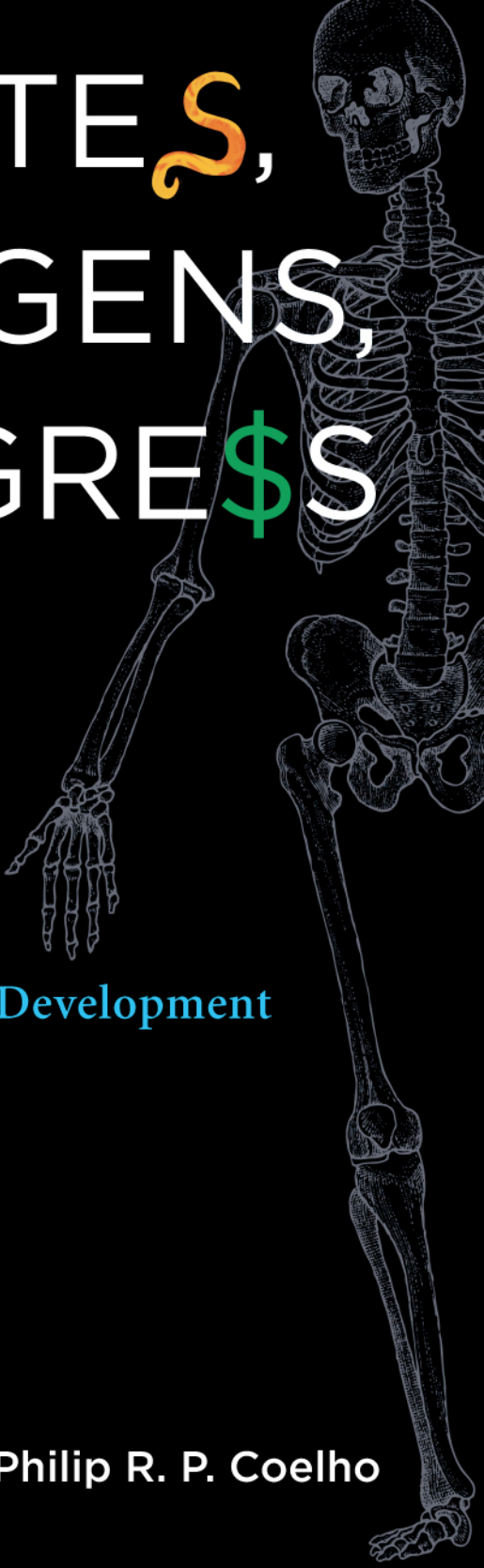
PARASITES, PATHOGENS, and PROGRE$S



Diseases and Economic Development

Robert A. McGuire and Philip R. P. Coelho

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The idea in this book that the interactions between natural and human forces affect both human history and the physical environment is long in the making. The genesis is a casual luncheon comment made by Gordon Tullock in 1984 that hookworm in the American South and the Rockefeller Sanitary Commission's attempts to eradicate it warranted an economic examination. This stimulated Coelho to author an unpublished paper on the relationship between biology and economic growth in 1985. A long collaboration between the two of us began in 1986, a collaboration that has resulted in the publication of several papers on the connections among biology, parasitic diseases, and American economic development. Still the material contained herein is original to this book with the exception of what appears in two chapters. Chapter 5 on the biological consequences of economic choices in British North America is a significantly revised version of an article of ours that appeared in the *Journal of Economic History* (March 1997). Chapter 6 on the disease environment in the antebellum South is based on another article of ours that appeared in the *Journal of Bioeconomics* (1999). The chapter, though, contains substantial new material on diseases and the antebellum South as well as significant revisions of the content of the original article. Some of the findings reported in chapter 6 also are contained in two other articles of ours that have appeared in the *Journal of Economic History* (March 2000) and *Social History of Medicine* (December 2006).

Over the years, various parts of the book have been presented at many conferences, seminars, and workshops, including the Citadel Conference on the South; Pre-Conference of the XII World Economic History Congress; Third World Congress of the Cliometric Society; Economics Department, DePauw University; Research Triangle Economic History Workshop; Workshop in the Economics and Biodemography of Aging and Health, University of Chicago; and at the annual

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1 Introduction: Biology, Diseases, and Migrations before the Twentieth Century

On November 29, 1847, in the Oregon Territory near present-day Walla Walla, Washington, Marcus and Narcissa Whitman were murdered. Marcus was attacked from behind by a Cayuse Indian who implanted a tomahawk deep into his skull. Later a group of Cayuse shot, beat, cut, mutilated, and, finally, decapitated and dismembered Narcissa. She died quickly; arguably her death may have been less painful than Marcus's who lingered moaning for hours before succumbing. Eleven other people died in the attack, all the survivors were women and children; many of the women were raped, all were enslaved. Within months, representatives of the Hudson Bay Company had arranged the release of the survivors. Subsequently, American settlers and soldiers sought and wreaked vengeance upon the Cayuse, guilty and innocent. By the late nineteenth century, the Cayuse had merged with other tribal groups because their numbers were too few to maintain an independent tribal society. The Whitman Massacre and the disappearance of the Cayuse society were linked, not by the retribution of avenging Americans, but by virtually invisible pathogens that were completely foreign to the Cayuse; therein lies the tragedy.

Marcus Whitman was a medical missionary who located his mission in the area east of the Cascade Mountains drained by the Columbia and Snake rivers. At the beginning of the nineteenth century, these lands were populated by an estimated 180,000 Native Americans; by the end of the century, there were less than 40,000. Whitman was sent to the Native Americans to alleviate their sickness and bring them the (Protestant) gospel. Whitman had the misfortune of being at the wrong place at the wrong time. A worldwide measles epidemic had broken out and by 1847 it had reached the Oregon Territory; it might have been introduced by the settlers who were following the Oregon Trail to the Willamette Valley. Wagon trains typically stopped and refreshed

themselves at the Whitman mission, and the emigrants could have borne the virus. More ironically the measles could have come from the adoption of the horse by the plains Indians. Ironic because only after Contact with the Old World was initiated by Columbus and the European voyages to the New World did the horse come to the Americas. Horses allowed Native Americans to travel widely and rapidly; in their travels, they could have picked up the measles virus and transmitted it to the Cayuse. However it came, the effects of the measles virus were devastating; one estimate has one-half of the Cayuse in the Whitman mission area dying. If *all* the Cayuse contracted the virus, this implies a case fatality rate of 50 percent; if less than 100 percent of the Cayuse contracted it, the case fatality rate would have been even higher.[1] The death rate of whites, both resident at the mission and the pioneers who were passing through, was a small fraction of that of the Cayuse; at most 15 percent of those who contracted measles died, and those who contracted it were probably a minority of the white population.

Some of the Cayuse believed that the Whitmans were responsible for the measles and were active in spreading it. This was the genesis of the Whitman Massacre, but the massacre of Indians by measles, cholera, smallpox, and other pathogens dwarfed all forms of human violence. After centuries of continual epidemics, Native Americans today are a small minority in their ancestral territories, victims of their evolutionary heritage that made them more susceptible to pathogens that were unseen and unknown by their victims. Yet a century and half after the works of Louis Pasteur, and Charles Darwin and Alfred Russel Wallace, histories are still written as if what these men discovered had no impact on the conquest of the New World, American Manifest Destiny, worldwide military campaigns, colonialism, slavery, and the revolutionary changes in industries and economies that permeate history. In contrast, *Parasites, Pathogens, and Progress* does not ignore their discoveries; it explicitly employs them. It brings biology, parasites, and pathogens into humanity's history and the economy.

The Western Hemisphere was initially settled by nomadic Asian tribes during the last Ice Age glacial. Glaciers trapped a large amount of the Earth's water; this lowered sea levels. The Bering Sea became a Bering Land Bridge, ranging up to 1,600 kilometers (1,000 miles) wide. Northeast Asian hunter-gatherers, the ancestors of Aboriginal Americans, came to America following the animal herds that populated the Land Bridge, migrating across the Bridge or along its southern coastal waters. The end of the Ice Age glaciation led to rising sea levels and the

disappearance of the Land Bridge that effectively isolated the New World from the Old. As the peoples of the Old World grew in numbers, they domesticated animals (horses, goats, sheep, cattle, fowl, pigs, and so forth) and from the diseases of animal herds pathogens jumped species and infected humans, resulting in smallpox, measles, chickenpox, mumps, and a host of other major and minor diseases. The Old World peoples gradually adapted to these diseases; humans who were most susceptible to diseases did not reproduce, those that did reproduce had, on average, more innate (genetic) resistance to the pathogens. Exposure to a specific pathogen also typically resulted in an acquired immunity that left the individual resistant to subsequent re-infection. One by one, diseases evolved from being epidemic diseases, where many are susceptible and killed, to endemic diseases whose victims are usually the previously uninfected (primarily children), leaving other groups relatively unaffected because of acquired immunities.

In his award-winning *Guns, Germs, and Steel*, Jared Diamond argues that the shape and position of the Eurasian land mass affected this process and, thereby, world history. Eurasia extends thousands of miles further in the east–west direction than it does on its north–south axis. Animals (and plants) evolve in ecologies that tend to be latitude specific, and have difficulties in adapting to the different climates that the earth's tilt imposes on its north–south axis. The east–west orientation and the vast grass lands of the Eurasian land mass allowed more animals to survive the depredations of hunter-gathers to become potential domesticates. Having more potential domesticates led to more actual ones; domesticated farm animals spread relatively easily on the east–west axis over the Eurasian land mass. Unlike Eurasia, the continents of the Western Hemisphere are much longer than wide; this contributed to the extinction of megafauna and led to a paucity of animals that could have been domesticated. In fact, the aboriginal peoples of North America had no domesticates aside from the dog (and the guinea pig in Mesoamerica). This meant that before Contact with the Old World, Native Americans were spared the ravages of the pathogens zoonoses that emerged from animal herds and flocks unlike the Old World peoples. Conversely, once intercourse started with the Old World, Aboriginal Americans were exposed to these diseases for the first time, and they died in numbers that were unfathomable to contemporaneous observers.

The disappearance of the Cayuse and the Whitman Massacre are symptomatic of the effects of pathogens on the aboriginal populations

of the New World. While Diamond's *Guns, Germs, and Steel* argues that the European conquest of the New World was caused by the aboriginal populations falling victim to European guns, steel, and the diseases that Europeans brought with them, *Parasites, Pathogens, and Progress* views the European takeover of the Americas as almost solely due to the introduction of Old World diseases. European advantages in war-making technologies may have hastened the outcome, but they did not determine the ultimate Europeanization of most of the Western Hemisphere. As a thought experiment, suppose that the European voyages to the Americas in the late-fifteenth and sixteenth centuries, rather than being controlled by the Conquistadors (uncouth villains bent on looting, raping, and enslaving), were instead sponsored and controlled by people who were the moral equivalent of Mother Teresa and Albert Schweitzer (covering both the Catholic and Protestant enthusiasts). But also suppose that the voyages between the New and Old Worlds took only two weeks instead of two months. What would have happened? In our view, the Old World conquest of the New would have been even more rapid, and the decline in New World peoples more complete.

Seeking to save bodies and souls the equivalents of Mother Teresa and Albert Schweitzer would have come in droves to the New World, bringing with them a hoard of Old World diseases, and their ineffectual (at best) sixteenth-century medical knowledge and practices. With the rapid arrival, the experience of the New World peoples would have been like bacteria that are subject to multiple cocktails of antibiotics; they would have been wiped out all at once. What actually happened was that Old World diseases were gradually introduced into "virgin" populations over centuries rather than almost immediately, as would have been the case if transport times had been drastically reduced. (In demographic and epidemiological terminology, a "virgin" population is one that has had no recent exposure to a pathogen.) Death rates in virgin populations to diseases common elsewhere can be horrific. In the nineteenth century, the death rates of Polynesians first exposed to measles approached 80 percent; in the twentieth century, Amazonian tribal societies exposed to measles and influenza had population implosions similar to the Polynesian experience. The New World's distance delayed the introduction of Old World diseases; the delays meant that aboriginal populations had a chance to repair some of the damages caused by the introduction of one "new" disease before another one would devastate them. Historically, even with the introduction of Old World diseases into the New World taking centuries rather than less

than a handful of years, by the eighteenth century Aboriginal populations of the New World had fallen by about 90 to 95 percent of their earlier levels. This allowed the Europeanization of much of the New World. In contrast, the European conquests and colonization of Asia and Africa were ephemeral. In these lands, Europeanization was doomed by the effects of African and Asian diseases on European peoples. So, more accurately reflecting the New World historical experience, Diamond should have titled his book *Germs, Germs, and Germs*; but then again, his publisher probably would have objected.

We tell the story of humanity's history that is an amalgam of the co-evolution of biology, the effects and efforts of humans, and economic production. Human history, much like living organisms, is an evolving entity; past, present, and future were and will be shaped and determined by the interactions among humans, the natural environment, and economic constraints. Histories that ignore the natural world, assuming that either it has little relevance for history, or if it does impact history its effects are unchanging, are, at best, incomplete. In reality, the natural world is continually changing; some changes are completely impervious to human actions, and others are a result of interactions between natural and human forces. Some of these changes materially affect both history and the physical environment. These are ongoing processes; there are no equilibria. Like life itself, history is an evolving process.

Parasites, Pathogens, and Progress integrates economic *and* biological views into an explanation of the historical development of humanity and the economy, paying particular attention to the American experience, its history and economic development. While it has much in common with the literature of medical and social historians, it still differs in several fundamental respects.[2] First, it takes a fundamentally economic approach; we are by training economists with historical bents. Second, it emphasizes the critical interactions among human choices, microorganisms, evolution, and diseases. Third, it views the environment and diseases as evolving phenomena; prior to the nineteenth century, local and regional diseases predominated. During the nineteenth century, pathogens and evolution played a different yet important role in explaining the economic development of the United States as local and regional disease pools, both within the nation and from abroad, became widespread and integrated. Fourth, it considers the establishment and growth of African slavery in the British New World as a result of colonial planters seeking the least-cost sources of

labor as well as the result of the biological traits of different populations (more accurately, the frequencies of various genetic traits within different populations and subpopulations). The early importation of Africans as slaves set in motion biological forces that permanently changed disease ecologies in the New World, fixing African slavery as an economic and social institution. Fifth, it stresses that the New World disease environment was dependent on or *endogenous* to human actions, albeit the disease environment was the *unwitting* result of human choices. We do not claim that we are the first to bring parasites and pathogens into the history of humanity and the economy, but we do so with emphasis and conviction that are missing in other histories.

African Slavery in the New World

Much of our story is devoted to explaining the origins and persistence of African slavery in the United States and its colonial antecedents. Following the European voyages to the New World and the subsequent population implosion of New World peoples, European colonialists faced the problem of obtaining labor to exploit the resources of the Americas. The high cost of passage to America relative to Old World incomes inhibited the self-financed migrations by working class people; consequently, British colonialists resorted to bound servile labor for agricultural workers. People, either voluntarily or involuntarily, were obligated (bound) to provide labor services (labor servitude) to the colonist who acquired their labor.

Europeans remained the primary source of unskilled agricultural labor in the British West Indies (Caribbean) until the middle of the seventeenth century and in the southern mainland colonies until the turn of the century. African slaves began to displace Europeans as the primary source of unskilled labor in the Caribbean during the 1650s and 1660s and in the southern mainland colonies about 1700 and thereafter. European-Americans always predominated in the northern and western United States (after independence) while African-Americans were relatively concentrated in the southern United States well into the twentieth century.

What explains the concentration of African slaves in the Caribbean and the American South and why was African slavery not predominant throughout the British New World? In brief, our explanation runs like this: the migrations of Africans and Europeans and the pathogens that they (unwittingly) brought to the New World explain the evolution of

regional disease ecologies in colonial America. Evolving regional ecologies along with the disparate biological reactions of Africans and Europeans to diseases explain the racial (ethnic) makeup of the regions of North America. Disparate biological reactions are an evolved response taking place over millennia to local disease ecologies. These disparate reactions to diseases explain why African slaves became concentrated in the tropics (Caribbean) and subtropics (the southern mainland). In specific local and regional disease environments, both the pathogens and the health of people of different ancestries were differentially affected. African-Americans and European-Americans reacted differently to regional disease ecologies. Differential effects persisted through the early twentieth century, impacting the health, physical development, and economic productivity of the two groups.

We write about what happened once Africans and Europeans came to British North America. Because of the heritage that their ancestral environments bequeathed to them, the eventual predominance of people of African ancestry in the tropics and subtropics of America, and the predominance of people of European ancestry in the temperate regions was predetermined. Europeans were, relative to Africans, less profitable sources of agricultural labor in the tropics and subtropics of both the New and Old Worlds; conversely, Africans were, relative to Europeans, less profitable agricultural laborers in the more temperate regions of both the New and Old Worlds. The European voyages to the New World unleashed migrations of Africans and Europeans and started an evolutionary process that changed the local and regional disease ecologies throughout the Americas. These changes had profound effects upon the course of American history and are still reverberating in the twenty-first century.

Institutions, Diseases, Development, and Diversity

Unlike recent trends in the literature on economic development and growth, our book does not emphasize the impact of institutions; we have two reasons for this omission.[3] The first is that our book is about the effects of parasites and pathogens on historical progress; because we write about this aspect of history does not mean that other aspects are unimportant. The second, and more important reason, is that institutions do not spring forth fully formed like Athena from Zeus's head. Institutions themselves are endogenous (determined within a society); disease environments, resource endowments, history, and economics

all interact in forming and limiting institutional design. As mentioned earlier, bound labor was one way of bringing people to the New World. The tradition of bound labor evolved from the apprenticeship system whereby a young man bound himself to a craftsman in order to learn a trade. The contractual obligation to serve an indentureship was a solution to the problems of imperfect or nonexistent capital markets, which would have allowed the apprentice to purchase training; and moral hazard, whereby a young man who might agree to work for a craftsman could abandon his master and obligations after the acquisition of skills. The point here is that the institution of bound labor evolved from economies that had low incomes, inadequate capital and labor markets, and substantial economic returns to acquiring skills; indentureship allowed servant and master to cope with these circumstances.

Institutions are historical creations; they are like evolving organisms, changing in response to changes in their environment, replicating and spreading, subject to all matter of constraints and preconditions. Changing the metaphor, institutions are like tastes; you may assert that tastes are given and immutable (*de gustibus non est disputandum*), but that is only for analytical convenience. Both tastes and institutions are integral products of evolution: biological, historical, and economic. Analyzing the impact of an institution at a given time may yield insights, but any historical view that assumes institutions are exogenous (originating outside a society) is likely to be terribly misleading. Labor institutions, in particular, are greatly influenced by changing disease ecologies and economic conditions; changes in labor institutions have major economy-wide effects because labor is a key component of human economic activities. Again in the context of North American history, African slavery and European indentured servitude were two institutional responses to the resource endowments and costs that dominated in the early history of European involvement in the New World.

In pre-twentieth century America, blacks and whites, northerners and southerners, and various other groups faced different disease experiences. These experiences were regionally and historically different. In general, climate, urbanization, transport developments, movements of people, and increasing population densities differentially affected people of different ancestral heritages and in different areas and regions. This diversity must be recognized to understand the impact of diseases on history; one size does not fit all.

An Outline of Our Story

The next chapter (chapter 2) begins with an examination of the impact of biology and demography on the pre-history and history of humanity. It asks and answers the big question: why has the human ability to manipulate the material world been so glacially slow? Literally, "glacially" vastly overstates humanity's progress. Since *Homo sapiens* appeared on the scene (about 200,000 years ago), there have been several periods when ice blanketed much of the Northern Hemisphere, but you can count on a finger the number of technological civilizations that humanity created over this era. Chapter 2 also lays the foundations for our evolutionary approach to history and the human economy.

Chapter 3 contains the core of our argument relating progress to population and pathogens. We attribute long-run economic growth to an increasing population that led to increased markets. This induced greater specialization and a concomitant increase in productivity. Subsequent developments in transportation services and a specialized transport network reduced transport costs and time, further widening the market. This is the virtuous cycle of economic growth. Offsetting this was a vicious biological cycle of economic growth: increased market size provided resources for the pathogens that assaulted humans. With increased human densities came animals that provided humans with transportation and food. The increased waste products of the animals and humans contaminated water supplies and soils, exposing people to existing diseases and providing breeding grounds for new diseases. Infectious diseases were more rapidly transmitted and widespread; more people were sick more often.

Chapter 4 applies our disease story to the American experience with a presentation of an economic and financial analysis of the two primary sources of bound labor (European indentured servants and African slaves) available to colonialists in British North America. Using basic financial calculations, chapter 4 shows that the historical experience contradicts the belief that Europeans and Africans had identical economic productivities throughout the New World. Different productivities of indentured servants and slaves are attributed to differential resistances to diseases.

Chapter 5 provides an in depth examination of the biological consequences that accompanied the European voyages to the New World, and British North America in particular. The biological consequences and economic factors provide an explanation for colonial planters'

subsequent choices of agricultural labor and the regional concentration of peoples of different ethnicities (ancestral heritages) in seventeenth-century British North America. The analysis in chapter 5 confirms the financial calculations derived in chapter 4.

Chapter 6 links the regional concentration of Africans and Europeans to the importation of African slaves into the Chesapeake Bay region and the entire American South. The chapter examines the disease environment of the antebellum American South and the linkages between infectious parasitic diseases and the productivity and physical development of peoples in the antebellum South.

Chapter 7 brings our story to the beginning of the twentieth century with empirical assessments of the impact of population growth, urbanization, increasing density, and transportation and other developments on the spread of diseases, increased morbidity and mortality, and long-run American economic growth during the nineteenth century.

The final chapter (chapter 8) emphasizes the difficulty of reconciling the time dimension over which evolutionary changes occur, and the aspects of time that surround us day to day. Small differences accumulate over centuries to become overwhelming, yet they go unremarked because they happen over time spans that human experience finds difficult to comprehend. Similarly, pathogens elude our senses because they are so minute, and human experience equates the minute with the inconsequential. Chapter 8 concludes with some comparisons and speculations.

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