and remote causes; the latter case, when they are part of institutions or systems of thought with profound social, economic, and environmental impacts, such as agriculture and public health. We will also defend the interpretation that agriculture and social medicine is an adaptation which is both biological (a human capacity that has arisen through evolution) and cultural (a set of knowledge and practices transmitted and improved over several generations).

Biological remote causes relate to historical or evolutionary explanations; they permit understanding how organs, systems, and behaviors as well as the cells, genes, and molecules that comprise organisms originated, evolved, and maintained themselves over generations (Mayr 1961, 1982; Perlman, 2013; Caponi, 2014a, 2014b; Stearns & Medzhitov, 2016; Gluckman et al., 2016). Within the context of evolutionary theory, these structures and behaviors that comprise a living body and carry out evident and vital physiological functions are considered evolutionary adaptations. The human body consists of a potentially uncountable number of evolutionary adaptations (for example: eyes that turn light into nervous impulses, lungs that breathe, nerve cells that transmit impulses, membranes that select what enters and what leaves a cell, the flight response, sexual desire, antibodies that deal with pathogens, bones that keep serve as leverages for the action of muscles), that emerged over intergenerational time through selective pressures on populations composed of numerous individual organisms that varied slightly among themselves. Evolutionary adaptations are the result of natural processes that occur at the level of populations, not individuals. Naturally, human diseases are not adaptations, but many adaptations are involved in infectious diseases; in the case of COVID-19, as in any parasite-host relationship, adaptations are involved in both viral and human populations.[2]

[2] It is important to bear in mind that there is another type of biological adaptation besides evolutionary which can cause confusion due to its similar-sounding name: physiological adaptation, which is the process of adjustments that an individual body makes to its physiology and behavior, most often contrary to that individual`s conscious desire. In fact, this is the most immediate and common meaning of the term “adaptation,” which is widely used by the general public and is erroneously extended to the evolutionary process. A person is said to have adapted to the cold, or eyes adapt to a dark environment, or that an athlete's heart adapted to repeated effort (CAPONI, 2014c). In other words, a physiological adaptation

Evolutionary or Darwinian medicine is a field of science that attempts to consider the relationships between proximate and remote causes when dealing with human disease. The evolutionary biologist George Williams and psychiatrist Randolph Nesse are considered to have founded this field. In 1991, they published a paper entitled "The Dawn of Darwinian Medicine" (Williams & Nesse, 1991), which they began with an example of an adaptive characteristic, the seven cervical vertebrae in the human neck, and questioned whether traditional medicine could explain this number. Initially, the answer was yes: seven vertebrae resulted from a series of ontogenetic events of a material nature that are well understood by the sciences which rely on proximate causes (such as physiology, embryology, and genetics). But to them, this explanation was incomplete. They argued:

> A complete explanation of how seven cervical vertebrae are normally produced by a human zygote leaves untouched the question of why that zygote's DNA should be so programmed. Why is it not organized to produce six or eight cervical vertebrae? And why should the zygote be capable of producing a functionally adequate neck at all? These last two questions find their answers in the Darwinian concepts of phylogeny and natural selection, respectively. Such answers are not alternatives to the answers from physiology and embryology, they are answers to different kinds of questions. (Williams & Nesse, 1991, p. 2).

Remote causes *and* proximate causes should be invoked to explain the constitution and number of cervical vertebrae. From this reflection, Williams and Nesse presented their perspective of the theory of evolution by natural selection that could be integrated into medicine, applying it to four categories of disease: 1) toxins; 2) genetic factors; 3) mismatches between the human body and the modern (Western) environment; and 4) parasitic infections (Williams & Nesse, 1991, pp. 1-2; Waizbort & Porto, 2018). They called attention to the importance of the vulnerability of our bodies' evolutionary adaptations that are involved in processes that could result in disease. Williams and Nesse also noted health problems resulting from the mismatch between the evolutionary environment, that shaped our physiological phenotype (in the savannas), and where we currently live, in an environment profoundly modified by the advent of work and of spoken and written language (Martins, 2017), which can lead to

means exercising the capacity to adjust a structure or behavior, a capacity that emerged via evolutionary adaptation (in other words, due to by natural selection). Evolutionary adaptations can create physiological adaptations: for example, eyes that can adjust to bright light, or skin, underlying tissue cells, and brains that can adjust to temperature, altitude, pressure, heat, humidity, or loud noises, all within certain limits that can range widely.

ailments such as, for example, obesity, asthma, and back problems. Three years later the same authors published *Why We Get Sick*, a medical nonfiction book in which they expanded examples of applying evolutionary theory to many other human diseases as well as psychological illnesses. In the 1991 article as well as the 1994 book, they noted that the epidemiologist Paul Ewald alerted them to the importance of combining proximate and remote causes to understand and perhaps explain certain diseases (Williams & Nesse, 1991; Nesse & Williams, 1996; Waizbort & Porto, 2018).

From 1980 to roughly 2000, Paul Ewald produced a relatively extensive body of epidemiological literature that contradicted certain established ideas, for example the notion that any parasitic relationship always evolves to commensal or even symbiotic interactions (for example, Ewald, 1980, 1991a, 1991b; for a revision see Waizbort & Porto, 2018). Ewald's publications do not summarize the entire scope of evolutionary medicine, but offer an idea of the contributions evolutionary theory can make to problems affecting public health. In 1994 Paul Ewald published *Evolution of Infectious Diseases*, in which he summarized his work over the previous decade on the evolution of infectious agents, especially those transmitted by natural or cultural vectors, developing the hypothesis that parasites could be tamed (Ewald, 1994). Later, other authors focused on human and non-human diseases using the structure of the theory of evolution by natural selection, including textbooks (Perlman, 2013; Stearns & Medzhitov, 2016; Gluckman et al., 2016). Measles, smallpox, cholera, malaria, various types of cancer, obesity, diabetes, asthma, allergies, cardiovascular diseases, and mental illnesses such as schizophrenia and autism are among the many human diseases associated with evolutionary interpretations. In 2012, Joe Alcock called evolutionary medicine a “new scientific discipline” (Alcock, 2012), based on the extensive literature.

Williams died in 2010. Starting in the early 2000s, Ewald turned to the study of cancer from an evolutionary viewpoint. He recently participated in a publication on the relationships between human microbiota and health inequities; this paper discusses the role of the human gut microbiome in infectious diseases, including considerations about COVID-19 (Amato et al., 2021). Nesse continues to work on psychiatric and psychological problems from an evolutionary viewpoint; his research

is a reference for understanding the mental and behavioral impacts of the pandemic (Launer, 2020; Raabe, 2021).

Several approaches regarding COVID-19 have been based on the concepts of evolutionary medicine (Cepon-Robins & Gildner, 2020; Crespi, 2020; Seitz et al., 2020; Wrotek et al., 2021; Alcock & Master, 2021). We selected one example, departing from a question: "What leads/led to the most alarming cases of COVID-19, in which many people experienced more severe symptoms and often died?" Several authors point out that the most devastating effects of COVID-19 do not arise precisely from how the virus acts on human respiratory cells, but rather from a *mismatch*, a misalignment in the human immune response to coronaviruses. More than the specific cellular damage caused by the virus itself, in severe cases the human immune system is thought to respond disproportionately to the risk it faces (Alcock & Master, 2021; Gao et al., 2020). It so happens that the immunological response to coronaviruses in bats is not the same as in humans. According to Crespi (2020), cell mechanisms in bats mobilize inflammation to a much lesser degree as a defense against coronaviruses than in other non-flying mammals. The efficacy of chiropteran immunological defenses is based on interferon systems; this protein produced by leukocytes and fibroblasts interferes with the replication of fungi, viruses, bacteria, and tumor cells and stimulates defense activity in other cells. Meanwhile, once SARS-CoV-2 is in the human body it specifically targets our interferon system, leading to substantial asymptomatic and pre-symptomatic transmission. Crespi points out that specific results of such mismatches are idiosyncratic and cannot be foreseen and depend on two events: the viruses escaped the specialized and developed defenses of their natural bat hosts, and face a landscape of divergent cellular and molecular human hosts (compared to bats). In this sense, bat viruses in human bodies represent a "double" mismatch in terms of evolutionary medicine, with both species subjected to new environments to which they are not adapted (Crespi, 2020).

REMOTE CAUSES OF COVID-19: WORSTER AND CHAKRABARTY

Donald Worster's text, which was the catalyst for this present work, is part of a virtual exhibition entitled “Another Silent Spring”, which he has maintained active on the *Internet* since April 2020. In this work Worster combines photographs of the natural and sociocultural world with a cutting interpretation of the causes of the COVID-19 pandemic. The title of the exhibition/narrative is a reference to the biologist Rachel Carson's 1962 book *Silent Spring*, in which she documented and discussed the drastic environmental effects caused by the indiscriminate use of pesticides and foresaw a dark future for humanity (Carson, 1962). The silence in the title referred to an imaginary landscape treated with DDT and other defensive chemicals, resulting in a brutal elimination of animals and plants and a muting of nature's orchestra. Worster notes that the silence caused by COVID-19 in some of the world’s largest cities during the early months of 2020 was the result of harsh social isolation policies that took millions of people, cars, and other urban machines off the streets of major cities, and ironically led to the appearance of animals within these cities that only a few months prior had been absent from urban life.

Worster uses the word "cause" or "causes" eight times. He does not qualify or describe this concept when, for example, he mentions the cause of the pandemic in contrast to the cause of the silent spring Carson imagined: “This time the cause is not a biocide but a dangerous virus that has jumped from lower animals, where it first evolved, all the way up to humans.” (Worster, 2020, p. 4). This spillover from non-human animals to humans involves events of historic dimensions, without which it would be difficult to imagine that a person in Brazil or in USA, for instance, would be infected by a pathogen supposedly harbored by bat populations in a faraway region of China that have lived almost harmlessly alongside coronaviruses since the dawn of time (Crespi, 2020). Among these events, Worster highlights the advent of agriculture and its extraordinary progress as a fundamental proximate cause:

> Even today agriculture is the biggest single cause of declining biodiversity and species extinction on the planet, turning old, relatively harmless viruses that had been generalists into deadly specialists that live on a narrowing biotic spectrum. Eventually, those specialists find their best sources of survival, not only in the barnyard, but also among our own kind. COVID-19 is spreading and

> attaching itself to us simply because there are so many of us. (Worster, 2020, p. 14).

We are many. Global overpopulation, which is expected to reach 11 billion people by the year 2100 (Rohr et al., 2019), has been fueled by fabulous developments in the ways that humans throughout history have obtained nutrients from plant and animal species, sometimes with the unsuspected aid of microorganisms (some of the best-known examples include bread, cheese, yogurt, wine, and beer). But to Worster, besides the immense improvements associated with agriculture, it should also be considered a proximate cause of the pandemic: it is the main cause of reduced biodiversity and species extinction today, resulting in a simplification of ecosystems that can favor opportunistic organisms such as coronaviruses. But agriculture should also be seen as a remote cause, an exogenous evolutionary adaptation (external to our body, as hives are external to bees, webs are to spiders, dykes are to beavers, as fishing for termites is to chimpanzees) which first appeared in the historical record approximately ten thousand years ago. By appropriating these causes used in biology and evolutionary medicine to deal with a human and social phenomenon, we interpret agriculture as a cluster of knowledge and practices transmitted from generation to generation that allow human populations to *control* and *manipulate* germination, growth, harvest, and, increasingly, the distribution of food, which previously was only collected or hunted from the surrounding environment when luck permitted. It was a system of ideas that favored the populations who adopted it. It is clear, however, that this capacity did not remain as it first emerged; it changed considerably, incorporating new knowledge and practices, generating production surpluses, paving the way to agglomerate large numbers of people and animals in villages and then cities and megacities, not without great benefits and extraordinary costs (both socially stratified).

Agriculture was not the only factor that contributed to our current situation, of course. We must remember the consumer goods industry and its trade around the world throughout the ages. But there may be nothing more vital than eating to stay alive, and to a great extent it is the unbridled exploitation of this need which is involved in this case. This is particularly true because this capacity for production and consumption was utilized without considering environmental consequences,

including the solid, liquid, and gaseous wastes resulting from these endeavors as well as the depletion of resources like soil and water.

Naturally, Worster is not the first author to name agriculture (especially on a global scale) as one of the causes of infectious disease. Within the scope of environmental history, Edmund Russell indicated methods of domesticating plants and animals (which became increasingly mechanized over time, especially after the industrial revolution) as a human force capable of profoundly changing the way individual humans interact with their surrounding environments, and the implications with pathogens derived from non-human wild and domesticated animals (Russell, 2003, 2011). Authors such as Alfred Crosby (1976) and Jared Diamond (1999) stressed the importance of agriculture as a cause of epidemic diseases. They considered agriculture and the domestication of animals to be the source of pathogens like the smallpox and measles viruses responsible for the widespread annihilation of American Indian populations during the century following Columbus's arrival in the Americas. Many tens of millions of people are thought to have died from illnesses caused by the immunologically unfamiliar microorganisms brought along by the Europeans during the period known as the Spanish Conquest. The Europeans, who transmitted the pathogens without being affected by them, were considered to have developed this immune resistance after generations of contact between men and women in the Old World and microorganisms from large domestic animals like cattle, pigs, and horses that were not present in the Americas prior to Columbus's arrival. In the 1970s, this idea was independently dubbed the "virgin soil epidemic" by Crosby (1976) and by William MacNeill (1976). Especially when the COVID-19 pandemic began and throughout 2020, humankind was so vulnerable partly because human populations who never came into contact with SARS-C0V-2 before lacked immunity: we also experienced a virgin soil epidemic.

Note that appealing to an immunological cause supported by geographical circumstances (which is the case of the epidemics that killed tens of millions of Amerindians during the 1500s) essentially means favoring the remote genetic, geographical, and biological causes that led to the tragic fate of original inhabitants of the Americas. But since the mid-1980s various historians, demographers, and

physicians have challenged the virgin soil hypothesis, arguing that other and especially proximate causes must be involved to favor disease lethality at the population level (Livi-Bacci, 2003; Sánchez-Albornoz, 2003; Jones, 2003, 2016; Waizbort, 2019). Notable among these proximate causes are the means by which the Spanish conquered the region - abducting the native labor force, enslaving people of all genders and ages, violating Amerindian women along with the reproductive capacity of the populations to which they belonged, eroding institutions and traditions, and finally undermining the minds and souls of the Amerindians who happened to survive. These factors, together with the immunologically novel microorganisms from the Spanish, would have paved the road for the devastation of the epidemics that followed. Livi-Bacci and Jones stressed that the *way* we interpret the power of diseases in the past has a major influence on how we see certain diseases today, and for this reason scholars of diseases in other ages and regions must maintain an ethical responsibility and political sensitivity to carefully weigh the factors that are at stake (Livi-Bacci, 2003; Jones, 2016; Waizbort, 2019). Something similar is seen in the current pandemic: assuming that SARS-CoV-2 is the main factor that caused the pandemic or assuming that the outcome of each case in each patient depends solely on each human individual's biological and immunological systems ignores precisely the combination of proximate and remote causes that these authors covertly propose as the solution to understanding the population collapse in the Americas during the sixteenth century. There, as now, social iniquities favored the parasites (Kessler & Aunger, 2022).

But in our view, Worster's references to the causes of COVID-19 would not have captured so much attention if he had not involved the remote causes of the pandemic. He makes it clear that without recognizing and eventually outlining the remote causes, the human species will have trouble deciphering the enigma that has infected more than 400 million people at this time and robbed the lives of over seven million people so far.[3] Worster's first reference to the remote, ultimate cause appears

[3] This number, naturally and unfortunately, is very dynamic, and during the process of writing this text has been adjusted several times. For more up-to-date statistics I suggest https://covid19.who.int/

in the singular, as an analogy between COVID-19 and the issue addressed by Rachel Carson in *Silent Spring*:

> By driving agricultural production to new heights, consumers threatened their own health as well as the health of the planet. (...) The ultimate cause, therefore, was not simply a concentration of economic and technological power; it was a deeper and broader cultural drive to conquer nature. While it was true that some powerful agribusiness companies had led the creation of new agricultural chemicals, showing "no humility before the vast forces with which they tamper," ordinary people bore some responsibility too. Millions of people had gladly bought and used those chemicals or otherwise supported their use. The domination of nature was what they commonly sought, and chaos was what they got. (Worster, 2020, p.6).

Note that in biological and evolutionary terms, admitting that a "cultural drive" is one of the remote causes of a disease means that such a capacity to control, direct, and manipulate natural processes can be considered an evolutionary adaptation. That the advent of agriculture has provided advantages to those who adopted it seems to be a truism that does not merit discussion. But continuous development of an adaptive capacity may not be adaptive. And even if we accept that our ability to dominate nature is an evolutionary adaptation, that does not in any way mean that we are doomed to repeat this impulse. Biology is not destiny. The history of Western medicine and other forms of intervention that are no less traditional where they arose shows just that: these practices looked for ways to help people and populations resist or fight diseases and other problems arising from the relationship between human populations and the environment, in other words, to circumvent or correct limitations or flaws in our evolutionary adaptations. What nature gives us, biologically speaking, is something that can be intervened upon, although unfortunately this is not always successful.

Worster highlights the importance of all of us, consumers, producers, and distributors, middlemen, processors, politicians, traders, and salaried workers, in this chain involving viruses and agriculture as well as wild and domestic animals and plants, in the case of Carson's silent spring as well as now. Our standard of living is also a cause of the pandemic. The interaction between human individuals and individuals of other species often passes through utilitarian and economic filters. We like to eat, and eat well, and diversify our diet to almost always include chunks of meat from non-human animals. We like to consume other goods, without thinking about

the consequences of mass consumption or waste disposal. To do so, we maintain obscene markets for production, processing, transport, and communication. Without mincing words, the problem arises from globalized capitalist massification, from the mechanized and computerized production of consumer goods, and from these goods we highlight the food industry in general as an extension of agriculture. As we know, the transport of merchandise (including food) and people offers opportunities for pathogen populations to reach different parts of the world within a matter of hours.

However, there is an important difference between considering capitalism and its forms of material mobility as the fundamental cause of the pandemic and understanding capitalism as one of the phases in the history of life on planet Earth. As we have seen, in relation to Carson's silent spring, Worster himself states that the remote cause was not only a concentration of economic and technological power. Meanwhile, the post-colonial historian Dipesh Chakrabarty attracted significant progressive criticism from the left when he indicated historical factors more remote than capitalism to explain the climate changes that are irreversibly threatening the planet and human lives (Chakrabarty, 2009; Silva & Lopes, 2021). In 2020 he applied this reasoning to a discussion of the causes of COVID-19, as is evident in the first paragraph of his essay "An era of pandemics? What is global and what is planetary about COVID-19," which was published in October in the online journal *Critical Inquiry*:

> The current moment of the COVID-19 pandemic belongs not only to the global history of capitalism and its destructive impact on human life, but it also represents a moment in the history of biological life on this planet when humans are acting as the amplifiers of a virus whose host reservoir may have been some bats in China for millions of years (...).Our history in recent decades has been that of the Great Acceleration and expansion of the global economy in the emancipatory hope that this will pull millions of humans out of poverty. Or at least that has been the moral justification behind the rapid economic growth in certain nations in Asia, Africa, and Latin America. From the point of view of the virus, however, the environmental disturbance this has caused and the fact of human global mobility have been welcome developments. Humans may win their battle against the virus––I really hope they do––but the virus has already won the war. This is no doubt an episode in the Darwinian history of life. And the changes it causes will be moments both in our global history and in the planetary history of biological life (Chakrabarty, 2020, p.1).

To Chakrabarty, especially since 1950 the advent of capitalism has resulted in a "Great Acceleration:" fast-growing human populations, a significant increase in the

pace of industrial production, widespread use of agricultural chemicals, and other human activities that even leave their mark on the geological record (Subramanian, 2019). This Great Acceleration has placed us in a new geological era known as Anthropocene (Crutzen & Stoermer, 2000; Steffen, 2021; Silva & Lopes, 2021). The COVID-19 pandemic may be the first global manifestation of the evolutionary and geological character of anthropogenic activities, with almost immediate consequences for the lives of human populations.

Such ideas dovetail with the understanding we obtained from Worster: the human impulse for production and consumption is an adaptation that has gotten out of control, a kind of mismatch or maladjustment in terms of evolutionary medicine. This brings us to Worster's second reference to the remote causes of the pandemic:

> Yet most of us remain uneducated in the science needed to understand epidemic history: the Darwinian earth. Yet even now, ignorance, or cultural resistance, characterizes many citizens, including some university professors, corporate executives, and even experts in public health. They simply haven't learned to think about disease in Darwinian terms, and thus they are doomed to repeat the ultimate causes of all the dying that keeps happening (WORSTER, 2020, pp. 16-17).

Thinking about disease in Darwinian terms is necessary, but in our opinion not sufficient, to avoid repeating the remote causes of deaths. We maintain these causes include our drive to control and manipulate nature without considering the undesirable consequences of these actions, as if the human species were immune to its own devices and to what happens to the other species of living beings that are part of the surrounding environment. As Chakrabarty points out, "these infectious diseases remind us of the deep evolutionary connections that exist between our bodies and other bodily forms of life" (Chakrabarty, 2020, p.4). Among these connections, Chakrabarty emphasizes our relationship with microorganisms throughout human history, stressing the need for the human species to understand itself as part of a planetary system that transcends as well as prescinds us. He also notes that this awareness should be incorporated in some way into our political and economic systems.

REMOTE CAUSES AND OLD POLITICS

The pathogen-host relationship is one of the touchstones of evolutionary medicine. Backed by rigorous scientific literature, Paul Ewald denied that this interaction always leads to commensalism or symbiosis. Many articles and textbooks on evolutionary medicine concur that the structure of evolutionary theory must be used to better understand and explain the relationship between human and microorganism populations (Perlman, 2013; Stearns & Medzhitov, 2016; Gluckman et al., 2016). In all these approaches, the short replication period of bacteria, viruses, and other microorganisms is highlighted compared to human generational time, and that this rapid reproduction allows the frequent emergence of variations which can become more transmissible and competitive, threatening not only other variants such as our natural or acquired immunity and even vaccine schemes. The issue, however, is even more complex: not all microorganisms, including viruses, are pathogenic. Many of them, again including viruses, live in our bodies, especially in our gastrointestinal tract, and carry out important functions in human homeostasis (Ley et al., 2006). Additionally, depending on a person or animal's internal ecology, non-pathogenic microorganisms may become pathogenic and vice versa (Alizon et al., 2009; Keen, 2012; Waizbort & Porto, 2018).

In 2020 and later in 2021, the political scientist Alex de Waal reciprocally published an article and a book combining sociopolitical and bio-evolutionary factors in various epidemics and pandemics throughout history, including COVID-19. Based on ideas from the anthropologist physician Rudolph Virchow, de Waal maintains that there is an “indissoluble connection between medical science, economic interest, and political ideology;” in his words, “medicine is a social science, and politics is nothing but medicine at scale” (de Waal, 2020, p. 19). Furthermore, medical science and political bodies should be critically informed by the theory of evolution by natural selection. Although the texts do not systematically use the theory of evolution in their general structure, de Waal's references to Paul Ewald on the significant virulence of the Spanish flu in the 1918–1919 pandemic shows the importance of this theory for equating epidemics and pandemic diseases:

> Medical officers at the time pointed to the ways in which the war and the mobilization for war, notably transatlantic troop transports and supply ships, facilitated the faster and wider spread of the virus. The theorist of viral evolution Paul Ewald makes a stronger case that it wasn't just coincidence that the deadly strain of influenza emerged at this time: 'The possible effects of war on the evolution of pathogen characteristics have been overlooked.' Specifically, the Western Front was an ecology in which the virus no longer faced a trade-off between transmissibility and virulence. Ewald argues as follows. Most infectious pathogens are transmitted when the host is mobile. A person who has mild symptoms and is moving around will infect more people than someone who is immobile with severe symptoms. This is the rationale for mobility restrictions to contain infections like influenza that spread easily. It's also why diseases that are most infectious in the period before they produce symptoms are most likely to spread (de Waal, 2021, p. 104).

Such ideas are clearly contained in Paul Ewald's book *Evolution of Infectious Disease* (1994), and also in several of his scientific papers. de Waal mobilizes evolutionary arguments, integrating them with political and social reasons to understand how pandemic diseases have affected human populations throughout history. We see that in the COVID-19 pandemic, the fact that we live in large populations that agglomerate in means of transport (among other public spaces) and that symptoms manifest days *after* the infected person can spread the virus should lead to greater virulence, if we follow Ewald's thinking and no preventive measures are taken. But isolation, social distancing, and masking reduce the circulation of the virus and consequently can retain the emergence of new, possibly more transmissible and virulent variants. Mass vaccination also threatens the virulence of viral populations by decreasing the number of probable infections and new transmissions. However, as long as viruses continue to circulate new variants will tend to appear, and people with immune deficiencies and those who refuse vaccines are at risk of encountering variants that may be more or less aggressive. The relation between viral transmission and human behavior is further highlighted by de Waal in the following passage:

> A generation of microbiologists have been warning us that if we want to keep our current way of life, we must constantly stay ahead of pathogens' evolution. Evolutionary biologists call this the 'Red Queen' dynamic, after the character in *Alice through the Looking Glass* who tells Alice she must run as fast as she can to stay in the same place. The microbiology of the Anthropocene suggests this metaphor is underpowered: we must accelerate as fast as we can to keep up with the quickening pace of microbial mutation and zoonotic spillover. Sustaining our hyperdominance requires an ever more elaborate engineering of the planetary environment, from climate to viruses. If we see our other lifeforms as either our possessions or our enemies, we have set ourselves on waging a war, which evolutionary logic tells us we cannot win. Such a historical

> ecological paradigm was once a minority view among infectious disease specialists. No longer. The concept of 'One Health' is gaining acceptance. This is the notion that the health of the planet, animal life, and human beings are interlinked. We need to understand the intersecting dynamics of pathogens, the environment, veterinary health, public health, and human livelihoods, and act in a joined-up way, fast (de Waal, 2021, p. 259).

de Waal's paper and book criticize the "war against pathogens" metaphor as an anthropocentric way of interpreting our relationship with other species of living beings like bacteria and viruses. In his opinion, assuming that the species that cause us harm are enemies in a war prevents us from understanding our own responsibility as citizens when infectious diseases emerge and persist. A new policy must incorporate a new metaphor to express a different way of seeing ourselves in relation to other species. The reference to the Red Queen hypothesis leaves no doubt that many political scientists understand just how profoundly human life is immersed in the process of biological evolution. But political decision-makers do not yet seem ready to consider that our controlling and exploitative nature is leading us to tragedies such as COVID-19.

Conclusion

The proximate causes of phenomena affecting human lives are complex and numerous, as are remote causes, which in turn are often buried in layers of time that are difficult to recover. Throughout this work we argue that agriculture (understood as an adaptation to dominate, control, and manipulate natural resources) is one of the remote as well as proximate causes of the COVID-19 pandemic, an impulse that has gotten out of hand. Indicating this supposed remote cause does not eliminate other supposed causes, whether remote or immediate. But it seems trivial that human superpopulation was facilitated by the ability to feed an ever-growing number of people, alongside increasing numbers of poor people who are on the fringes of the industrialized food production chain. Worster, Chakrabarty, and de Waal point to the theory of evolution as unavoidable knowledge in the search for a healthier and truly democratic society. How much longer will we deny our condition as biological animals and products of evolutionary processes that need other animals and other living beings, in the name of a political belief that economically profits off our desire to

consume natural resources modified by human companies? As de Waal points out, if we wish to be sincere with our children and grandchildren we need to be informed critics of scientific legacies to make decisions (especially in public health) that do not pave the way to and sustain causes that can lead to millions and millions of deaths.

In many cases, the theory of evolution was and is still considered by the general public to be an expression of the capitalist spirit of competition. Published in the Victorian era, it seemed primarily to convey competitive values, with the mechanism of natural selection leading to the improvement of species and especially humans at the expense of lesser individuals and populations. But this characterization of the theory is a bad caricature at best. We dream with an attempt to reconcile the theory of evolution with progressive and humanitarian ideals (Singer, 2000). This call for us to incorporate evolutionary theory into our worldview is not a mere academic question for the authors we have dialogued with here in this article. Instead, it is a reflection that must be incorporated into our public and political life, or else some day in a not-too-distant future we will have an even sadder microbiological story to tell.

Ethical Approval

This article does not contain any studies with human participants performed by any of the authors.

Informed Consent Statements

This article does not contain any studies with human participants performed by any of the authors.

Competing Interests

The author declares no competing interests.

Data availability

Data sharing is not applicable to this research as no data were generated or analysed.

ACKNOWLEDGEMENTS

The author would like to thank doctors Dominchi Miranda de Sá, Maurício Luz, and André Filipe C. da Silva for reading and criticizing versions of the manuscript, as well as the reviewers of the work, who contributed to its improvement.

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Pavimentos de la Pandemia: Causas Próximas y Remotas del COVID-19

RESUMEN

Este artículo investiga cómo los historiadores Donald Worster y Dipesh Chakrabarty, de forma independiente, emplean el concepto de causas remotas en su evaluación de las causas de la pandemia de COVID-19. Luego de introducir estas dos categorías em el ámbito de la teoria evolutiva, intentaremos mostrar que ambos historiadores sostienen que la teoría evolutiva es necesaria, pero ciertamente no suficiente, para comprender cómo los humanos interactúan con otras especies, especialmente animales (salvajes y domesticados), que estan relacionado con el desbordamiento de especies patógenas. Señalan que el impulso humano de controlar y manipular los fenómenos naturales para nuestro propio beneficio es una adaptación evolutiva que se ha descontrolado y fue una de las causas remotas fundamentales de la pandemia. Concluimos con un llamado a estrechar lazos entre la medicina informada por la teoría de la evolución y las ciencias sociales en un intento de combinar causas próximas y remotas y comprender mejor el lugar de la humanidad en la naturaleza, junto con los riesgos políticos y sociales de utilizar los recursos naturales sin tener esto en consideración.

Palabras clave: COVID-19; evolución, causa remota, worster; chakrabarty; política.

Recibido: 14/02/2023
Aprovado: 16/05/2023