THE NEO-COLUMBIAN EXCHANGE

The Second Conquest of the Greater Caribbean, 1720–1930

Stuart McCook
University of Guelph

Abstract: The landscapes of the Greater Caribbean have been undergoing a process of ecological globalization since the arrival of European explorers and settlers in the late fifteenth century. The character of this ecological globalization has changed over time. Models of commodity-led economic development drove, directly or indirectly, the neo-Columbian exchanges of the long nineteenth century (roughly 1720–1930). The neo-Columbian exchanges differed from the Columbian exchanges of the sixteenth and seventeenth centuries in several key ways: They were increasingly mediated by imperial and transnational scientific institutions. The geographical scope of the exchanges grew, and the Greater Caribbean saw many new direct introductions of people, plants, and animals from Asia and the Pacific, as well as from the eastern part of the Atlantic World. A parallel movement of pathogens from Asia and the Pacific also introduced new epidemic diseases—especially crop diseases—to the Greater Caribbean. The neo-Columbian exchange drove the region's dramatic expansion in agricultural production, but this constructed abundance came at the expense of ecological impoverishment and fragility.

In 1723, the French captain Gabriel Le Clieu landed in Martinique after an arduous transatlantic crossing from Nantes. He carried with him a precious live coffee plant (*Coffea arabica*), from the Jardin des Plantes in Paris. Just three decades before, coffee cultivation had been limited to the Arabian Peninsula, southern India, and Ceylon. In 1699, the Dutch had transferred coffee from the Malabar Coast of India to their colony in Java; in 1706, they sent a coffee plant from Java to the Amsterdam Botanical Gardens; in 1714, the burgomaster of Amsterdam sent a young coffee tree as a gift to King Louis XIV of France, where it was cultivated in the Jardin des Plantes. Nine years after that, Le Clieu took an offspring of that plant to Martinique; according to legend, all the New World coffee industry was founded on the progeny of that single plant. Indeed, in the following decades, the plant's offspring were sold, smuggled, stolen, or sometimes even freely exchanged across the Caribbean and into mainland South America. Le Clieu's coffee plant was not the only one to make the Atlantic crossing in the early eighteenth century. The Dutch had also transplanted coffee directly from Europe to their New World colonies at around the same time. By the mid-eighteenth century, coffee had disseminated widely throughout the Greater Caribbean and across tropical Latin America. In less than a quarter century, a regional crop had gone global (Candolle 1904; Mauro 1991; Smith et al. 1992).

The introduction of coffee to the New World symbolizes the beginning of a new phase of global biological transfers to the Americas, which can be characterized

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collectively as the neo-Columbian exchange. This article focuses on the shape of the neo-Columbian exchange in the Greater Caribbean, a region that includes the islands of the Caribbean, as well as the Atlantic coasts of tropical Central and South America and their hinterlands. The neo-Columbian exchange defined the Greater Caribbean by giving the region its distinctive ecological and economic shape. From an ecological perspective, the Greater Caribbean ecumene (to adapt a term from Mintz [1996]) consists largely of the colonial and postcolonial landscapes organized around the production of tropical commodities for markets in Europe and (later) North America.[1]

The Greater Caribbean was given its distinctive shape by exotic organisms—plants, animals, and people—introduced to support this export economy (Mintz 1974, 1996; McNeill 2010). In the two hundred years between 1720 and 1930, the plantation economy in the Greater Caribbean reached its apogee and then fell into sharp decline in the mid-nineteenth century with the abolition of slavery. The region's agricultural export economy revived in the late nineteenth century, as the United States expanded its economic and political power in the region. The U.S. sugar and banana companies in the Caribbean, in particular, greatly expanded production between 1880 and 1930. Scholars disagree about whether this later agricultural boom was simply an extension of the colonial plantation economy or something altogether different (Ayala 1999). From an environmental perspective, as I outline here, the continuities are more striking than the changes.

Biological introductions from the Old World to the Greater Caribbean began with the arrival of Europeans in 1492 and, as Crosby (1972) argues in the closing chapter of *The Columbian Exchange*, have never stopped. But this superficial continuity masks ebbs and flows in the pace of these introductions, as well as significant changes in the economic, political, technological, and scientific infrastructures that enabled them. The initial Columbian exchange took place between roughly 1492 and 1700. It was characterized by the transfer of epidemic diseases that could prosper in the "virgin soils" of Amerindian populations, which had historically had little exposure to Old World microbes. It was also characterized by the spread of Old World plants (sugarcane being the leading example, but also bananas, cotton, indigo, and other crops), and the spread of Old World animals (horses, cattle, goats, pigs, chickens), many of which prospered in ecological niches where they had few competitors. Cumulatively, the Columbian exchange was a disaster for the indigenous inhabitants of the New World (Crosby 1972, 1986). The inhabitants of the Greater Caribbean arguably bore the brunt of the exchanges; on many of the islands, the indigenous population was almost completely wiped out (Cook 1998). By the seventeenth century, however, the pace of transoceanic exchanges had slackened. The first, transformative wave of migrants had already arrived, and the second was yet to come.

The neo-Columbian exchange can be distinguished from the Columbian ex-

1. This definition differs slightly from the broader definition that J. R. McNeill offers in *Mosquito Empires*. McNeill's definition is more expansive, including parts of subtropical and temperate North America. For the sake of space and simplicity, the definition in this article focuses exclusively on the tropical zones.

change in five major ways. First, and most important, the neo-Columbian exchange was driven decisively by the Greater Caribbean's agricultural economy—the quest for economic growth through agricultural exports. Most of the organisms deliberately introduced to the Greater Caribbean in this period supported the agricultural export economy. Second, new global scientific networks—both public and private—shaped the global movement of plants and animals. Third, new technologies—such as railroads and steamships—accelerated the global and regional diffusion of organisms. Fourth, direct introductions from the Indian Ocean basin, Asia, and the Pacific became commonplace, thus making the neo-Columbian exchange truly global. During the initial Columbian exchange, some Asian organisms—most significantly sugarcane—had reached the New World. But the global journey of sugarcane was a slow migration, and the sugarcane introduced to the New World had long been domesticated in the eastern Atlantic world (Galloway 1989). In contrast, coffee traveled from Java to Martinique in fewer than two decades. Many other organisms—including Chinese laborers, zebu cattle (*Bos indicus*), and the cholera bacteria (*Vibrio cholerae*) made similarly rapid and direct journeys from the Eastern Hemisphere to the New World. Finally, the neo-Columbian exchange was not an encounter between separate worlds. The New World in general and the Greater Caribbean specifically were no longer "virgin" soil. The demographic and epidemiological advantages enjoyed by Old World people, animals, and plants in the sixteenth and seventeenth centuries had largely disappeared by the eighteenth century. If anything, the advantages often lay with the creolized landscapes and peoples of the Greater Caribbean (McNeill 2010).

This article is organized thematically rather than chronologically. The goal is to highlight the particular features of the neo-Columbian exchange that gave the Greater Caribbean its distinctive shape. The emphasis on the continuities in this period, however, does not mean that the neo-Columbian exchange was in any way static. During these two centuries, the Greater Caribbean saw commodity booms and busts; the opening of new agricultural frontiers, and the exhaustion of older ones; the apogee and decline of the slave trade from Africa; and the introduction of exotic plants, animals, pathogens, and pests. The political and economic relations that structured the neo-Columbian exchanges also changed constantly. This account of the neo-Columbian exchange is exploratory rather than comprehensive; the examples proffered here are case studies that illustrate a much larger process.

THE ECONOMIC IMPETUS FOR ECOLOGICAL EXCHANGE: AGRICULTURE, ABUNDANCE, AND INNOVATION

Mercantilist colonial governments and liberal nation-states alike saw the export of tropical commodities as the key to economic growth. Tropical commodities had played an important role in the Caribbean economy from the beginning of European colonization, although the Spanish were more interested in minerals than agriculture. But the Spanish quickly shifted their focus to mining on the mainland, and they let the Caribbean languish. In the seventeenth century, other

European powers—particularly Great Britain, France, and the Netherlands—established plantation colonies in the Caribbean. Small sugar islands such as Barbados could generate fabulous wealth—for a few generations.

Agricultural innovation drove the neo-Columbian exchange. Although many Caribbean planters believed in the myth of prodigal nature—the idea that the natural wealth of the region's landscape would support abundant agricultural production—in fact the Caribbean's landscapes could not sustain the agricultural economy without constant intervention (Fernández Prieto 2005). As Melville (1994) and other environmental historians have noted, landscapes are not static; they are dynamic, constantly changing entities. Creating and sustaining the Caribbean's abundant landscapes required almost constant ecological innovation. A key feature of this innovation during the eighteenth and nineteenth centuries was the importation of exotic people, plants, and animals. To prosper, both economically and ecologically, the introduced organisms required an appropriate landscape; if such landscapes did not already exist, then they had to be created and maintained.

Caribbean commodity booms began in earnest during the eighteenth century as the economies of the region prospered through the cultivation and export of crops such as tobacco, indigo, coffee, cacao, and, above all, sugar (Watts 1987). By century's end, the French colony of Saint-Domingue was the world's largest producer of both coffee and sugar. The Spanish gradually began to catch up with their competitors in the mid-eighteenth century as part of the Bourbon reforms. They began systematically promoting the agricultural development of their Caribbean colonies. As early as 1728, they organized a monopoly company—the Real Compañía Guipuzcoana—to promote the Venezuelan cacao industry. The most significant commodity boom in the Spanish colonies came in the late eighteenth and early nineteenth centuries, with the unprecedented expansion of the Cuban sugar industry (Piñero 1988; Bulmer-Thomas 1994).

Elite faith in commodity exports as the engine of economic growth proved surprisingly robust, even as liberalism supplanted mercantilism as the dominant economic ideology. It survived dramatic political transformations, lasting through the rise and decline of European imperialism in the Greater Caribbean; the revolutionary nationalism of the early nineteenth century; the abolition of slave trade and later slavery; and, later in the nineteenth century, the advent of North American neocolonialism. It weathered significant economic changes; imperial mercantilists, nationalist liberals, and North American corporations working in the Caribbean all pursued wealth through commodity exports (Bulmer-Thomas 1994).

The quest for economic development drove Caribbean governments (both colonial and national) and planters to import plants and animals from across the global tropics. They also imported people to the New World tropics and required most of them to sustain the agricultural economy. During the neo-Columbian exchange, immigrants—both free and coerced—arrived in the Greater Caribbean in unprecedented numbers, mostly from Africa, with smaller numbers from Asia and Europe. Much of the economic fate of the Greater Caribbean in these years depended on the neo-Columbian exchange.

By the nineteenth century, a considerable amount of agricultural innovation was directed at solving agricultural problems rather than creating new opportunities. The agricultural booms of the eighteenth and nineteenth centuries had depended heavily on the destruction of the region's forests. Although some smaller islands in the Greater Caribbean had been heavily deforested by the seventeenth century, arguably the greatest period of destruction lasted from the mid-eighteenth century to the early twentieth century. Planters replaced old and diverse forests with comparatively simple and specialized landscapes devoted to producing economically valuable organisms. In Cuba, deforestation had been limited to a small part of the island before about 1780. After that, sugar planters gained the upper hand in insular politics and gutted most of the island's forest protection laws. Over the following century, almost all of Cuba's lowland forests were cut down and brought into sugarcane cultivation (Funes Monzote 2008). Across the Greater Caribbean, the expansion of the coffee industry largely drove forest clearances in the highlands, whereas the expansion of the sugar and banana industries drove clearances in the lowlands (Dean 1997; Williams 2003).

These new landscapes were economically powerful but also vulnerable to a host of problems. Planters began to complain constantly about soil exhaustion and varietal degeneration as the productivity of their crops declined. Soil erosion became a growing environmental problem, particularly in areas that depended on slave labor. Planters were aware that contour planting could help with soil conservation. But many of them, like the coffee planter P. J. Laborie (1798) of Saint-Domingue, argued that their crops should be planted in straight rows both to maximize productivity and to allow for overseers to keep an eye on the slave labor. And, as we will see here, ecologically specialized landscapes were often vulnerable to diseases and pests. Over the eighteenth and nineteenth centuries, most major crops in the Greater Caribbean suffered several potentially catastrophic epidemics and a host of smaller problems. Constant innovation was necessary to sustain the agricultural economy in the face of these problems. Increasingly, this innovation was conducted in botanical gardens and agricultural research institutions.

THE SECOND CONQUEST: INSTITUTIONS AND TECHNOLOGIES

The original Columbian exchange had depended heavily upon technological and cognitive innovations. The technological innovations included the development of long-distance sailing vessels that enabled Europeans to sail around the globe. Important cognitive innovations included learning about global wind patterns, which in turn allowed Europeans to reliably plan transoceanic voyages (Crosby 1986). The neo-Columbian exchange, in turn, depended on technological and cognitive innovations of its own. Global biological exchanges became institutionalized through imperial and transnational networks of scientific research stations. Smaller scientific innovations made it easier to transplant live plants and animals across the globe. Technologically, the development of steam shipping and railroads in the nineteenth century helped bring the continents closer together by dramatically reducing transportation times.

Scientific institutions also gave the neo-Columbian exchange its particular shape. In particular, public and private botanical gardens, agricultural experiment stations, and nurseries provided the institutional infrastructure necessary to move live plants quickly on a global scale. By the end of the eighteenth century, the European imperial powers all had botanical gardens that collected and disseminated organisms—especially plants of scientific or economic value. The French Empire supported a series of botanical gardens in its possessions across the global tropics. In the eighteenth century, the empire established botanical gardens in Île-de-France (Mauritius) and Île Bourbon (Réunion) in the Indian Ocean. In the Caribbean, the French operated botanical gardens in Saint-Domingue, Martinique, and Guadeloupe, and on their mainland possessions in Guiana and Cayenne. Nutmeg, cinnamon, and clove trees made their way from the Moluccas to the Caribbean through this network. The French botanist Pierre Poivre collected these plants in the Moluccas in the early 1770s and brought them to the Indian Ocean gardens in Île-de-France and Île Bourbon. Shortly afterward, the plants were sent from the Île-de-France to Cayenne, and in 1786 they were sent from Cayenne to Saint-Domingue. Just two years later, in 1788, a further cargo of exotic crops containing these and other plants arrived at the Jardin du Roi in Saint-Domingue directly from the Île-de-France (Grove 1995; McClellan 1992). As with the coffee plant, these spices circumnavigated the globe in a matter of years rather than centuries. The imperial network of botanical gardens made this possible.

In the nineteenth century, the British Royal Botanic Garden at Kew emerged as the most influential center for global plant transfer, a reflection of the rise of British imperialism in Asia and Africa. Two of the most important of these transfers were the transfer of the cinchona tree (whose bark provided a medicine against malaria) and the seeds of the rubber tree from Brazil to Southeast Asia, especially the British colony of Malaya (Dean 1987; Drayton 2000; Brockway 2002). Conversely, the British botanical gardens in Jamaica, St. Vincent, and Barbados also imported exotic plants from Asia and Africa, such as new varieties and hybrids of sugarcane from Java and the Pacific. Later in the nineteenth century, the United States began to play a major role—directly and indirectly—in shaping agricultural innovation in the Greater Caribbean. After 1898, the U.S. Department of Agriculture helped establish agricultural experiment stations in Cuba and Puerto Rico. Moreover, U.S.-born or trained botanists and agricultural scientists staffed or collaborated with institutions in Central and South America and did extensive work in acclimatization (McCook 2002).

These public, official biological exchanges marked only one part of a much broader exchange, much of which remains unrecorded. Individual planters, agricultural associations, and corporations also transferred plants and animals globally, in parallel with the official institutions. In early twentieth-century Cuba, the American expatriate sugar planter Edwin F. Atkins established an acclimatization garden on his sugar central in Cienfuegos, as did the Cuba Sugar Club at the Central Baraguá in the 1920s. The United Fruit Company operated a botanical garden and agricultural experiment station in Tela, Honduras. These private botanical and agricultural research institutions were not, however, exclusively the

province of imperial or neocolonial organizations. The Cuban Círculo de Hacendados, an association of Cuban agriculturalists, also imported and experimented with exotic varieties of sugarcane and other crops (Fernández Prieto 2005, 2009). These organizations, in turn, often obtained their plants through a network of commercial tropical greenhouses in Europe, such as William Bull's nursery for exotics in Chelsea, London, or similar institutions in Belgium and the Netherlands. The greenhouses received and disseminated exotic plants from across the tropics, often bringing new varieties and species of crops into circulation. Even in this period, however, neither public nor private scientific institutions were necessary for the global transfer of plants. It seems likely that some enslaved Africans and migrants from India and China may have brought plants with them to the Greater Caribbean. Unfortunately for historians, the history of private plant transfers—whether by Europeans, Africans, or Asians—remains murky.

Innovations in technology also helped speed the introduction of new organisms into the Greater Caribbean. The transportation revolution of the nineteenth century is perhaps the most obvious of these. After about 1830, steamships gradually began to supplant sailing ships in transoceanic trade. The steamships that propelled the neo-Columbian exchange after 1830 were made of steel, driven by steam, and fueled by wood or coal. Each of these reflected an innovation that involved a new relationship and a new understanding of the natural world. The duration of transoceanic and regional voyages diminished significantly—from months to mere weeks or days. The reduced travel time increased the likelihood that organisms could survive the oceanic crossings. The introduction of river steamers and (later in the nineteenth century) the construction of railroads opened up the interior of the large islands and of the mainland to contact with the outside world, thus ending centuries of comparative isolation. These technological innovations also dramatically reduced global transportation costs, which made the opening up of new agricultural frontiers economically viable (O'Rourke and Williamson 2000). Although much of the existing scholarship focuses on how this transportation revolution helped connect tropical producers with their markets in North America and Europe (north-south connections), an equally important effect was to create new east-west connections across the global tropics.

Other, seemingly more innocuous technologies made it easier for live organisms to be transported long distances. Before the nineteenth century, transporting live plants had been fraught with difficulties, owing to the many changes in temperature and humidity as the plant made its global journey. This explains why Le Clieu's voyage with coffee has been commemorated in history and legend. Such transfers remained difficult until the 1820s, when the British botanist Nathaniel Bagshaw Ward developed a small, portable greenhouse—later known as the Wardian case—that could maintain reasonably constant levels of temperature and humidity aboard ship. This invention allowed planters and botanists to transport live plants over long distances reliably, thus making global plant exchanges much easier (Ward 1842; Brockway 2002; Darby 2007). After the Wardian case was developed, for example, long-distance transportation of live coffee plants became commonplace. In the 1880s, planters in Ceylon casually imported live coffee plants from Jamaica and Central America and scarcely thought this to be worthy of

comment (McCook 2006). The easy and swift movement of seeds, seedlings, and live plants helped reshuffle the global botanical kingdom. But science and ships alone were not enough to ensure that biological introductions were successful. For new crops and new livestock to succeed, they needed people to care for them.

PEOPLE: THE RISE AND FALL OF MASS MIGRATION TO THE GREATER CARIBBEAN

The agricultural economies of the Greater Caribbean depended on the continuing introduction of people from across the global tropics. Natural increase was not enough to provide a steady labor force. The population of the tropical Americas reached its nadir around 1750, just as the export economy began to grow. Initially, the demographic recovery in the long nineteenth century—at least in the Greater Caribbean—was through coerced immigration, first through the slave trade and later through indentured servitude. Africans were the largest body of immigrants by far; after the abolition of slavery in the mid-nineteenth century, a small but significant trickle of immigrants from Asia, especially China and India, succeeded them. The Asian migrations had no precedent in the earlier colonial period. Only toward the end of the nineteenth century did immigrants from Europe and North America arrive in the Caribbean in any significant numbers—and even those remain limited.

Comparatively few Europeans migrated to the Greater Caribbean in this period. Tropical diseases were a major check on voluntary immigration in the period. During the original Columbian exchange, differential immunity had worked in the favor of the immigrants. By the mid-eighteenth century, however, the populations of the Americas were no longer epidemiologically virgin. They were home to populations with several centuries of experience with yellow fever, malaria, smallpox, and other virulent diseases introduced during the conquest. People born and raised in the New World tropics had generally acquired some sort of immunity to the major tropical diseases, especially yellow fever and malaria. New arrivals, especially from temperate regions, did not always enjoy the same levels of immunity to these diseases.

This differential immunity helps explain the low levels of European immigration to the New World tropics. Mortality rates among new immigrants from the temperate regions were astoundingly high. In fact, the historian J. R. McNeill argues that the differential mortality rates helped preserve the geopolitical status quo in the Greater Caribbean until the late eighteenth century. The British sent a large fleet and army to capture Cartagena in 1741; mortality from yellow fever ultimately forced the army to withdraw without having met their goal. Although the British later succeeded in capturing Havana in 1762, yellow fever decimated the occupying forces. As movements for independence emerged in the late eighteenth century, the geopolitical implications of the diseases changed (although the differential immunity did not). The diseases favored the Creole armies in the rebellious states over the European armies sent to suppress them. Nowhere was this more visible than in Haiti, where British and French attempts to reconquer the island and suppress the rebellion failed. The British invasion in 1794 cost them some fifty thousand men, and the French attempt in 1802 cost them about forty

thousand men. Far more of these soldiers died of yellow fever than died in combat (McNeill 1999, 2010). Such epidemic diseases remained a specter that presented a strong disincentive for anyone to migrate to the Greater Caribbean.

Nonetheless, Europeans did migrate to the Greater Caribbean steadily, though on a small scale. Many, of course, were civil and military government officials, businesspeople, or plantation owners and their families. The Greater Caribbean also received immigrants from Holland (either directly or through Brazil) in the late eighteenth century, many of whom were Sephardic Jews. Many settled in the Dutch islands in the Caribbean, and later some moved to other islands and the mainland. As the Americas opened up to European migration in the nineteenth century, most migrants bypassed the tropical lowlands and settled in the more temperate and healthy highland regions of the mainland. Some postindependence plans to colonize Europeans in the Greater Caribbean came to naught. For example, a group of Scottish settlers attempted to establish themselves in Topo, near the city of La Guaira, Venezuela, in 1827. There, they intended to cultivate coffee and indigo. As with many other such colonization schemes, the "fertile" land that the settlers had been promised could not, in fact, sustain the intended economic activities. In the case of Topo, large-scale soil erosion produced by indigenous agriculture and the colonial timber industry left the soil so badly degraded that, according to one historian, the land "could not be cultivated, let alone produce sufficiently large harvests to support the colony's two hundred or so people and still leave enough to be sold commercially" (Rheinheimer Key 1988, 75). After two years, they gave up and the entire colony moved north to Guelph, in the British province of Upper Canada.

Of course, other European migrants to the Greater Caribbean enjoyed more success. Europeans often migrated to the highlands of the Caribbean, northern South America, and Central America, where they played a critical role in the development of coffee farming—both as landowners and as peasant farmers. Other Europeans prospered even in the humid lowlands of the Greater Caribbean. To give one example, in the mid-nineteenth century, three-quarters of the hacendados in Ponce, Puerto Rico, were European immigrants. In 1847, European immigrants owned all eight of Ponce's largest haciendas. One owner was from Spain, and the others from Germany, France, and Great Britain (Dietz 1986). Later in the nineteenth century and in the early twentieth century, many Spaniards migrated to Cuba and Puerto Rico (Bergad 1984; Losada Alvarez 1995). Later in the nineteenth century, there was a small but significant wave of Arab migrants from the Ottoman Empire, especially Syria and Lebanon (Fawcett and Posada-Carbo 1997). Nonetheless, in the lowland Caribbean, other groups usually outnumbered Europeans. They may have dominated the institutions of political and economic power, but demographically they were outnumbered.

Demographically, and in almost every other respect, Africans were by far the most significant group of migrants to the Greater Caribbean. The African slave trade had formed an important part of transoceanic migrations during the conquest era as well; some 2 million Africans were brought to the New World before 1700. Between 1725 and 1867, about 3.8 million more African slaves were brought to the Greater Caribbean. Slightly more than 2 million of these were taken

to the British Caribbean (the Leewards, the Windwards, Trinidad, Jamaica, Barbados, and the Guianas), some 988,000 to the French Caribbean (Saint-Domingue and the French Windwards), 843,000 to the Spanish mainland and the Caribbean, and 32,000 to the Dutch Caribbean (Eltis 2001). They, too, suffered from the same kinds of diseases as Europeans, but they often had more direct experience and had acquired immunity to yellow fever, smallpox, and other contagious diseases (Kiple 1984). Those who survived the crossing—and their descendants—helped sustain the Greater Caribbean's agricultural landscapes for several centuries. Without their (coerced) labor, for example, sugarcane cultivation would not have spread as extensively as it did in the colonial Greater Caribbean.

The history of African migration to the Greater Caribbean neatly illustrates the political and economic structures that underlay the neo-Columbian exchange. This migration (and any human migration) was, of course, a biological phenomenon as much as an economic and political one. In this instance, the biological process depended almost entirely on economic and political decisions. As is well known, the mass forced migration of Africans to the Greater Caribbean had almost completely ended by the mid-nineteenth century because of changing economic and political conditions. Several key events brought this to a close—the revolution in Saint-Domingue destroyed one of the major destinations for slaves in the New World. This was followed by the formal abolition of the slave trade in the British Empire in 1807 and the abolition of slavery in 1833. The abolition of slavery in Cuba in 1886 finally extinguished African slavery in the Caribbean. The end of the slave trade ended the strong (and largely unidirectional) relations between West Africa and the Greater Caribbean that had endured for the previous three centuries.

As the Atlantic slave trade declined, planters in the Greater Caribbean turned to Asia for a new source of agricultural labor. Sugar planters in the West Indies brought coolies from China to work under contract. Between 1853 and 1873, more than 130,000 Chinese laborers migrated to work in the cane fields of Cuba alone. Working conditions there were brutal, and mortality was high. An American traveler to Cuba observed, "[T]hey feel the weight and shame of bondage [but] it is a comfort to think that they can look forward to a day of emancipation; for the coolies are bound for a term of eight years only during which their time is severe enough, but at the end of which they are their own masters" (Pérez 1992, 69–70). In spite of this ambivalent assessment of their fate, the coolies did not fare well in Cuba. By the end of the nineteenth century, the Chinese population in Cuba had dwindled to fewer than fifteen thousand people. Chinese laborers also migrated to the British Caribbean (in smaller numbers), where they tended to enjoy somewhat better conditions than in Cuba (Watts 1987; Look Lai 2003).

India was also a major source of Asian immigrants to the Greater Caribbean. Most Indian migrants were indentured laborers brought to work in the British Caribbean, especially in Jamaica, Trinidad, and British Guiana. The earliest groups of immigrants in the 1830s often succumbed to diseases, ill treatment, and malnutrition. The migrants who arrived after 1850 fared much better. Improved regulation of work conditions, improved sanitation, and a greater number of female migrants meant that, unlike the Chinese coolies in other parts

of the Caribbean, Indian migrants often stayed in the Caribbean once their term of indenture was over and established self-sustaining communities. Their numbers remained comparatively small—before 1917 some 38,000 migrated to Jamaica and 144,000 migrated to Trinidad—and outside of those areas they did not have the same demographic presence as did migrants from Africa or Europe (Watts 1987). The Dutch also encouraged the migration of labor from Asia to Suriname, including some 34,000 immigrants from British India and another 33,000 from Java, in the Dutch East Indies. Roughly two-thirds of the Indians and three-quarters of the Javanese laborers settled permanently in Suriname (Hoefte 1998).

By the mid-nineteenth century, however, mass immigration was no longer required to sustain populations in the Greater Caribbean. Improvements in public health and nutrition contributed to declining mortality. Watts (1987) suggests that nineteenth-century population growth in the island Caribbean was between 1 percent and 2 percent. In part, mass migration was no longer required because the populations were by then large enough to sustain the agricultural economy. Still, the dominant presence of nonwhites in most of the Greater Caribbean makes an important point about the nature of the neo-Columbian exchange. As the anthropologist Sidney Mintz (1974, 47) has observed, "[N]o one who was not European ever migrated to the Caribbean freely." Coercion and exploitation—of landscapes and of people—lay at the heart of the neo-Columbian exchange.

BIOPROSPECTING: NEW SPECIES AND NEW VARIETIES

In the original Columbian exchange, agricultural producers in the Greater Caribbean continuously introduced new species and new varieties of plants and animals, in the hopes of improving their economic situation or staving off decline. These introductions have not always drawn as much historical attention as they might have. Studies of global transfers of plants, animals, and people often privilege the first arrival; they pay less attention to subsequent ones. These biological transfers should be seen as processes rather than events. For example, the first variety of sugarcane was introduced to the New World in the late fifteenth century. The next recorded variety of sugarcane was introduced to the Greater Caribbean from Tahiti in the late eighteenth century. By the last third of the nineteenth century, introduction of new species and varieties of cane were so frequent that it is difficult to keep track of them all. The pace of introduction reflected both the expansion of European imperialism in Asia and the Pacific and new pressures for innovation from planters. Over the long nineteenth century, the introduction of new plants and animals to the Greater Caribbean was part of a broader process of experimentation and innovation in the region's agriculture.

Biological exchanges in this period focused as much on the introduction and diffusion of new varieties as it did on new species. Planters regularly imported new varieties of major tropical crops. This represented new sources of supply; in the eighteenth and nineteenth centuries, European powers had consolidated political and economic control over major centers of biological diversity in Africa, Asia, and the Pacific. This process also represented new demand from planters

in the Greater Caribbean, who hoped that new varieties might help increase the productivity of their farms; open up new pioneer fronts that were not hospitable to traditional crop varieties; or at least help mitigate the impacts of soil erosion, diseases, and pests in their existing farms.

The case of sugarcane illustrates the broader trends. Before the mid-eighteenth century, the sugar plantations of the New World depended on a single variety of sugarcane (later known as Creole cane). New varieties began to arrive in the New World in the last decades of the eighteenth century. The French explorer Louis-Antoine de Bougainville discovered a new cane variety in Tahiti in the 1780s and baptized it "Otaheite cane." It was attractive to planters because it produced much higher yields on virgin soil than did the traditional variety. The French sent Otaheite seedlings to their colonial botanical gardens across the global tropics. By 1793, the new variety had reached Cuba, and from there it diffused through the rest of the Caribbean. In 1819, the explorer Alexander von Humboldt (1819, 85) described its economic and ecological importance for the Greater Caribbean:

> The sugarcane of Otaheite . . . is one of the most important acquisitions, for which Colonial agriculture is indebted to the travels of naturalists. It yields not only one third more of juice than the creolian cane on the same space of land; but from the thickness of its stem, and the tenacity of its ligneous fibres, it furnishes much more fuel. This last advantage is important in the West Indies, where the destruction of the forests has for a long time obliged the planters to use the canes deprived of their juice, to keep up the fire under the boilers. But for the knowledge of this new plant, the progress of agriculture on the continent of Spanish America, and the introduction of the East Indian and Java sugar, the revolutions of St. Domingo, and the destruction of the great sugar plantations of that island, would have had a more sensible effect on the prices of colonial produce in Europe.

In the 1850s, a second major new variety of cane, the Cheribon (or Crystalina), was introduced to the New World from Java, after the Otaheite cane "failed" because of diseases and soil erosion. In the 1880s, the pace of varietal innovation increased after sugar breeders in Java and Barbados independently discovered that it was possible to breed hybrid sugarcanes. The Dutch, in particular, produced thousands of new cane hybrids—known as POJ canes, after the Proefstation Oost Java, where they were developed. These canes were freely shared with sugar planters around the world. One of these, POJ 2878, was widely adopted in Puerto Rico and Cuba after a viral disease of sugarcane threatened the traditional canes that had been cultivated there (McCook 2002).

Some of the new plant introductions were not cash crops, but most supported the agricultural export economy in one way or another. For example, European planters introduced new food crops to feed their slave labor. The most important of these was the breadfruit (*Artocarpus altilis*), a tree native to the western Pacific. At the request of planters on Jamaica, the British navy sent Captain William Bligh to collect breadfruit plants in the Pacific and bring them to the West Indies. His first attempt was unsuccessful, ending with the famous mutiny on the HMS *Bounty* (Bligh 1920). His second attempt, in 1793, was successful. France and Spain also transplanted the breadfruit from the Pacific to their colonies in the Greater Caribbean at about the same time, albeit with less fanfare and turmoil. The Caribbean

slaves did not much like the breadfruit, however, and they seldom consumed it on a large scale. In most of the Greater Caribbean, then, breadfruit was commonly used as animal feed, particularly for swine. Breadfruit did gain some popularity as a food staple among rural peasants in the nineteenth century, after abolition (Morton 1987; Watts 1987; Smith et al. 1992; Kiple and Ornelas 2000).

New plants were also introduced to the Greater Caribbean to address the growing problem of deforestation. The expanding export economy often placed tremendous pressure on Caribbean forests, so finding quick-growing tropical trees for timber and fuel became a priority. One of the most popular of these introductions was the eucalyptus tree, native to Australia and the western Pacific islands. The first European to describe the *Eucalyptus* genus was the French botanist L'Héritier, who encountered the plant on a voyage to Tasmania in 1788 (Sahut 1888). They were introduced to the British West Indies through the colonial botanic gardens in St. Vincent and Jamaica (Richardson 2004). Private companies also contributed to the spread of eucalyptus. The Gran Ferrocarril de Venezuela introduced eucalyptus trees to Venezuela in the late nineteenth century. There, the eucalyptus trees accelerated reforestation and provided railroad companies and sugar mills with a renewable supply of timber for fuel and for construction. Eucalyptus trees were also reputed to have medicinal uses. In Venezuela species of eucalyptus trees were reputed to "keep mosquitoes at bay and reduce malarial miasmas" (Pittier 1926, 224). In 1898 Governor Cornelius Moloney of Barbados similarly proposed planting eucalyptus trees on Grenada and Carriaco (in the Grenadines) to act "as force pumps to the swampy areas of these islands" (Richardson 2004, 192).

New animals were also imported to the Caribbean in service of the region's changing rural economy. In the nineteenth and twentieth centuries, the Greater Caribbean and Latin America went through several cattle cycles. The European cow (*Bos taurus*) had been introduced to the Caribbean by Spanish settlers in the late fifteenth and early sixteenth centuries. Settlers developed a new breed—the Criollo—specially adapted to the conditions of the New World. Criollo cattle, along with other draft animals, were often used to power sugar mills in the eighteenth century (Watts 1987). The Criollo cow remained the dominant breed in the Greater Caribbean until the mid-nineteenth century, when British planters in Jamaica introduced zebu cattle (*Bos indicus*) from South Asia. This introduction was a product of British imperialism; the historian John Rouse (1977, 196) notes that "English plantation owners [in Jamaica] were aware of the capability of the Zebu as a draft animal from the experience of their compatriots in India." In the Greater Caribbean, the introduction of zebu cattle was tied to the expansion and industrialization of the sugarcane industry. These hardy cattle carried carts of cut sugarcane to the mechanizing sugar mills. Zebu and Criollo cattle were crossed, and ultimately most of the pure Criollo lines disappeared. The zebu and zebu-Criollo hybrids were also better adapted to dry savanna environments than the pure Criollo cattle, effectively allowing cattle production to spread to areas where it had not been possible before. In the early twentieth century, the need for draft oxen declined as sugar mills mechanized all aspects of the industry and the

tractor gained in popularity. The zebu and Creole cattle, and their hybrids, were in turn replaced by herds of European beef and dairy cattle, such as the Jersey, Shorthorn, Hereford, Holstein, Friesian, and Charolais breeds (Rouse 1972, 1977).

By the early twentieth century, new plants and animals—or at least new breeds of plants and animals—imported from Africa, Asia, and the Pacific had come to dominate the agricultural landscapes of the Greater Caribbean. Coffee farms dotted the highlands of the island Caribbean, Central America, and the South American mainland. Bananas and genetically renovated sugarcane spread across the lowlands. New food crops—the breadfruit and the mango—worked their way into to the human and animal diets. The lives and livelihoods of Caribbean peoples were organized around plants and animals that had been introduced from the Old World.

ACCIDENTAL EXCHANGES: DISEASES, PESTS, AND WEEDS

Not all global transfers during the neo-Columbian exchange were deliberate. Stowaways of one sort or another—a cavalcade of viruses, fungi, ticks, fleas, mosquitoes, weeds, rodents, and other organisms—also made the crossing. Even though these introductions were not deliberate, they were made possible by the prevailing patterns of trade and empire, and by the agricultural economy. They reflected the reorganization of landscapes and the movement of organisms to maximize export production. The Greater Caribbean also experienced a wave of new diseases and pests introduced from as far afield as Asia and the Pacific, as well as the interior of Africa. All of the region's biological communities—people, plants, and animals—suffered epidemics and infestations. The new epidemics of human and animal diseases were seldom as dramatic as those during the initial Columbian exchanges. The human populations of the New World were no longer epidemiologically virgin. The same was not true of the region's plants—even the introduced plants. Few, if any, significant plant diseases or pests were introduced from the Old World to the New during the initial Columbian exchange. This reflected the comparatively small number of plant introductions and the long voyage. In the absence of diseases and pests, Old World crops often flourished in the New World. But with the increase in biological transfers during the long nineteenth century, this epidemiological status quo began to change. The disease patterns of the long nineteenth century were precursors to the trade-related infections of the late twentieth and early twenty-first centuries (Kimball 2006; Miller 2007).

Across this period, the diseases that killed the most people continued to be ones that had been introduced in the initial Columbian exchange—especially yellow fever and malaria. But while the diseases remained largely the same, the neo-Columbian exchange did introduce substantial new populations of susceptible hosts. Immunologically inexperienced migrants moved to the Caribbean from Europe, Asia, or elsewhere in the tropics. The vast new development projects—the constructions of roads, railroads, and canals through frequently marshy coastal areas—brought such populations of people into contact with *Aedes aegypti* (carrier of yellow fever) and the *Anopheles* mosquitoes. These public works often changed

the landscape in such a way as to favor the proliferation of mosquitoes, especially by creating large pools of standing water. Many of the people who worked in these regions—French, American, and West Indian—died (Sutter 2007). Large-scale military operations, such as the attempts by European armies to reconquer Saint-Domingue, and later the Spanish and U.S. military expeditions to Cuba and Puerto Rico during the War of 1898, also brought new populations of vulnerable hosts into the native range of the mosquitoes. In Cuba, for example, Spanish and later U.S. troops were much more likely to die of yellow fever than were native-born Cubans (Espinosa 2009; McNeill 2010).

Among the human population, the cholera epidemic of the 1830s was arguably the most significant introduced epidemic. Cholera is caused by *Vibrio cholerae*, a microorganism commonly transmitted from person to person through contaminated water or through contact with fecal matter. Its native home is the Ganges River valley of India. In 1817, an epidemic broke out in India, spreading eastward into Russia and reaching northern Europe by 1832. From there, the disease quickly crossed the Atlantic into Canada and the United States, and from there down to the Caribbean. Cholera reached Havana on a ship from the United States, and between 1833 and 1836, it carried away some thirty thousand people, including twenty-two thousand slaves. This epidemic did not spread to any other Caribbean islands, although it did reach Mexico, where it wreaked havoc in Mexico City. A second epidemic reached Cuba in 1848, once again arriving on a ship from the United States. This second epidemic did not remain contained to Cuba. It spread to the Greater and Lesser Antilles, leaving some forty thousand people dead in Jamaica alone and another thirty thousand dead in Puerto Rico. In the West Indies, as in other parts of the world, cholera killed about half the people it infected. In many islands, it left as much as 10–15 percent of the population dead. The historian Kenneth Kiple (1985) estimates that, in the Caribbean alone, cholera killed between 150,000 and 200,000 people (Hays 2003).

New plant epidemics also plagued the Greater Caribbean, in a pattern that echoes the virgin-soil epidemics among humans during the initial Columbian exchange. Before the nineteenth century, few major diseases or pests afflicted the major crops of the Caribbean. The exotic crops cultivated in the New World had left their diseases and pests behind them in the Old World. For several centuries, then, the plants prospered in their adopted Caribbean homes. In the nineteenth and twentieth centuries, however, the barriers against diseases and pests began to break down. Bacteria, fungi, and viruses silently accompanied seeds, seedlings, and plants as they were exchanged across the globe. And when they arrived in the Caribbean they often found purchase in landscapes—the large monocultures—that favored their growth and reproduction. One such disease was the Panama disease of bananas. The disease (caused by the fungus *Fusarium oxysporum* f. sp. *cubense*) had first been identified in Australia in 1874. By the 1890s, it had spread by means unknown to banana plantations in Panama and Costa Rica; early in the twentieth century it spread throughout the banana farms of the Caribbean basin. The epidemics of Panama disease were triggered by the large-scale reorganization of tropical forests into banana monocultures, as the large American and British fruit companies reorganized tropical landscapes through Central America

and the Caribbean. The disease first appeared in Panama in the 1890s, and by the turn of the century, it had reached the large banana farms of Costa Rica and Honduras. Between 1906 and 1911 outbreaks were recorded in Suriname, Cuba, Trinidad, Puerto Rico, and Jamaica (Soluri 2003). The economic impact of the Panama disease could be significant; the United Fruit Company claimed that the disease caused it to close six divisions in four countries; Costa Rica's share of the global banana market fell by more than half between 1915 and 1928 (Bulmer-Thomas 1994; Marquardt 2001; Soluri 2005).

Significantly, by the late nineteenth century, scientists and planters had begun to learn how to prevent some of these unwanted exchanges. They developed local and global systems for surveillance, containment, and eradication of introduced diseases and pests. There were some small success stories. When the sugar farms on Java were stricken with a disease known as *sereh* in the 1890s, planters in the New World successfully prevented the disease from spreading to the New World (McCook 2002). Still, there are some recorded instances of a pathogen successfully reaching the New World but being prevented from gaining a foothold. In the early 1900s, the coffee rust fungus (*Hemileia vastatrix*) reached Puerto Rico on coffee seedlings originally shipped from Java. The fungus spread from the seedlings to nearby coffee plants in the city of Mayagüez; nonetheless, a sharp-eyed American botanist identified the disease and destroyed the infected plants before the disease could spread to the main coffee zones of Puerto Rico's highlands (Wellman 1961; McCook 2006). Still, new diseases continued to appear despite control efforts, such as the Panama disease and Sigatoka in bananas and the mosaic disease of sugar. Scientists discovered techniques for managing and mitigating many of these diseases, but at a high cost. Constant innovation had become necessary just to sustain existing levels of agricultural production, or even to forestall decline. Caribbean farmers, like farmers in the United States, "were cursed by the Red Queen's dictum: they had to run hard just to stay in place" (Olmstead and Rhode 2008, 41).

The introduction of exotic plants, animals, and pathogens to the Caribbean often produced continuing cycles of new introductions. For example, the rat, which had snuck into the Americas sometime during the initial Columbian exchange, became a major problem in the sugar cane fields. To solve the rat problem, one enterprising planter in Jamaica imported the mongoose (*Herpestes auropunctatus*)—a small mammalian carnivore—from India in 1872. (This is yet another example of a direct biological transfer from Asia to the Greater Caribbean.) Planters in Puerto Rico, Haiti, and elsewhere in the Caribbean introduced the mongoose to their islands. By the 1890s the mongooses had brought the rat population under control, but the solution proved, in the words of one contemporary biologist, "dearly bought." The mongooses "increased until they spread over the whole island and became a greater pest than the rats on account of their wholesale destruction of poultry, game, ground-nesting birds of various kinds, reptiles, and even fruits." This in turn had further repercussions, as "the decrease in birds was followed by a marked increase in certain insect pests," especially ticks (Palmer 1899, 175). Ironically, it seems that the ticks began to prey on other species—including the mongoose. By the early twentieth century, the mongoose population in Jamaica had begun to slowly decline (Hill 1897; Courchamp, Chapuis, and Pascal 2003).

Over the longer term, the rat population adapted to the mongoose by shifting their habitat up into the trees, where the mongooses did not climb. According to one recent scientific account, "there can be little doubt that the mongoose in the West Indies . . . has helped to endanger or exterminate more species of mammals, birds and reptiles within a limited area than any other animal deliberately introduced by man anywhere in the world" (Lever 1994, qtd. in Courchamp et al. 2003, 354).

The case of the mongoose illustrates the complex and fragile underpinnings of the neo-Columbian exchange. In general, the increased agricultural productivity came at the cost of increased ecological vulnerability. The elites of the Greater Caribbean had introduced a range of organisms to the region in pursuit of agricultural productivity, and for a (comparatively) short time they often enjoyed spectacular prosperity. But the Greater Caribbean also became increasingly vulnerable to accidental biological introductions (such as cholera and the Panama disease) or to the unintended consequences of deliberate introductions (such as the mongoose). Strict quarantine legislation and regular surveillance helped mitigate some of these potential problems. And scientific research offered (at least) the hope that introduced diseases, pests, and weeds could be eradicated or somehow managed. But in spite of this, accidental exchanges—often with harmful consequences—had become commonplace in the Greater Caribbean by the early twentieth century. The pathologies of tropical agriculture had become global.

THE EBB OF THE NEO-COLUMBIAN EXCHANGE

The neo-Columbian exchange gradually subsided in the early twentieth century, although global biological exchanges never ceased altogether. The links between the Greater Caribbean, Africa, and Asia weakened with the decline of the colonial plantation complex. For a brief time, the very decline of the plantation complex fostered some new global exchanges, such as the importation of indentured labor from India and China and the introduction of zebu cattle. In fact, the Greater Caribbean often became a *source* of biological transfers in the other direction, as European powers exported Caribbean plants and animals (and sometimes people) to their more economically dynamic colonies in Africa and Asia. After abolition in the Caribbean, for example, many British West Indian planters moved to Ceylon. Coffee planters in India, Ceylon, and parts of Africa imported seeds of Jamaica Blue Mountain coffee, hoping to reproduce that coffee's famed quality. New World crops such as cocoa and rubber were also taken eastward; by the early twentieth century, cocoa production in West Africa had vastly outstripped the New World plantations in the Caribbean, Mesoamerica, and Ecuador. Later in the nineteenth century, U.S. economic and political interventions in the Greater Caribbean stimulated a second wave of global biological exchanges. After World War I, however, official enthusiasm for biological prospecting and global biological transfers waned. More nativist views gained sway at the U.S. Department of Agriculture and other key scientific agencies (Pauly 2000).

After the war, trade recovered somewhat, and with it new biological exchanges. In the postwar period, three Caribbean crops enjoyed a period of reasonably

sustained growth—bananas, sugar, and coffee. The Cuban and Puerto Rican sugar industries reached their peak of growth in the decade following World War I. It was in these years that planters on both islands began cultivating hybrid canes imported from Java on a large scale, and (not coincidentally) in the same period, the mosaic virus of sugar cane was accidentally introduced into the region. The banana industries of Central America and Colombia, managed by American-owned companies, also enjoyed a similar period of economic growth and expansion—along with their first severe epidemic, described earlier. Finally, in the 1920s, Colombia and Central America doubled their share of global coffee production, largely through the opening of new pioneer fronts rather than any significant innovation. Unlike the other two crops, coffee managed to escape any significant diseases or pests—more as a result of a great deal of luck and small amount of vigilance than because of any inherent superiority of the plant (Bulmer-Thomas 1994).

The Great Depression of 1929 effectively ended the neo-Columbian exchange. Global demand for tropical commodities stagnated through much of the 1930s. Although the volume of exports from Latin America and the Caribbean gradually recovered after 1932, their value did not necessarily recover with the same speed. The economic and institutional order that had structured the neo-Columbian exchange since the early eighteenth century was moribund. By the 1930s, there was no longer the same pressure to increase commodity production and to colonize new frontiers. By the 1930s, many of the most important introductions had already taken place, and the most important agricultural frontiers in the Greater Caribbean had been colonized. The threat of new diseases and pests had also dampened the enthusiasm for unrestricted introductions of plants and animals. The focus of agricultural innovation generally and agricultural science specifically had largely shifted from global bioprospecting to systematic breeding. Likewise, scientists and farmers alike came to favor chemical control of diseases and pests rather than biological control. A new chapter in the continuing history of the Columbian exchanges in the Caribbean began with the many transformations that swept the region after World War II.

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