The Depopulation of Hispanic America after the Conquest

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In 1574, the cosmographer López de Velasco published his *Geografía y descripción general de las Indias*. Together with much other interesting information and data, Velasco reported the number of tributaries as enumerated in each district in tax reports and other assessments (López de Velasco [1574] 1971). Adding up the data yields a total close to 2 million, corresponding to 8 to 10 million people for all of Hispanic America, comprising the majority of the total population of the Western Hemisphere.[1] This number reflects the knowledge of Spanish authorities in the early 1570s—80 years or so after Columbus's landfall, 50 years after the destruction of the Aztec capital Tenochtitlán by Cortés's expedition, and 40 years after the assassination of the Incan emperor Atahualpa in Cajamarca at the hands of Pizarro and his companions. Three decades later, at the beginning of the 1600s, the population was smaller: in central Mexico it had declined from 2.7 million in 1568 to 1.4 million in 1595 (Cook and Borah 1971). In Peru (current boundaries) the population fell from 1.3 to 0.9 million between 1570 and 1600 (Cook 1981: 94). I cite the data from Mexico and Peru, not only because they represented the most populous, densely settled, and advanced areas of the Western Hemisphere, but also because the quality of the information, for that period, was relatively high and at any rate unsurpassed until the end of the eighteenth century. After the mid-sixteenth century, the colonial governments in the Virreinatos of Nueva España and Peru reformed the taxation system and made serious efforts to enumerate the tributaries, while curtailing tax exemptions and relocating dispersed populations.[2] The *visitas* (visits, or inspections), although not properly modern censuses, were efficient headcounting operations made by knowledgeable functionaries and offer a reasonable picture of the population's size and distribution.[3]

Before the 1560s and 1570s, there are glimmers of information, but no reasonably complete population counts. For Mexico after 1546, the taxation system inherited from the Aztecs was revised through a series of inspections whose results are available in a document (*Suma de Visitas*) that reports counts for 900 localities, about half the total for central Mexico (Cook and Borah 1960a and 1960b). However, a large proportion of families and individuals were exempted from the tribute—and therefore not counted—and extensive areas were not covered by the inspections, reducing the value of the document for estimating the total population. In Peru and elsewhere, quantitative knowledge before the mid-sixteenth century is limited to scattered local information that does not permit a reasonably accurate estimate of the total population. What is known, however, is sufficient to corroborate the testimony given by contemporaries of a continued population decline, even collapse, in the decades following the Spanish Conquest. Among the major Caribbean islands, the native Taino Indians were almost extinct by 1550, plummeting from a contact population that although not in the millions—as some modern scholars have estimated[4]—certainly numbered several hundred thousands (Livi-Bacci 2003b). The coastal areas of the gulf of Mexico and of Peru were largely depopulated by mid-century, their inhabitants killed or dislodged by malaria in the former and by the wars and the intrusion of Europeans in the latter. Evidence of a similar nature can be found for other parts of the hemisphere.

So the story of the first century of the Spanish Conquest is one of decline, collapse, or catastrophe. But while there is a reasonable consensus around the population estimates for the latter part of the sixteenth century, there is wide disagreement about the size of the native populations at the time of first contact (Alchon 2003: 150–172). Table 1 gives an idea of the extent of disagreement, the ratio of the highest to the lowest population estimate being 12:1.

A discussion of the merits of the various estimates is beyond the scope of this essay. Eclectic methods and criteria were used in obtaining them, ranging from assessments based on archaeology and geographical and political factors to the backward projection of depopulation rates observed for

TABLE 1 Estimates by twentieth-century authors of the population of the Western Hemisphere at the time of first contact with Spanish settlers (millions)

	Kroeber (1939)	Steward (1949)	Rosenblat (1954)	Dobyns (1966)[a]	Denevan (1976)	Denevan (1992)
North America	0.9	1.0	1.0	11.0	4.4	3.8
Mexico	3.2	4.5	4.5	33.8	21.4	17.2
Central America	0.1	0.7	0.8	12.2	5.7	5.6
Caribbean	0.2	0.2	0.3	0.5	5.9	3.0
Andes	3.0	6.1	4.8	33.8	11.5	15.7
Lowland South America	1.0	2.9	2.0	10.1	8.5	8.6
Western Hemisphere	8.4	15.5	13.4	101.3	57.3	53.9

[a]Estimates from Dobyns are averages of low and high variants, which for the hemisphere as a whole are 90 million and 112.6 million.
SOURCE: Denevan (1992), pp. xviii and 3.

a later period to an earlier one. However, the assumed size of the population at the time of first contact is not a neutral factor when trying to discern the causes of the ensuing demographic disaster. There are three reasons why the decision whether to select a high estimate or a low one influences the explanation of the following demographic downfall. For the sake of conciseness, I will name them "confiscation of labor," "diffusion of disease," and "Conquest's atrocities."

Confiscation of labor. This was a powerful cause of the social and economic dislocation brought about by the Conquest, often producing a fall in agricultural production and resultant famine. The conquered Indios were not legally slaves, but they were forcibly employed by the Europeans to provide services and support on their haciendas, for transport and construction, and in the search for gold (Simpson 1966; Alchon 2003: 242). On the island of Hispaniola (modern Haiti and Dominican Republic), for instance, the Spaniards numbered no more than 10,000 at the height of their settlement period around 1510.[5] This population size was large enough to wreak havoc in a society of a few hundred thousand people or so, as some (myself included) conjecture the island contained at contact. But it was too few to have a decisive negative impact in a society with 8 million people, as some modern authors have assumed was the case.[6]

Diffusion of disease. New diseases imported from Europe were a major cause of the population collapse in the Americas, as I later discuss. However, the extent and speed of their diffusion were certainly greater in densely settled areas and much less so where the population was of small size, scattered, or isolated. So the assumed size of the population at first contact is a relevant question when assessing the impact of the new pathologies on the demographic collapse.

Conquest's atrocities. Atrocities were repeatedly perpetrated against the conquered peoples, particularly with the first wave of the Conquest. But the direct impact of killings, maimings, rape, abduction, and depredations on the conquered population must have been directly associated with the ratio of conquerors to conquered, and therefore inversely correlated with the natives' population size.

Paradigms of collapse: The origin of the Black Legend

Fray Toribio de Benavente, who took the *nahuatl* name of Motolinia (the Humble), was one of 12 Franciscan friars sent to the Indies for the purpose of converting the natives to Christianity. He arrived in Mexico in 1524, less than three years after the fall of Tenochtitlán. Motolinia traveled throughout the country, preached to the Indians in *nahuatl* (their native language), and converted, christened, married, and buried multitudes of Indians. He shared the awareness of other contemporary observers that the natives were becoming fewer and fewer. His *Historia de los Indios de la Nueva España* was probably written in the 1540s; the first chapter deals with the "ten plagues" that devastated Mexico (Motolinia [1858]1973: 13–18). They were: 1) smallpox that struck the country in 1520, "and in the majority of the provinces more than half the population died, in others slightly less,"[7] followed by measles in 1531; 2) war and the "many who died in Nueva España's conquest and particularly in the city of Mexico;" 3) the famine that followed the war because the fields had been devastated and abandoned; 4) the *calpixques,* supervisors of labor in the fields and tax collectors on behalf of the Spanish *encomenderos* (*conquistadores* and colonists to whom the land and the natives were granted); 5) the excessive tributes exacted from the natives, including in gold; 6) the mines of gold and the craving for gold; 7) the rebuilding of the "great city of Mexico" by Indians obliged to lend their labor and provide materials without compensation; 8) enslavement of Indians, who were sent to work in the gold mines; 9) the corvées for supplying those who worked in the mines; and 10) fighting among various factions of the Spaniards themselves.

Motolinia's ten plagues can be reduced to four main categories of proximate determinants of population collapse: the new pathologies; the violence of the wars of Conquest, exerted in the suppression of rebellions or in civil conflicts, with their direct consequences of devastation, famine, and hunger; the confiscation of labor for food production, the search for gold, transportation, and the construction of public, religious, and private buildings; and the loss of traditional autonomy and the attendant social and economic dislocation. Most contemporary observers—religious people, government functionaries, military men, chroniclers, even many *encomenderos* (who benefited from some of the "plagues")—subscribed to part or all of Motolinia's list. Rarely, however, when relating the evils of the Conquest, was a hierarchical order of importance given.

When Motolinia arrived in Mexico, Bartolomé de las Casas had been in the Indies for more than two decades. First an *encomendero*, he soon took religious orders as a Dominican, became an embattled advocate for the natives, and, thanks to his influence on the King and Court of Spain, inspired legislation favorable to the Indians. While Motolinia's History remained unpublished for centuries, the famous pamphlet of Las Casas, *Brevísima relación de la destruición de las Indias* (A Brief History of the Destruction of the Indies), written in Seville in 1542, was published in 1552 and became popular throughout Europe (Las Casas [1552]1996; see also Las Casas [1875–76]1951). An invective against the oppression of the Indians and the cruelty of the Spaniards, the book contains a horrifying list of violence perpetrated by the conquerors and the *encomenderos*. The book is not a chronicle, but a passionate defense of the natives and a denunciation of the double tyranny of the Spaniards: "the first consisting of unjust, cruel, bloody, and tyrannical wars," the second "of the oppression with the most harsh, horrible, and hard serfdom to which humans and animals had ever been subjected" (ibid.: 78). Indeed, Las Casas's efforts succeeded, to a certain extent, in modifying the *encomienda* system through promulgation of the "New Laws" in 1542. His book was translated and published in English, Flemish, French, German, and Italian; it was the foundation of the "Black Legend" of the vicious cruelty of the Spanish Conquest and was widely used as a vehicle of anti-Spanish, anti-Catholic propaganda. The Black Legend was for centuries the handy paradigm for the interpretation of the political, social, and demographic collapse of the native populations. Rejected by the Spanish culture, particularly in the nineteenth and twentieth centuries, the paradigm underwent a gradual revision elsewhere, as new analysis and findings offered a more comprehensive and balanced view of the colonization of Hispanic America (Keen 1969; Hanke 1971). If the ideological foundations of the Black Legend can be found in the pamphlet of Las Casas, the empirical analysis of its factors appears already in the writings of Motolinia, who took issue with Las Casas's thesis.

Motolinia was not alone (aside from Las Casas) in denouncing the evils of Conquest, but he was the most articulate of a host of writers of the time. Fernández de Oviedo, official historian of the Americas and one of many of Las Casas's critics, with a wide experience of the New World, wrote that "the death of these people was likewise occasioned in great measure by the shifting about which the governors and assessors made of these Indians [the Tainos of Hispaniola], from their going from master to master and from one lord to another and their passing from one greedy [hand] to another even more so, were all clearly ways and means leading to the total extinction of their race" (Oviedo [1851]1992, I: 66–67). And "since the mines of gold were rich and the greed of men insatiable, some overworked excessively their Indians, others did not feed them as they should have…" (ibid.: 67). Pietro Martire d'Anghiera, an Italian humanist at the Court of King Ferdinand who had first-hand knowledge of the reports of the various protagonists of the Conquest, attributed the demise of the Indians to the "deadly craving for gold" that, indeed, was archetypical of the first wave of conquerors and adventurers (Anghiera [1516]1930). José de Acosta, Provincial of the Jesuit order in Peru and a naturalist who had traveled to every corner of the country, wrote about the depopulation and desolation of the coasts and of their multiple causes (Acosta [1590]1986: 198–199). Pedro Cieza de Léon, who arrived in Cartagena (now in Colombia) in 1535 at age 15, and for 13 years served military, administrative, and political functions, was a careful and perceptive observer and a credible historian who traveled from the Caribbean coast to what is today Bolivia. He notes the depopulation of entire regions from Panama to the Titicaca region, and attributes it to diseases and to a quarter-century of incessant wars—Spaniards against Indians, Indians against Indians, Spaniards against Spaniards—that brought universal desolation to the country (Cieza de León [1553]1985). Garcilaso de la Vega, son of a Conquistador and of his Inca Princess concubine, writes extensively of the destruction brought about by the war to the elaborate infrastructures of the Empire: canals, aqueducts, roads (Vega [1609]1977). And the Marqués de Cañete, third Viceroy of Peru, wrote to King Philip the Second in 1566: "it is impossible to remedy everything, particularly the ever worse treatment that the encomenderos make of the Indians, because your Majesty must know that a Viceroy will not be able to prevent any Spaniard resident who robs, exhausts, or maltreats them and this happens in such a way that although my heart is hard it will break seeing what is happening.... The Indians are consuming themselves, and if God does not help, it will happen to them as it did to the Indians of Hispaniola..." (Academia de la Historia).

Many more examples could be drawn from the chronicles, documents, reports, and letters written by the many participants in the Conquest and colonization in the century after the first contact. The essence of their testimonies is that there had been a collapse and that its causes were many and complex. These were of various nature: biological (new diseases), environmental (destruction of infrastructures, deforestation, impact of livestock brought from Europe), political (wars, loss of liberty and autonomy), social (dislocation and disruption of communities, forced migration), economic (changes in production patterns, exploitation and confiscation of labor), and demographic (abduction of women, separation of couples, migration). Some of the commentators ranked the possible factors, but only a few thought that any particular factor was indisputably predominant.

The epidemiological paradigm

During the last three or four decades, the Black Legend and the multicausality of the catastrophe in post-Conquest America have been almost forgotten. In an influential paper reviewing the historical evidence, Henry Dobyns concluded that the contact population of America had been severely underestimated and that "a standard depopulation ratio of 20 to 1 [95 percent] between initial contact and the beginning of population recovery" was an acceptable measure of the collapse (Dobyns 1966: 414). Thirty years later in a widely and justly acclaimed book, Jared Diamond stated: "Throughout the Americas, diseases introduced with the Europeans spread from tribe to tribe far in advance of the Europeans themselves, killing an estimated 95 percent of the pre-Columbian Native American population" (Diamond 1997: 78). I will not enter the long academic debate that first endorsed the radical upward revisions of the earlier moderate estimates ("high counters" superseding the "low counters") and then upgraded the impact of the new diseases from the status of an important contributing factor to the almost exclusive cause of the disaster, finally attributing to them 95 percent of all native post-Conquest deaths, as if pre-Columbian populations lived in a disease-free Eden.[8] The fact is that very high estimates of the size of the population at the time of first contact have been reinforced by epidemiological considerations, and, reciprocally, the acceptance of a predominant or exclusive role of the new diseases has buttressed the shaky foundations of high estimates. An abrupt fall of the native population from 100 million to 5 million could hardly be attributed to the cruelty of the few thousand Conquistadores, but could very well be the consequence of deadly diseases.

Let us address the basic question: how well founded is the "epidemiological paradigm" that imputes to the new diseases the predominant role in the demographic collapse? Let me state first my conclusion, which may not please those in search of easy-to-use formulas: the long-term impact of the new diseases was the more negative the more "damaged" the demographic system became and the less able it was to rebound after a shock. By demographic system I mean the complex interaction between survival, reproduction, and mobility that ensures the continuation of a population: a system that ultimately depends on social, economic, and environmental factors. In some cases—in the large Caribbean islands, for example—the system was so extensively damaged by the European intrusion that the population was wiped out before the first epidemic set in. In other cases—as in the missions of Paraguay, discussed below—the demographic system was maintained and the population expanded in spite of recurrent deadly epidemics of new diseases. Between these extremes were a variety of situations, each to be evaluated in its own right.

In the Americas, contact with Europe brought new diseases: smallpox, measles, diphtheria, rubella, and mumps among them. These are called "crowd diseases" because domesticated animals living in herds and in close contact with sedentary populations are believed to have developed their viruses and eventually passed them to humans. Diamond writes that "Eurasian crowd diseases evolved out of diseases of Eurasian herd animals that became domesticated. Whereas many such animals existed in Eurasia, only five animals of any sort became domesticated in the Americas: the turkey in Mexico and the U.S. Southwest, the llama/alpaca and the guinea pig in the Andes, the Muscovy duck in tropical South America, and the dog throughout the Americas" (Diamond 1997: 212–213). These animals did not live in enormous flocks or herds and did not come into frequent physical contact with humans. In any case there were fewer opportunities for the development of diseases and for their transmission to humans, whose settlement in the Western Hemisphere was also relatively late.[9] For these reasons, many Eurasian and African diseases did not exist in America (or in Oceania), and its natives lacked the immunity that develops with a long exposure to infection with them. They were "virgin soil" populations and the new diseases were hazardous for nonimmune individuals, although each of these diseases was less harmful to the demographic equilibrium than the plague had been in Europe in the fourteenth century. Unlike the plague, they conferred immunity to survivors so that they would not succumb to a subsequent epidemic. Lethality for smallpox (the proportion of the infected who died, or the case mortality rate) was between 20 and 50 percent depending on age (Dixon 1962), as against about 80 percent for the plague.[10] For measles, lethality among the nonimmune was below 10 percent; for other Old World diseases it was of the same order of magnitude or lower. Because smallpox, after Columbus, was without doubt the main factor in epidemic mortality, I will deal with it here. Obviously, the interaction of "new diseases" makes the American case complex; these other diseases combined their negative effects with those of smallpox in ways that are impossible to reconstruct or simulate.

Epidemiological models can be highly sophisticated, but when most of the relevant parameters are unknown, as is the case for the Amerindian population, they are of little use. Some elementary calculations may serve the purpose of our argument. An outbreak of smallpox infecting a whole "virgin" population would result in a general mortality between 30 and 40 percent, but this would be an extreme estimate, since there are always individuals who are absent or who by chance are spared the infection or are "resistant" to the virus. The survivors would then acquire permanent immunity. In a small community the epidemic burns out for the lack of susceptible individuals because those who have survived are immune, which is the reason for the periodicity of some epidemics. A subsequent epidemic would strike only when a sufficient number of susceptible, nonimmune individuals (those born after the first epidemic) had emerged, and its impact would be lower than that of the first epidemic because part of the population (a smaller part, the farther away the second epidemic is from the first) would be immune.

Let us imagine the most adverse situation: the whole population—say, the 1,000 individuals forming the population of a hypothetical village—gets the infection; 40 percent die and 60 percent survive, or 400 and 600 respectively. For smallpox to strike the village again, it is necessary that enough new nonimmune individuals—those born after the first wave—be available. Alexander von Humboldt reported the then current opinion that smallpox struck, in America, every 16–18 years (Humboldt [1807–11]1973: 44);[11] this was indeed the frequency with which it hit the Guaraní Indians in the 30 Paraguay missions in the seventeenth and eighteenth centuries. So let us assume that 15 years later, smallpox strikes the hypothetical village again; suppose that, among the 600 survivors, births have equaled deaths during the interval, and that at the time of the second outbreak the population still numbers 600 individuals. At the outbreak of the second epidemic 40 percent of the population (or 240 persons) were born during the preceding 15 years and are therefore susceptible: the number of deaths will be 240 x .40 = 96, and the mortality, which was 40 percent in the first epidemics, will now be 16 percent (96 ÷ 600 x 100). The number of survivors (all immune) will be 504. A third epidemic after another 15 years and with the same parameters would yield 81 deaths (16 percent of the population) and 423 survivors. So after three epidemics, in the space of 30 years, the population of the village would have been reduced to slightly more than 40 percent of the original population: collapse and catastrophe are apt words to describe such an outcome.

The example above is extreme and unrealistic for three reasons. The first is that at the onset of an epidemic, not all susceptible individuals become infected. A significant fraction avoids contagion because of chance, nature (some individuals are more resistant to contagion), or remoteness from the sources of infection. This fraction tends to increase with time because symptoms tend to be recognized and contact is avoided. The second reason is that the level of mortality has been set at 40 percent, close to the maximum, whereas the case mortality rate is likely to decrease after the first epidemic. This happens because of two groups of factors, biological and social. The process of selection among those who survive favors the more resistant individuals who may pass their favorable traits to the next generation, thus diminishing their vulnerability. In the process of social learning, fear is mastered and the sick are not left alone without care, food, or water; remedies are tried and retained if beneficial. The rate of survival may therefore increase. "Many were dying because, as they all got sick at the same time, they could not cure each other, and there was nobody who would give them bread or other things," wrote Motolinia when commenting on the great 1520 epidemic (Motolinia [1858]1973: 14). Finally, there is a third reason the above model is unrealistic. A quasi-universal law, verified in innumerable historical cases, implies a "rebound" after an epidemic shock, or a temporary surplus of births over deaths. The birth rate increases because of an increase in unions among survivors who have lost their partners and in many cases also because of an increase in fertility. The death rate declines because the epidemic has claimed the most vulnerable individuals in higher proportions, be they children, the elderly, or the frail. In other words, the population does not remain stationary between epidemics, as postulated in the worst-case example (Livi-Bacci 2000).

Let us now relax the extreme and unrealistic parameters used above, and let us assume that 1) at every epidemic 70 percent of the individuals are infected; 2) the case mortality rate declines from 40 percent in the first outbreak to 30 percent in the following ones; 3) in the interval between epidemics the population recovers 15 percent of its initial (post-epidemic) size (less than 1 percent per year). After 30 years, the village would count

901 individuals.[12] This outcome is hardly a collapse or catastrophe as it was in the first case, where only 423 persons survived after the third epidemic.

The epidemiological model can be readily made more sophisticated, by modifying the intervals between epidemics, introducing survival and fertility functions during normal and epidemic times, mixing different crowd diseases, and introducing interactions and retroactions between phenomena. This would not make the model any more realistic, because all the needed parameters would be hypothetical and the logic would not greatly change. Smallpox sowed disaster among the natives at its first appearance because the entire population was potentially susceptible to its destructive force.[13] But its more or less regular return wrought damage that depended not only on the number of the susceptible, but also on the diffusion of contagion, on the rate of survival of the infected, and on the ability of the social system to react and rebound. With the passing of generations a selective process of adaptation of the nonimmune could set in. In short, the fate of the native population depended not only on biological factors but also on social and demographic factors and on chance. If in some societies (notably in the Caribbean islands) natives were wiped out, this was not necessarily the fault of smallpox; if in other cases (that of the Paraguay missions) there was a more or less rapid recovery, this could happen notwithstanding smallpox. The epidemiological paradigm is so well entrenched that new disease epidemics are postulated to have struck the natives even when there is no evidence that they did so; and population decline is attributed to new diseases even when other factors may explain it. In the following sections I discuss two controversial cases that illustrate my point: Hispaniola (a case that can be extended to Cuba and Puerto Rico) and Peru.

Did smallpox arrive late? Hispaniola

There is firm evidence that smallpox reached the New World in December of 1518. In a letter dated 10 January 1519, the Hyeronimite fathers (who were then in charge of crisis-ridden Hispaniola) wrote to the King of Spain: "When the Indios were leaving the mines to return to their villages, in December of the past year, it pleased our Lord to send upon them a pestilence of smallpox that is not yet ceasing and of which have died and are at present dying almost one-third of the aforementioned Indios.…[W]e have been told that in the island of San Juan [Puerto Rico] a few Indios have started dying of the above-mentioned smallpox" (CDI 1864, I: 366). Two months later the same fathers indicated that the epidemic had run its course. By the time smallpox struck Hispaniola, the Taino population was reduced to less than 20,000 out of a few hundred thousand at the time of contact, and the colonists, short of manpower, were leaving the island for the American mainland. The population had been declining for a quarter-century, but letters, reports, and other documents carry no trace of a major epidemic hitting the island. This does not rule out the possibility that imported infections had been ravaging the "susceptible" Tainos; however, it is likely that other factors as well (including lowered fertility) were depressing the population of the island. In short, one does not need to postulate the recurrent action of epidemics and mortality crises as the exclusive explanation for the precipitous decline of the island's population (Livi-Bacci 2003a, 2003b).

Was the 1518 smallpox epidemic the first episode of the dreaded disease? Some writers have hypothesized an earlier arrival of the infection in Hispaniola, but the surviving evidence is thin—if it can be called evidence at all.[14] So the question remains whether it is possible that smallpox, as a mass disease (or indeed other imported pathologies), took so long to reach the New World in spite of the increasing number of arrivals from the European mainland. It is true that each subsequent ship traveling from Spain to America transported sailors, settlers, plants, animals, and pathogens and, therefore, it seems plausible that "to argue that no disease transfer took place on these voyages is to assume the highly improbable" (Cook 1998: 43). Maybe not so improbable, at least for smallpox. Crosby has argued that smallpox reached Hispaniola so late (in 1518) because the course of the illness—from initial infection to its elimination from the body, leaving a surviving patient immune—takes a month or less, while "the voyage was one of several weeks so that even if an immigrant or sailor contracted smallpox on the day of embarkation, he would most likely be dead or rid of the virus before he arrived in Santo Domingo" (Crosby 1972: 46).

Crosby's observation is fundamental and can be carried further. In the case of smallpox, the latent period of infection is 12 to 14 days (during this incubation period the individual is not contagious), after which the individual is infectious (the virus can be transmitted to another person) for about ten days, following which a surviving person is immune for life (Anderson and May 1979, I: 365). So, a total of 22 to 24 days elapses between the day in which the virus penetrates the body and the day in which infectiousness gives way to life-long immunity. For measles, another lethal pathogen for the Indios, the latent period is 9–12 days and infectiousness lasts 5–7 days; 14–19 days after contracting the virus, the individual is also immune for life.

Sea traffic between Spain and Hispaniola was officially registered starting in 1506; 204 ships departed from Seville and other ports of the region directed to Hispaniola in the period 1506–18 (16 per year on average), with a minimum of six in 1518 and a maximum of 31 in 1508 (Chaunu and Chaunu 1956, VI, 2: 496). Given their modest tonnage, we can assume that the average ship could carry about 45 persons, between crew (30) and passengers (15) (Mörner 1975). Assuming that all of them went ashore, more than 9,000 persons set foot on the island between 1506 and 1518, for whatever length of stay. We can assume that a comparable number went ashore between 1492 and 1505.[15] With a total of perhaps 20,000 people traveling to Hispaniola, the probability that an infected person made the passage and started an epidemic before the 1518–19 epidemic was certainly greater than zero. But how much greater?

In order to start an epidemic in the New World, the following three conditions had to be fulfilled. 1) A person with a latent infection, or in the infectious state, boarded a ship. 2) This person, if surviving, was infectious on board for 12 to 14 days, or between the 11th and the 25th day of navigation (if the ship was boarded on the first days of latency) or between the 1st and 15th day (if the ship was boarded at the end of latency). Since the voyage between San Lucar, or Cadiz, and Santo Domingo lasted 48 days on average (with a minimum of 40 and a maximum of 68 days), this hypothetical person would be either dead or healed on arrival. He, or she, had therefore to transmit the virus to another crew member or passenger, starting a chain of infection at the end of which one or more infected persons would disembark at the destination. Contagion on board, in close quarters, would be easy (if not certain) if one or more people were not immune; however, one susceptible individual would not be enough because (in most cases) he or she would also be either dead or healed by the destination. 3) One or more infected persons, once on the island, start the epidemic.

Elsewhere (Livi-Bacci 2005) I have shown that the probability that an infectious adult would board a ship bound for Hispaniola was on the order of 2 percent a year. This result derives from a simple arithmetic exercise that considers the population of the province of Seville (500,000 inhabitants at the beginning of the sixteenth century) from which most sailors and travelers came[16] and assumes that in that population smallpox was endemic as in other large urban areas of Europe and was causing 10 percent of all deaths, of which only 5 percent were deaths to adults (since smallpox, where endemic, was a children's disease); that every year 16 ships with an average load of 45 adults would travel to Hispaniola; and that it was unlikely an infected person with the easily detectable marks of smallpox would be allowed on board. This exercise yields, as I said, a probability of 2 percent and therefore, using the simplest of models, implies an average waiting time of $1 \div 0.02 = 50$ years before a person carrying the infection would set foot on board a Hispaniola-bound ship.[17] This probability must be multiplied by the probability of the start of a chain transmission on board and by the probability that an infectious passenger disembarking would ignite the epidemic. These two probabilities were certainly very high, but lower than 1, so that the total probability would be further decreased below 2 percent, and the theoretical waiting time for the first smallpox epidemic to explode in Hispaniola would be longer than 50 years.

I conclude, then, that the Tainos were unlucky: they contracted smallpox 26 years after Columbus, and not 50 or more years later, as the elementary model predicts. Had smallpox struck in 1542 (or later), however, the number of Taino victims would have been extremely small, since they had, by that time, almost disappeared for reasons other than smallpox. My argument is that scholars should not distort history by postulating events that might not have taken place. It is quite likely that the 1518 smallpox epidemic was the first to hit the New World (Henige 1986: 16), and it would be better to try to explain what carried the Tainos to quasi-extinction in the absence of smallpox (and maybe of other major classic epidemics).

Why were the Tainos wiped out? Starting in the second decade of the sixteenth century, when the negative consequences of the decline of the native population for the economy of Hispaniola became evident, the debate over the causes of the ongoing demographic catastrophe was intense. Las Casas and the Dominicans of the island participated in the debate, but so did the Hyeronimite fathers, high administrators and officials such as Gonzales Dávila, Zuazo, and Espinosa, and many long-term, prominent residents of the island. Oviedo, who arrived on the island in 1523 and was no proponent of Las Casas's thesis, also gives his own assessment (Livi-Bacci 2003b: 50). Gold fever and the *encomienda* system are the principal causes they mention. Too many Indios (up to one-third of the adult male population) in the mines, neglect of other productive activities, long *demoras* (periods of work in the mines, up to ten months every year), overwork, lack of food, unsuitable climate and environment, maltreatment, and separation from their families—all led to high mortality and low fertility among the Tainos. The *encomienda* system was also to blame. The Indios were shifted from one area to another and from master to master, exploited and overworked. The main institutional tool of dislocation was the *repartimiento*—a population count that served as the instrument of population relocation. With it, complained Zuazo, "Indians belonging to the province of Higuey were forced to go to Xaraguá or La Cabana, places distant from Higuey some hundred leagues" (CDI 1864, I: 309). The fortress of Santo Domingo was built with labor brought from Higuey following the "pacification" of the area. The rulers needed Indian labor for agriculture, mining, and construction, and other considerations were secondary. The island's officials were instructed to build new villages near the mines, to ensure that one-third of the male labor force was employed searching for gold and that at least 1,000 natives at any given time worked in the mines belonging to the king (CDU 1885, 2: 1–127).

A *repartimiento* of 1514 (in which *caciques*—chiefs—with their Indians were assigned to Spaniards) gives some information concerning population redistribution under the *encomienda* system. The total number of *caciques*, according to my own reconstruction, was 362, whose people were assigned to 498 *encomenderos*, indicating that a considerable number of *cacicazgos* (clans, communities under a *cacique*) were redistributed among two or more masters (Arranz Márquez 1991). In 37 cases this redistribution was "interdistrict," with Indios of a single *cacicazgo* assigned to two or more *encomenderos* residing in different districts. These data indicate the extensive redistribution effected by a single *repartimiento* (whose impact must be summed with that of the two preceding ones).[18] The weakening of clan and family networks, changes in material living conditions and work regimes, and the need to forge new adaptive strategies with new masters combined to produce negative consequences. It is also likely that concubinage with native women was another factor that lowered indigenous reproduction.

The explanation proposed by competent, though at times biased, eyewitnesses can be summarized as follows. The Spanish conquest involved widespread economic and social dislocation that created the conditions for higher mortality and decreased fertility. Economic dislocation was due to the "confiscation" of native labor, coerced from the normal subsistence activities and employed in the production of food, goods, and services for the newcomers and, later, also in the production of gold. Labor employed in the mines, in turn, had to be supported by native labor working in the *conucos* (fields). This double "attack" on the traditional patterns of production and consumption increased work, decreased consumption, worsened living conditions, and increased vulnerability to scarcity in a subsistence economy where accumulation was unknown. Although only a few hundred Spaniards were living on Hispaniola until the beginning of the sixteenth century, their demands for food, labor, and services placed a heavy burden on the relatively small Taino society.[19] The more so in the following decade, when the colonists numbered in the thousands and the Taino population had become smaller.

These general causes had a profound impact on the island's demographic system. The 1514 *repartimiento* reveals traces of low reproduction and unbalanced sex ratios.[20] Two of the 14 districts (Concepción and Puerto Plata) specify the number of men and women among the "Indios de servicio" belonging to each *cacique*. Table 2 reports the total number of men, women, and children for the *caciques* for whom this more detailed information was available and whenever at least one child was mentioned. Two features are evident: there are fewer women than men, and the child–woman ratio is extremely low.

TABLE 2 Men, women, and children in two districts of Hispaniola recorded by the *repartimiento* of 1514

District	Men	Women	Children	Ratio of women to men	Ratio of children to women
Concepción	949	786	217	0.828	0.276
Puerto Plata	128	108	34	0.844	0.315
Total	1,077	894	251	0.830	0.281

NOTE: The data refer only to those *caciques* (chiefs) for whom the number of men and women was specified and when at least one child was reported.
SOURCE: Livi-Bacci (2003b).

The low ratio of women to men could be the consequence of enumeration bias, differential mortality, or perhaps the fact that more women than men escaped from their masters. A more likely hypothesis is that a higher proportion of women lived as *naborias* (serfs) in the households of the *encomendero*; many younger women were their concubines, and quite a few *cacicas* (women chiefs) or *cacique*'s daughters were married to *encomenderos*. In other words, male conquerors were in successful competition for young, healthy native women, who were thus removed from the reproductive potential of the Taino population. In the *repartimiento*, 186 Spaniards specified the origin of their wives: 121 (65 percent) were Castilian and 65 (35 percent) were natives (Arranz Márquez 1991: 223).

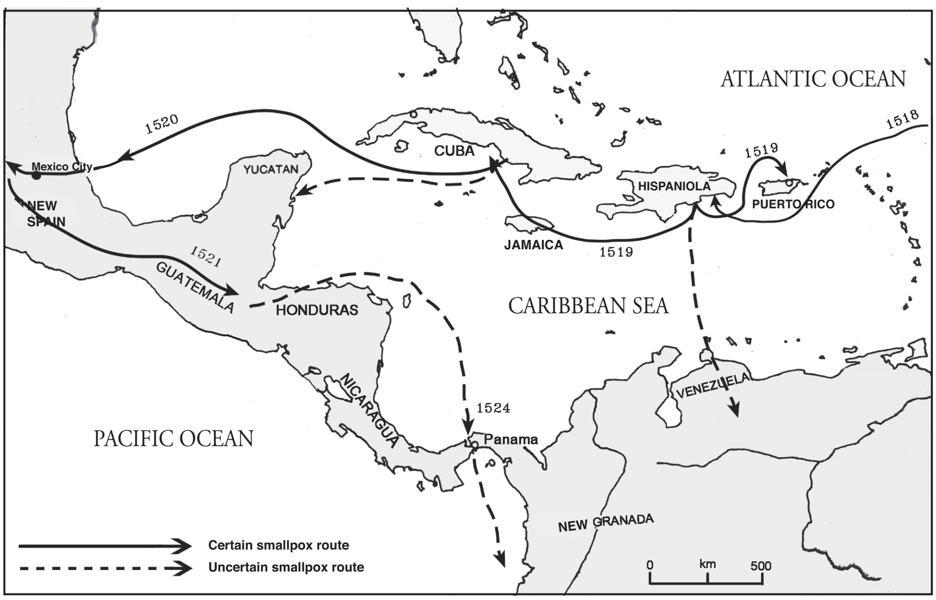
The loss of Taino women from the native reproductive pool—one-sixth of them, according to the *repartimiento*—reduced reproductive potential significantly. But this would not affect the child–woman ratio (0.281 in Table 2), which was extremely low. Such a ratio would occur in a stable population declining at an annual rate of 3.5 percent.[21] Unusually high infant and child mortality, or unusually low fertility, or a combination of the two, could be responsible for the low child–woman ratio—there is no way to tell. However, many contemporary observers commented upon the scarcity of children, the fruitless unions, the consequences of the forcible separation of women from their husbands, and the like. Legislation was intended to protect women, prohibiting them from working in the mines or engaging in farming activities when pregnant or raising children below the age of three. But these laws were made in Spain and were implemented half a world away by greedy masters under the weak supervision of island officials. Natives working in the mines were separated from their families for eight or more months of the year.

The extremely low Taino reproductive rates can be explained by the geographic and social dislocation of the community. While the violent campaigns of conquest and "pacification" undoubtedly took a heavy toll, it was dislocation that produced an irreversible decline. Contemporaries saw the continuous shifting of the population from one place to another as one of the major causes of the island's depopulation. This constant dislocation caused hunger, disease, and mortality, but it also caused a separation and weakening of family and clan ties. Marital unions were more difficult and precarious and fertility declined. Living conditions deteriorated, survival conditions worsened, and new diseases (before smallpox), while maybe not responsible for major epidemics, certainly added complexity to the island's microbial world and increased its mortality. Not only the economic and social systems but, with them, the demographic system of the Tainos collapsed. Neither the Black Legend, with its exceptional cruelty, nor the "virgin soil" paradigm, with its disease-related mortality, is required to explain the extinction of the Tainos. The disruptive effects of conquest were sufficient cause.

Did smallpox precede the conquerors? Peru

Did smallpox strike Peru before the arrival of Europeans? This hypothesis has achieved the status of an incontrovertible historical event. But the foundations of the theory of a Peruvian epidemic in the 1520s—years before Pizarro set foot in the country—are, at best, weak. Let us review the trail of smallpox after its certain arrival in Santo Domingo in December 1518 (Figure 1). It spread immediately to nearby Puerto Rico and then to Cuba; in April or May of 1520 it was carried to Mexico by Narvaez's expedition, sent by the governor of Cuba to restrain the independent and successful Cortés. It was in Cempoala (near Veracruz) that "when the companions of Narvaez landed, there was also a black man sick of smallpox who infected those who had given hospitality to him in their house, and then an Indio passed it to another Indio; because many slept and ate together, the plague propagated in such a short time that it continued to kill throughout the region" (López de Gómara [1552]2001: 233). Smallpox traveled inland to Tepeaca and Tlaxcala and finally reached the valley of Mexico in September–October and struck Tenochtitlán, killing Cuitláhuac, successor to Montezuma. It raged for two months in the valley and then wore off, traveling to Chalco (Sahagún [1938]1977: 136–137). The Spaniards were certainly helped in the siege of Tenochtitlán by the disarray caused by the epidemic. The continuation of its path is uncertain, although it is plausible the disease diffused to the rest of Mexico through the radial web of the trading routes departing from

FIGURE 1 The first smallpox epidemic in the New World



Tenochtitlán. It may have reached Yucatan; Diego de Landa, writing in the 1560s, refers to a disastrous plague that had hit the country "more than 50 years before," which could have been smallpox (Landa [1881]1968: 57).

Did smallpox continue its course southward, to Central America, the Caribbean mainland, and beyond? High mortality was recorded in Guatemala, in 1519–21, before the expedition of Pedro de Alvarado. The only certainty derives from a 1527 document stating that slaves had to be brought to Panama, Nata, and the port of Honduras because smallpox had decimated the Indians (Newson 1986: 128). Is it true to say that in Panama historical evidence ends? "Southward in the great Andean cordillera that stretches along the entire western coast of South America, the heartland of the great Inca Empire, the first great smallpox pandemic ravaged Amerindian peoples. As in the example of Aztec Mexico, where the ruler Cuitláhuac succumbed to the foreign infection, the Inca ruler Huayna Capac fell victim to a hideous alien disease" (Cook 1998: 72). Huayna Capac died, presumably, between 1525 and 1527; a long and furious civil war followed between two of his sons: Huascar, his legitimate heir in Cuzco; and Atahualpa, lord of Quito. When Pizarro took Atahualpa prisoner in Cajamarca, the conflict was practically over, with Huascar's final defeat following shortly after. What the Spaniards found was a population exhausted by a long war. Had it, like Mexico, also been depleted by smallpox?

The historical evidence is very thin, being primarily based on the accounts of the death of Huayna Capac written by Juan de Betanzos and Cieza de León a quarter-century after the event (Cook 1998: 76). Both of them had a wide experience of Peru and are credible witnesses of the Peruvian events. Betanzos does not mention the word "smallpox" but talks about "sarna" and "lepra," cutaneous diseases that others have interpreted as "verruga peruana" (*Bartonellosis*), an indigenous disease transmitted by the sandfly.[22] Cieza de León mentions smallpox (viruela) and adds that the contagion killed 200,000 people (Cieza de León [1880]1988: 194). Betanzos and Cieza had to rely on the native accounts of past events; moreover, the definition of diseases, when not based on the direct observation of symptoms, was often generic. It is an attractive hypothesis that a single smallpox pandemic, initiated in the Caribbean and continuing in Mexico and perhaps Central America, would cross the isthmus and spread to South America—or, alternatively, could reach the Atlantic coast of South America by sea—undermining the great Inca Empire. Attractive does not mean plausible, however. This hypothesis postulates that smallpox could travel thousand of miles spreading by face-to-face contact, through lands sparsely settled, in humid climates and surviving the rainy seasons (the virus does not thrive in humid climates), over mountain chains and deserted stretches of land. Epidemiologists would characterize this hypothesis as improbable, if not impossible. And until new evidence is gathered, smallpox must be absolved of guilt for such an early South American catastrophe.

Historians, mining the copious documentation that has survived, find evidence of three important and apparently widespread sixteenth-century epidemics in the Andean region: one in 1546, another in 1558, and the third throughout the period 1585–91. The symptoms described in the first epidemic are vague and cannot be pinpointed to a precise disease (Cieza de Léon [1553]1985: 138–139). The second is believed to have been smallpox (but could have been measles), brought to Colombia by slaves taken from Hispaniola, and successively spread to Ecuador and to Peru proper. This would be the first smallpox epidemic after the arrival of the Spaniards (Lastres 1951: 76; Newson 1999: 127); the smallpox that devastated the populations in Brazil's coastal settlements a few years later (1562–65) was probably an independent outbreak. The third period of high mortality, between 1585 and 1591, is responsible for a large part of the losses suffered by Peru between the early 1570s and the end of the century (Lastres 1951: 77). Smallpox is cited, but also measles and typhus; it is not impossible that the three occurred in the same period. It is reported, however, that smallpox, initiated in Cartagena in 1588, spread throughout South America in the following years.

In the last three decades of the century, Peru lost about one-third of its population, more in the coastal areas, less at high altitudes. These losses are well documented by inspections, relatively careful for the times (Table 3). Interesting features of Table 3 are the ratios of boys per tributary, and of boys and girls under 18 per woman 18 and older. Neither ratio is incompat-

TABLE 3 Population of 146 *encomiendas* in 24 districts of Peru, circa 1573 and circa 1602

	Tributarios	*Muchachos*	*Viejos*	*Mujeres*	Total population
1573	90,442	99,612	24,733	251,795	466,748
1602	66,596	66,967	25,072	166,260	324,895
1602 (1573 = 100)	73.6	67.2	101.4	66.0	69.6
Percent annual variation 1573–1602	–1.06	–1.37	0.05	–1.43	–1.25

	Ratios						
	Population per *tributario*	Men per 100 women	*Muchachos* per *tributario*	*Muchachos* and *muchachas* per *mujer* 18 and older	*Viejos* per 100 men	*Muchachos* per 100 men	Men 18 and older per 100 women 18 and older
1573	5.2	85.4	1.10	1.31	11.5	46.3	75.7
1602	4.9	95.4	1.01	1.35	15.8	42.2	92.3

NOTE: *Tributarios*: tribute-paying adult men; *muchachos*: boys aged 0–17 years: *muchachas*: girls aged 0–17 years; *viejos*: men aged 50 and older; *mujeres*: women aged 18 and older. The 146 *encomiendas* represented over 50 percent of the total population of Peru proper.
SOURCE: Cook (1982).

ible with a normal level of population replacement.[23] But even more interesting is the ratio of men to women, and particularly of men 18 years and older to women of the same age. A significant shortage of adult men is evident in 1573; this may be due to various factors, such as men's more frequent evasion of taxation or their incorporation into the Spaniards' households as serfs. But it may also reflect the losses of men during the bloody civil wars terminated only 20 years before.

Before the 1570s, the quantitative material is scarce, although inspections had been initiated under Pizarro and continued after the end of the civil wars. But a few glimpses of the past are possible: for instance, the Huanca tribe (who had supported the Spaniards at the time of Conquest and the loyalist faction during the civil wars), who lived in the central valley of the river Mantaro, had 7,200 tributaries in 1572; but their chiefs displayed to the inspectors their records, carefully kept by the *quipu* (knotted threads of various colors), which demonstrated that the tributaries numbered 27,000 at the time of Huayna Capac, half a century before (Espinoza Soriano 1986: 178). In the northern region of Huánuco inhabited by the Chupachos, an inspection made in 1562 counted 800 tributaries, as against 4,000 "at the time of the Inca," probably around 1530 (Murra 1967; Wachtel 1971: 139, 157–161). A similar decline affected the inhabitants of the Yucay "sacred valley," along the course of the Urubamba, 15 miles northwest of Cuzco: 780 tributaries in 1558, one-fourth of the 3,000 counted in 1530 (Wachtel 1971: 140, 168–170). Less catastrophic had been the destiny of the Aymarás and Uros around Lake Titicaca, in the region of Chucuito, subjected to a careful inspection in 1567 that enumerated 15,404 tributaries; the two main chiefs, Don Martin Cari and Don Martin Cusi, displayed to the inspector the *quipu* that certified the existence of 20,270 tributaries "at the time of the Inca" (Espinoza Soriano 1964: 64–66, 204–206).

These samples are too few to allow generalizations; the accuracy of the data is unknown; the equivalence between the tributaries under the Inca and the tributaries under the Spaniards is only approximate; the "Inca time" has no precise calendar reference. Nevertheless, the samples support the view that a demographic collapse had, indeed, taken place. Disease is no doubt a likely explanation: two general crises had occurred, in 1546 and 1558. But wars, devastations, and famines are also very good candidates and are explicitly cited by a myriad of sources. The evidence is impressive. Cieza de León, who traveled throughout Colombia, Ecuador, Peru, and Bolivia, everywhere finds evidence of depopulation that he attributes, in the majority of cases, to the consequences of the wars against the Indios and of the civil wars between factions of Spaniards, each supported by loyal Indios. Cieza cites war as the cause of the depopulation of the valley of the Rio Magdalena, of the valleys between San Miguel (Piura) and Trujillo and between Trujillo and Lima, in the districts of Chincha, Tarapacá, and Nazca, in the province of Arequipa, and in the regions of Cajamarca and Andaguaylas. In Puerto Viejo "the population had declined more because of the wars than because of disease," while between Cali and Popayan, hunger caused the collapse because of the neglect of cultivation in time of war. Elsewhere, depopulation resulted because the Indios had been dislocated or dislodged by the intrusion of the Spaniards (Cieza de León [1553]1985: 75, 120, 215, 283, 361).

How could a few adventurers, however determined, well armed, and well mounted, sow havoc in half a continent? The armies were small, never exceeding 2,000 men: in the battle of Jaquijaguana (1548), near Cuzco, that saw the defeat of the rebellion of Gonzalo Pizarro (brother of Francisco), the plenipotentiary of the King, Pedro de la Gasca, had 1,900 men, and Pizarro 1,500 (Lockhart 1994: 233). But each army commanded numerous native auxiliaries, for transport, service, and general support; they devastated the fields and cut the supplies of the opposing faction; they often took their revenge on hostile tribes or on natives supporting the opposing party. After a quarter-century of almost uninterrupted warfare, the country was depleted and exhausted (Assadourian 1994). Migration and dislocation had forced entire tribes from their original villages. At the end of the civil wars, Pedro de la Gasca wrote to the Council of the Indies that the natives "abandon the mountains and their hideouts, go back to their villages…make their fields in the proximities of the roads, and do not run away, as they used to do, from the traveling Spaniard" (Levillier 1921: 210). The case of the Huanca tribe is an example of the burden of the conflict on the natives. In 1558 the Huanca's chiefs initiated a legal action for the recognition of their services and presented a detailed list of men, animals, staples, weapons, and tools supplied to the Spaniards during 15 years, from the assassination of Atahualpa in 1533 to the defeat of Gonzalo Pizarro in 1548 (Espinoza Soriano 1971; Assadourian 1994: 40–60). The document lists 154 items: among them a total of 27,000 people (mainly men) were lent to the various expeditions, an average of 1,800 per year, out of a population that counted 12,000 tributaries at the time of Huayna Capac, and only 2,500 in 1548. This amounts, on average, to one adult for every four tributaries per year; 7,000 of them never returned to their villages. The list of staples and animals confiscated was endless: almost 900 units between ships, lambs, and llamas every year, as well as cereals, potatoes, eggs, meat, fish, and an estimated total of 57,000 *fánegas* of maize—equivalent to the caloric requirement of 600 men per year.[24] And this tribe was on the winner's side.

The main features of population change in Peru may be summarized as follows : 1) A traumatic quarter-century between the death of Huayna Capac and the late 1540s–early 1550s, mainly due to warfare and its consequences. Warfare most likely bred disease, but this does not seem to have been the primary cause of the disaster. 2) A decade or two of respite, attenuated decline, and, in a few areas, recovery. 3) Thirty years of sustained population decline, but not collapse, between 1570 and 1600, with epidemics contributing significantly to the crisis of 1585–91.

Disease without disaster: The 30 missions of Paraguay

The Jesuits initiated the evangelization of the Indios in the region of Guayrá in 1587, but it was after the creation in 1604 of the Jesuit province of Paraguay that their penetration south of Amazonia gathered strength (Livi-Bacci and Maeder 2004). The province of Paraguay included a vast region comprising modern-day Chile (until 1625), Argentina, Uruguay, Paraguay, and about one-third of Bolivia and Brazil, for a total of about 7 million square kilometers. By and large, the presence of the Jesuits was well accepted by the Indios. Their concentration within Jesuit missions implied avoiding the feared system of the *encomienda*. At the same time, the Indios were protected against the slave-hunting expeditions of the Portuguese that for decades had ravaged their villages and decimated their tribes. The Jesuits created a web of missions, each one formed by the concentration of Indios in planned villages under the strict rule of the Jesuit fathers, who controlled the administration and the economy as well as religious and social life. The Crown encouraged and supported the missions for the double purpose of protecting the area from the intrusions of the Portuguese descending the river system southward from São Paulo, and defending the channels of communication with Upper Peru.

From the 1640s—when the Jesuit missions of Paraguay achieved territorial stability—to the early 1730s, the Guaraní population guided by the Jesuit fathers increased from 40,000 to over 140,000 (Maeder and Bolsi 1980).[25] This was a consistent long-term increase, with only a trickle of new arrivals due to proselytizing balanced by the losses of Indios escaping the strict control of the fathers. During a short period—between 1733 and 1739—disaster struck the missions: wars, hunger, epidemics, and emigration halved the population, after which a steady recovery set in until the final crisis and the end of the experiment in 1767, the year of the expulsion of the Jesuits from Spain and its colonial empire. The political, social, and economic regime overseen by the Jesuits had a profound impact on the Guaraní demographic system: in spite of very high mortality and the recurrent epidemics introduced from abroad, early and monogamous unions and a stable social structure allowed high birth and growth rates. Whenever mortality rose because of epidemics or other exceptional events, the dynamic reproductive system was able to repair the damage. The statistics collected every year for each of the missions (at their height there were 30 missions in the valleys of the Paraná and Uruguay rivers) provide reliable data on population, families, births, deaths, and marriages.[26] The median birth rate in the period 1690–1767 was 61 per thousand and the death rate was 44 per thousand, allowing—in years not affected by mortality crisis—a natural increase of 17 per thousand (Table 4). The median value of the expectation of life at birth was 24.5 years and the total fertility rate was 7.7 births per woman; about half the population were *muchachos* or *muchachas*, males and females below the ages of 17 and 15 (Livi-Bacci and Maeder 2004).

These values speak of a population with a high potential for growth—the consequence of the sedentary lives of the once-seminomadic Guaraní, of their universal marriage, and of the young age at marriage. The natural reproduction of the population was extremely rapid; this, together with a low intergenerational interval owing to the low age at marriage, had two main consequences—one social, the other epidemiological. In the social realm it facilitated the rapid process of change, religious and cultural, that the Jesuits were eager to promote through the education of children and adolescents and the strict discipline imposed on them. In the epidemiological realm, the very high birth rate meant that in every year there was a robust "injection" of susceptible individuals into the population, not immunized by a preceding epidemic and therefore vulnerable to viruses and microbes introduced from outside. The high birth rate implies that the system had the potential to fill the gaps opened in the periods of stress. Rebounding after crisis and stress was a well-known feature of premodern European societies, but in many South American populations the ability to rebound was compromised by the impediments to reproduction imposed by the social dislocation produced by contact. The Guaraní population was free from those checks: on the contrary, the policy of the Jesuits tended to maximize fertility through early, universal, and stable marriages.

TABLE 4 Birth rate, death rate, and rate of natural increase (per thousand) in the 30 Jesuit missions of Paraguay, 1690–1767

Period	Number of years with available data in the period	Birth rate	Death rate	Natural increase
Mean				
1690–1767	50	59.1	56.8	2.3
1690–1732	15	64.1	45.1	19.0
1733–1767	35	56.9	61.4	–4.5
Median				
1690–1767	50	61.3	44.2	19.1
1690–1732	15	63.2	41.2	24.6
1733–1767	35	55.4	44.3	10.5

SOURCE: Livi-Bacci and Maeder (2004).

Before the mission system was fully developed, new diseases brought from Europe had taken a disastrous toll. It is likely that the Guaranís had acquired (at the price of very high mortality) a degree of immunity not dissimilar to that of the European populations. I have already pointed out that smallpox devastated the populations of the coast of Brazil between 1562 and 1565; in 1590 a "pestilence" (smallpox) took a high toll in the recent settlements of Asunción, Ciudad Real, and Villa Rica and in the Guayrá: "pestilence took a horrifying toll among the inhabitants of the city [Asunción] and a hundred died daily. After nourishing itself in the city, the epidemic stormed the countryside where the damage was more deadly because of want of the necessary" (Guerra 1999: 214). The epidemic had started in Cartagena in 1588 and traveled through the continent down to the Strait of Magellan (Pastells 1912: 80). There is fragmentary evidence of local epidemics in the region in the first decades of the seventeenth century; almost all the missions were hit by the epidemic of 1634–36 (smallpox, measles, and perhaps scarlet fever or typhus); another widespread epidemic occurred in 1653–55. A detailed scrutiny of the civil and religious documentation offers a complex picture of the crises, major and minor, local and general, that affected the region: some identified by name, some called by the generic term plague (*peste*).[27] Gonzalo de Doblas, who had wide knowledge of Guaraní society after the expulsion of the Jesuits, observed that "smallpox and measles are the only diseases that cause a horrible mortality among the Indios, because, as many years pass without suffering these epidemics, when these appear and only few of the living have experienced them, contagion spreads rapidly and few are those who assist the sick because everybody flees contamination" (Doblas 1970: 29). Doblas touches on the basic elements of epidemiology: the size of the susceptible population and of those already immunized at the time of the outbreak, the intervals between successive epidemics, and the lethality of the disease.

The diseases causing epidemics among the Guaraní were not endemic but were introduced from the exterior. The demographic dimensions of the villages, which rarely surpassed 5,000 inhabitants, and those of the total population were below the minimum threshold necessary for viral diseases like smallpox and measles to sustain themselves. Among the Guaranís, since the birth rate was very high (60 per thousand) and the age structure very young (almost half the population was made up of *muchachos* and *muchachas*), the reintroduction of the disease, even after a short interval following the preceding epidemic, found a high proportion of susceptible people. Between 1690 and 1767 there are five waves of smallpox (1695, 1718–19, 1733–39, probably 1749, and 1764–65), one every 15 years on average. At fifteen years' remove from a preceding episode, the reintroduction of smallpox would have found all children under age 15 susceptible (about 50 percent of the total population) and a share (let us suppose one-third) of the population above that age that had not been previously infected. In this case, two-thirds of the population would have been susceptible. If the birth rate had been 30 per thousand, instead of 60 per thousand, as it was in many European populations, the proportion of susceptible individuals at the time of the reintroduction of the disease would have been lower—close to two-fifths of the total population. It follows that even in the case of an equal level of contagion and an equal lethality of the disease, general epidemic mortality would have been substantially higher in the Paraguayan case than in the European one.

General mortality caused by smallpox in a "virgin" population whose inhabitants were 100 percent infected would be extremely high—between 30 and 40 percent, as discussed earlier. In a "non-virgin" population, but one with a very young age structure (as was the case with the Guaranís), mortality was also very high, but lower than that of a comparable virgin population by a factor proportional to the share of the susceptible population. We may factor the difference between the mortality of a virgin and a non-virgin population into three components: (a) the proportion of the immune, (b) the proportion of the infected, and (c) the rate of survival of the infected who, once cured, are immune. Let us see how these three factors must have played out among the Guaranís.

For (a) we have already shown that, given the prevailing birth and death rates and intervals between epidemics, the proportion of the immune must have been around one-third. For (b), the concentration of the Indios, previously dispersed and mobile, into densely settled missions must have raised the proportion of the infected among the susceptible. If for no other reason, the Indios in the seminomadic state had at least the possibility of escaping the epicenter of the infection. The Jesuit fathers tried to minimize contagion, isolating the infected in hospitals separated from the villages, and this might have lowered the negative effect of high density. Father José Cardiel describes the precautions taken on the occasion of a smallpox epidemic, presumably that of 1738–39: "the nature was such that if a person of a household was infected, contagion extended to the other inhabitants. I ordered a number of huts to be made in the vicinity of the village, and another group of huts—well constructed—farther away. When somebody fell ill, we transported him to the first group of huts. If the disease was not smallpox—and we would see it in a few days—we sent him back to his house. But if it was smallpox, then we transported him to the farther away huts, burnt to the ground the hut that had previously hosted him, and a new one was constructed in its place" (Furlong 1953: 188). The strategy was ingenious. In spite of these precautions, however, it is likely that the missions' Indians were more exposed to contagion than their seminomadic counterparts.

As far as (c) is concerned—the proportion of infected individuals who survived—we can only speculate. But it makes sense to think that the cohesive social organization of the missions would enhance the survival of those who fell ill. They were assisted and nourished by the Jesuit fathers, their assistants, and family members, who were separated from the sick but prevented from escaping and so abandoning children and spouses. Abandonment was one of the major concurrent causes of death, and this was a frequent pattern among the Indios, abundantly documented from the sixteenth to the twentieth centuries. Referring to the epidemic of 1635–37, Padre Diego de Boróa wrote that many died because when they became sick, the rest of the families fled in terror. In the missions, the sick in the hospitals were regularly assisted and fed, and were less at risk of dying than those in other communities who were abandoned by their families and friends (Sepp 1990: 179).

In the years without severe social or epidemiological crises the toll of deaths was between 40 and 45 per thousand; in years of severe crisis mortality exceeded 100 per thousand. Following this distinction, 1695 was a year of severe crisis for nine of the 13 missions of Paraná (data for Uruguay's individual missions are missing). In that year the aggregate number of deaths for the 30 missions was 16,000, corresponding to the extraordinary mortality rate of 200 per thousand. Mortality rates of 150 or 200 per thousand continued to be the rule in years of smallpox epidemic. A severe crisis affected four of 28 missions in 1719 (1718 was even worse, but we lack the data), and of the 30 missions existing thereafter, 21 were affected by a severe crisis in 1733, 16 in 1738–39, seven in 1749, and 14 in 1764–65 (Livi-Bacci and Maeder 2004).

The Guaraní experience is a valuable contribution to our knowledge of the demography of the colonial period. Three major conclusions can be drawn from it. The first concerns the epidemiological and demographic consequences of contact: one or two centuries after initial contact, the epidemics continued to be devastating even though they took place in a non-virgin population. Each epidemic found a population in which two persons out of three were susceptible. The high population density of the mission villages increased the risk of infection despite the efforts of the fathers to isolate the sick. It follows that the impact of epidemics in the nearly 150 years of Jesuit rule was no less devastating than in the century following contact.

The second conclusion is that the Jesuits' policy of fostering early marriage and enforcing its stability maintained the birth rate at the maximum possible level for a normally constituted large population. The high birth rate generated a large surplus of births over deaths in normal years and compensated for the deficit of births in years of crisis. In contrast with other American experiences following contact, where the high mortality from imported diseases combined with a low birth rate consequent on the destruction and dislocation of the population, the Guaraní population grew rapidly for a century and compensated for the losses due to four epidemics, two wars, and related famines.

The third conclusion is that the political system formed by the Jesuits, while it lasted, prevented the Guaranís from mixing with whites and blacks. Isolation prevented the demographic "impoverishment" of this indigenous population as a consequence of incorporation (voluntary or forcible) of women into the reproductive system of whites, a process that weakened other indigenous populations. Social stability and economic achievement led to an increase in the standard of living, which must also have had a positive impact on the Guaranís' demography.

Epilogue

The cases discussed in this essay convey a simple message. The near demise of American Indios cannot be explained by a simple, monocausal paradigm (see also Alchon 2003: 145). Such an attempt ignores the complexity of the sixteenth-century disaster and overlooks the rich variety of historical events that contributed to it. But equally unsatisfactory is a modern version of the Black Legend that accepts the multicausality of the catastrophe—as Motolinia did—but does not attempt to give some hierarchical order to the factors at play.

A worthwhile effort would be to group the varied depopulation situations created by the impact of the Spanish Conquest into different types. This would require a careful comparative analysis of a plurality of cases, far beyond the few situations presented here: a preliminary attempt may serve as an epilogue to this essay.

A first impact type is represented by the Caribbean case. Here the Conquest's impact was most violent, and the natives were on the verge of extinction when the first documented smallpox epidemic struck the islands. The Caribbean experience laid the foundations of the Black Legend. In the Caribbean all the negative aspects of the Conquest acted with full force: direct killing of the natives in the process of subjugation; slavery and forced labor; destruction of communities and forced migration; a comparatively high ratio between conquerors and conquered; abduction of women of reproductive age. The Spaniards' quest for gold—a search for a high and immediate return as compensation for a very risky venture—worsened the negative impact of the Conquest. Increased mortality and weak reproduction explain depopulation. The Caribbean case includes, beyond the Greater Antilles, the islands of pearls (off the coast of Venezuela), the coasts of the mainland called Castilla de Oro, and other gold-yielding areas. The extermination of the natives was rapid, completed in only a few decades.

Another impact type comprises the low-lying coastal areas of the Gulf of Mexico and the Pacific coast of Peru. Depopulation in these two areas was much more rapid than on the plateau of Mesoamerica or at the high altitudes of the Andes. There are several explanations for these differences. First, the pathogen load in the low, humid, and hot areas was heavier than elsewhere, interacting negatively with the new diseases imported from Europe. This general and tentative explanation needs confirmation. For the Gulf of Mexico, however, depopulation could have been associated with the introduction of the *anopheles* mosquito in a favorable habitat and with the ensuing diffusion of malaria (Carter 1923). A further explanation, for the Pacific Peruvian coast, centers on the vulnerability of the coastal valleys where the natives settled, and the destructive effects of the European intrusion, such as the appropriation of the best land and of the system of irrigation, depriving the Indians of precious resources for survival. Settlers were pushed inland so that emigration, in addition to high mortality and low reproduction, may have caused depopulation. It is on the coast that Lima, the major Spanish settlement in South America, was founded and that the European impact was highest with all the negative consequences for natives.

A variant of the preceding impact type includes the sometimes violent expulsion of the natives from their traditional settlement areas, pushed back into a less favorable habitat, thus weakening their ability to survive and reproduce. This type can be applied to Brazil, where the Portuguese (numbering perhaps 30,000 at the end of the sixteenth century) were sparsely settled along the coastline. The voracious demand for manpower in the plantation system and the conflicts with the natives gradually pushed the natives into the interior. Although the slave trade supplied African labor, the colonists organized slave-hunting expeditions in the interior to seek indigenous labor, further depleting the native society. Enslaved or indentured Indians often did not reproduce themselves, and native women were drawn into the European reproductive pool. This type of expulsion and destruction of human resources was replicated in other areas of the continent.

The opposite of the Caribbean and the coastal systems is the case of the Guaraní missions. Social change under the Jesuits' rule brought a new form of stability to the natives, favoring the monogamous couple, excluding contact with Europeans and Africans, reinforcing communitarian solidarity, and minimizing conflicts. In spite of the new diseases, the population expanded during the seventeenth century. Of course, during this century other South American populations, once they reached their nadir, started to increase, as happened in Mexico in the seventeenth century or in the Andean region in the early eighteenth (Sánchez Albornoz 1994: 97, 105–106), so that the Guaraní missions example might appear less special than I claim. But the interest and originality of the Guaraní case is that it shows two basic facts: differences in epidemic mortality between "virgin" and "non-virgin" populations were much smaller than is commonly assumed, and the actions of the Europeans mattered a great deal.

The two major populations of the continent, in the Mexican plateau and at the high altitudes of the Andes, are typologically very similar—both areas suffered a rapid, though imprecisely measured population decline—but also diverge in several respects. They are similar in that the strong identity of the two societies was not upset by the Conquest, and their demography rebounded in the long run. They differ in that the burden of Conquest was heavier in Peru than in Mexico. In Peru violent wars and conflicts ravaged the country during the second quarter of the sixteenth century, while Mexico was rapidly "pacified" after Tenochtitlán's fall; in Peru the confiscation of labor for personal services, transport, and work in the mines and fields was extremely widespread and continuous, while in Mexico the burden was lighter and there was a relatively free labor market; in Peru taxation of the natives was heavy, in Mexico less so and more flexible; in Peru the iron hand of Viceroy Toledo imposed an extensive resettlement of the population, while Mexico retained much of its original settlement pattern.

With respect to their demographic profiles, the comparison between the two areas is problematic, not only for lack of documentation, but also because Peru's population decline had started a few years before the Conquest with the wars for the succession to Huayna Capac. In the following decades, war was the main factor in demographic decline, leaving an unbalanced sex ratio and weakened reproduction. On the other hand, the demographic decline of the last 30 years of the sixteenth century was less pronounced in Peru than in Mexico (rates of decline respectively of 1 and 2 percent). One hypothesis is that the impact of the new pathologies was deadlier in Mexico than in Peru. Possible explanations include the environment, climate, and patterns of settlement. The high density of central Mexico and, in particular, the Valley of Mexico (where, at its center, was found the most populous concentration of Europeans in America), the radial routes that reached the peripheral area from the valley, and the more frequent direct contacts with Europe: these factors may have led to a more severe impact of the new diseases in Mexico. In contrast, the comb-like conformation of Peru, with settlements along the Andes axis and in the valleys, perpendicular to the sea coast—and with difficult communications from valley to valley—may have slowed the diffusion of epidemics (Shea 1992:161), as may have a lower density and the peripheral location of the major concentrations of Europeans (in Lima) and the greater distance from Europe. A last factor, perhaps, was the lesser load of pathogens and parasites at the very high altitudes of Peru. In short, new diseases had a lesser impact in Peru than in Mexico, and this fact might have offset the heavier burden the Conquest imposed on the Andean populations.

New diseases were certainly a very important factor—often the major factor—in the depopulation of America. But if we let history speak, we see that a rise of mortality due to human factors, a weakening of reproduction, and expulsion and forced migration of the indigenous people into hiding or into inhospitable areas were also powerful factors in the decline. Behind the demise of the Indians lay not only the blind determination of germs, but also no less deadly human forces.

Notes

This essay reflects some of the findings and ideas presented in my book *Conquista: La distruzione degli indios Americani* [Conquest: The Destruction of the American Indian] (Bologna: Il Mulino, 2005). A more detailed presentation of some of the arguments in this essay is also found in Livi-Bacci (2003a) and Livi-Bacci and Maeder (2004).

1 The estimates of the native population at contact assign to Hispanic America between 74 and 79 percent of the continental population (see Table 1 above).

2 In the initial decades of Spanish rule in Mexico, tributes were paid by the community; after 1557 they were paid by the individual tributary. In Peru the tributary system was extensively reformed under Viceroy Toledo in the early 1570s.

3 In Peru a general inspection was organized by Viceroy Toledo and carried out in 1572–75, under the direction of 63 functionaries belonging to the civil and ecclesiastical administration. Inspectors were supposed to count individual households and their members. In earlier visits in Peru and Mexico, inspectors often relied on reports of local authorities. The question of the quality of the reports has yet to be addressed systematically. The definition of a tributary, of a household, of the various groups of individuals (young, old, etc.), and the extent of exemptions from taxation vary from one region to another and from one period to another.

4 Cook and Borah (1971) estimated Hispaniola's population at the time of first contact at 7.975 million; Watts (1987) at 3 to 4 million; Denevan (1976) at 1.950 million. See Livi-Bacci (2003b: 7).

5 The *repartimiento* (count) of 1514 enumerated 738 *encomenderos* (Spanish settlers), corresponding to perhaps 3,000–4,000 people. An unknown number of Spaniards were servants or laborers with no Indians allotted to them; the figure of 10,000 Spanish residents, cited for the end of the first decade of the sixteenth century, is probably too high. Through the *encomienda* system native workers were allocated to Spanish settlers who were supposed to instruct them in the Christian faith, care for and protect them, and pay them decent wages in exchange for their services. This feudal institution fell short of slavery, but lent itself to a variety of abuses; the "New Laws" of 1542 reduced the power of the *encomenderos* and redefined the reciprocal rights of masters and natives. The *repartimiento* (distribution) was the technical operation through which the Spanish authorities allotted the natives to the *encomenderos*. See Simpson (1966).

6 Ovando arrived in Hispaniola in 1502 with 2,500 settlers; the entire Spanish population at the time was 3,000 at the most. But they depended on the natives for their survival: natives had to produce food for them and provide all sorts of materials and services. The impact of this demanding minority on a population of, say, 100,000 was quite heavy: not so if we follow other authors' opinions that estimate Hispaniola's population in the millions (see also endnote 19). These issues are discussed in Livi-Bacci (2003a).

7 In the *Memoriales*, Motolinia says that "half" the Indians died (not "more than half"), in "some" (not "in the majority of") provinces. For a discussion of the two sources, see McCaa (1995).

8 Dobyns also proposes a 96 percent depopulation rate, with a ratio of 25:1. The 95 percent depopulation rate, attributed to disease, has become an article of faith. Cook (1998: 206) writes: "More than 90 percent of the Amerindians were killed by foreign infections." Diamond (1997: 197, 211), again, reports 95 percent depopulation rates, and even 99 percent: "When such partly immune people came into contact with others who had had no previous exposure to the germs, epidemics resulted in which up to 99 percent of the previously unexposed population was killed" (Diamond 1997: 92). On these issues, also see Henige (1998).

9 Diamond (1997: 213) writes:

> Initially, most surprising is the absence of any human disease derived from llamas (or alpacas), which it's temtping to consider the Andean equivalent of Eurasian livestock. However, llamas had four strikes against them as a source of human pathogens: they were kept in smaller herds than were sheep and goats and pigs; their total numbers were never remotely as large as those of the Eurasian populations of domestic livestock, since llamas never spread beyond the Andes; people don't drink (and get infected by) llama milk; and llamas aren't kept indoors, in close association with people.

10 "In a small proportion of individuals smallpox infection runs a hyperacute course" (Dixon 1962: 2). This is hemorrhagic smallpox (purpura variolosa) of the "fulminating type" with a case mortality rate close to 100 percent (ibid.: 6–7). This extreme form seems to affect few individuals during an epidemic: there are no epidemics of hemorrhagic smallpox.

11 According to McCaa (2004), Humboldt, who wrote after his trip to America at the turn of the century, was correct for the eighteenth century, but not for earlier centuries.

12 This result is a matter of elementary arithmetic: even small variations in the assumptions will produce widely different results. It follows that any hypothesis concerning the depopulation of the native population can be corroborated by the output of a particular model.

13 As for the first smallpox outbreak in Mexico in 1520–21, Brooks has raised doubts about the high population losses claimed by contemporaries (Brooks 1993). This position has been justifiably criticized by McCaa (1995).

14 Guerra has hypothesized that swine flu was spread in Hispaniola in 1493 by eight infected sows that Columbus (in his second voyage to America) embarked in La Gomera (Canary Islands) and disembarked in Hispaniola (Guerra 1988). The only firm point is that the sows were embarked; that they were infected is Guerra's hypothesis. Cook has hypothesized that the natives were infected in 1493–94 by smallpox brought back to Hispaniola by the sole survivor of the six natives brought to Spain by Columbus in early 1493 (Cook 2003).

15 1,200 went ashore on Hispaniola during Columbus's second expedition in 1493; 1,000 with Bobadilla in 1502; and 2,500 with Ovando in 1502, to name only the major expeditions.

16 According to the 1591 census of Castille, Seville had 18,000 households, and the rest of the province (Cadiz, Puerto Santa Maria, San Lucar de Barrameda, Jerez de la Frontera, and their districts) had 96,618.

17 500,000 presumed inhabitants of Seville at the beginning of the century, with a death rate of 30 per thousand, would yield 15,000 deaths per year, 10 percent of which, or 1,500, would be due to smallpox, or 125 per month. If the case mortality rate was 25 percent, we can assume that every month 125 x 4 = 500 persons would be infected. If any infected person (regardless of the outcome: healed or dead) was infectious, on average, for eight days, then on every day of the year the number of infected persons would be (500 x 8)/30 = 133.33. But in populations where smallpox was endemic, the vast majority of the infected were children; following the hypothesis that adults were 5 percent of the infected, then on every day of the year there would have been .05 x 133.33 = 6.67 infected adults. These were those at risk of going on board: with over 250,000 adults, the probability was 6.67/250,000 = 0.0000266. Every year 16 ships with an average of 45 people would travel to Hispaniola: so the probability that an infected person would board a ship bound for Hispaniola would be: 16 x 45 x 0.0000266 = 0.019, or 1.9 percent.

18 Following the instructions of the court, Governor Ovando ordered a first *repartimiento* of the natives between 1503 and 1505. A new general *repartimiento* was ordered by the King in 1509 and carried out by Diego Colón, son of Columbus, in the following years. The documentation of these two *repartimientos* has been lost (see Arranz Márquez 2001).

19 Elsewhere (Livi-Bacci 2003b), I have estimated the population of Hispaniola at contact, based on a number of conditions (carrying capacity, productivity of labor, organization in clans and villages, etc.). I concluded that the number of Tainos at Columbus's arrival could be placed between 200,000 and 300,000,

with probabilities abruptly falling for estimates below 100,000 or over 400,000. It is also likely that at Ovando's arrival the total population had already declined to perhaps half its initial size, particularly as a consequence of the famine of 1494. Modern estimates of the contact population of the island range between a minimum of 60,000 and a maximum of 8 million, with the astonishing ratio of 1:133.

20 The nature, characteristics, and shortcomings of the 1514 census—the first census in the Americas—are discussed at length by Arranz Márquez (1991: 194–200 and 233–255).

21 Omitting from the estimate the cases for which no children were indicated among the Indios allotted to a given settler (on the hypothesis that it was an omission on the part of the inspector, rather than a reflection of reality), children were 9.8 percent of the total population; children were in theory defined as all persons below age 14, but even taking age 12 as the upper limit such a low proportion (if true) indicates a rapidly declining population (Livi-Bacci 2003b: 32 n).

22 An interesting debate on the cause of death of Huayna Capac took place in the session "Epidemics and demographic disaster in colonial Latin America" at the American Historical Association Conference (Washington, DC, 2004). See in particular the papers presented by McCaa et al. (2004) and Kirakofe (2004), as well as the comments of Noble David Cook to the session's paper. Mann (2005: 87) accepts the theory of an Andean smallpox epidemic without hesitation: "With its fine roads and great population movements, Tawantinsuyu [Inca Peru] was perfectly positioned for a major epidemic. Smallpox radiated throughout the empire like ink spreading through tissue paper. Millions of people simultaneously experienced its symptoms: high fever, vomiting, severe pain, oozing blisters everywhere on the body." Perfect description: but did the event actually happen?

23 In a stable population with an expectation of life at birth around 24 years and a rate of growth equal to zero, the ratio between the population below age 18 and half the adult population aged 20 to 50 (under the hypothesis that this would correspond to the number of conjugal couples) is around 1.9 to 1.

24 One *fánega* corresponded to 58 liters and, in terms of maize, approximately 46 kg. Under the assumption that 300 kg of maize would be the caloric equivalent of an adult's requirement for one year, we may calculate that 57,000 x 46 = 2,622,000 kg of maize had been confiscated from the Huancas in 15 years, or 174,800 kg per year, corresponding to the caloric requirement of 174,800 ÷ 300 = 583 adults.

25 The area of the 30 missions considered here, in the valleys of the Paraná and Uruguay rivers, covered an area of some 100,000 square km. But if the territories dedicated to cattle raising and the harvesting of yerba mate are included, then the entire area under the missions' influence is two to three times larger.

26 The Jesuits kept careful statistics in each village. Unfortunately the parish books recording baptisms, burials, and marriages cannot be located, if indeed they have survived. For each village, however, a recapitulation was made at the end of each year, called *planilla*, that reported the total population, with a breakdown for young, old, widows, and widowers; the number of married couples; and the number of baptisms, burials, and marriages. *Planillas* exist for 50 out of 78 years between 1690 and 1767. Baptisms of adults (new converts) were rare and generally recorded separately from infant baptisms. During the height of the mission system, the Jesuits did not proselytize among the heathen Guaraní: vital rates, therefore, represent the inner dynamism of the missions' populations.

27 Sparse evidence of the lethality of smallpox is available. In 1612, in Arauco (Chile), 153 of 273 infected individuals died (56 percent); in 1614, in three missions of the Guayrá, lethality was much lower (11 percent). In Yapeyú smallpox killed 30 percent of the population. In Santa Maria 50 percent of the population fell ill—whether from smallpox or measles is unclear—and one-fourth of these died. In 1667, smallpox killed half the inhabitants of Corpus, and more than a century later (1788) two-thirds of the population of San Borja fell ill of smallpox and one-fourth of these died (Livi-Bacci and Maeder 2004).

References

Academia de la Historia. *Colección Muñoz* 70: 38.

Acosta, José de. [1590]1986. *Historia natural y moral de las Indias*. Madrid: Historia 16.

Alchon, Suzanne Austin. 2003. *A Pest in the Land: New World Epidemics in a Global Perspective.* Albuquerque: University of New Mexico Press.

Anderson, Roy. M. 1982. "Directly transmitted viral and bacterial infections of man," in Roy M. Anderson (ed.), *The Population Dynamics of Infectious Diseases*. New York: Chapman and Hall.

Anderson, Roy M. and Robert M. May. 1979. "Population biology of infectious diseases," Part I, *Nature* 280(2 August): 361–367; Part II, *Nature* 280(9 August): 455–461.

Anghiera, Pietro Martire d'. [1516]1930. *Mondo Nuovo (de Orbe Novo)*. Milano: Alpes.

Arranz Márquez, Luis. 1991. *Repartimientos y encomiendas en la Isla Español.* Santo Domingo: Fundación Garcia Arévalo.

Assadourian, Carlos Sempat. 1985. "La crisis demográfica del siglo XVI y la transición del Tawantinsuyu al sistema mercantil colonial," in Nicolás Sánchez Albornoz (ed.), *Población y mano de obra en America Latina*. Madrid: Alianza Editorial.

———. 1994. *Transiciones hacia el sistema colonial andino.* El Colegio de México, México e Instituto de Estudios Peruanos, Lima.

Brooks, Francis J. 1993. "Revising the conquest of Mexico: Smallpox, sources, and populations," *Journal of Interdisciplinary History* 24(1): 1–29.

Carter, Henry R. 1923. "Place of origin of malaria: America?," «http//etext.lib.viginia.edu/etcbin/fever».

CDI. 1864. *Colección de documentos ineditos relativos al descubrimiento, conquista y colonización de las antigas posesiones Españolas en América y Oceania*, Volume I. Madrid.

CDU. 1885. *Colección de documentos ineditos relativos al descubrimiento, conquista y organización de las antiguas posesiones españolas de ultramar*, Volume 2. Madrid: Real Academia de Historia.

Censo de Castilla de 1591. 1984. Vol. I. Madrid: Instituto Nacional de Estadistica – INE.

Chaunu, Huguette and Pierre Chaunu. 1956. *Séville et l'Atlantique, 1504–1650.* S.E.V.P.E.N, Volume VI/2, Paris.

Cieza de León, Pedro. [1553]1985. *La Crónica del Perú*. Madrid: Historia 16.

———. [1880]1988. *El señorio de los Incas*. Madrid: Historia 16.

Cook, Noble David. 1981. *Demographic Collapse: Indian Peru, 1520–1620.* Cambridge: Cambridge University Press.

———. 1982. "Population data for Indian Peru: Sixteenth and seventeenth centuries," *Hispanic American Historical Review* 62(1): 73–120.

———. 1998. *Born to Die: Disease and the New World Conquest, 1492–1650.* Cambridge: Cambridge University Press.

———. 2003. "Una primera epidemia americana de viruela en 1493?," *Revista de Indias* 63(January–April).

Cook, Sherburne F. and Woodrow Borah. 1960a. *The Indian Population of Central Mexico, 1531–1610*. Berkeley: University of California Press.

———. 1960b. *The Population of Central Mexico in 1548: An Analysis of the Suma de Visitas de Pueblos.* Berkeley: University of California Press.

———. 1971. *Essays in Population History: Mexico and the Caribbean*, Volume 1. Berkeley: University of California Press.

Crosby, Alfred J. 1972. *The Columbian Exchange: Biological and Cultural Consequences of 1492.* Westport, CT: Greenwood Press.

Denevan, Willam M. (ed.). 1992. *The Native Population of the Americas in 1492*. Second Edition. Madison: University of Wisconsin Press.

Diamond, Jared. 1997. *Guns, Germs, and Steel: The Fates of Human Societies.* New York: Norton.

Dixon, C. W. 1962. *Smallpox.* London: Churchill.

Doblas, Gonzalo de. 1970. "Memoria sobre Misiones," in P. De Angelis (ed.), *Colección de Obras y Documentos*. Buenos Aires: Editorial Plus Ultra.

Dobyns, Henry F. 1966. "Estimating aboriginal populations: An appraisal of techniques with a new hemispheric estimate," *Current Anthropology* 7(4): 395–416.

Espinoza Soriano, Waldemar (ed.). 1964. *Visita hecha a la provincia de Chucuito por Garci Diez de San Miguel en el año 1567.* Lima: Ediciones Casa de la Cultura del Perú.

———. 1971. "Los Huancas, aliados de la Conquista," *Anales Cientificos de la Universidad del Centro del Perú* 1, Huancayo.

———. 1986. *La destrucción del Imperio de los Incas*. Lima: Amaru Editores.

Furlong, Guillermo. 1953. *José Cardiel, S.J. y su Carta-Relación.* Buenos Aires: Libreria del Plata.

Guerra, Francisco. 1988. "The earliest American epidemic: The influenza of 1493," *Social Science History* 12(3).

———. 1999. *Epidemiología americana y filipina. 1492–1898.* Madrid: Ministerio de Sanidad y Consumo.

Hanke, Lewis. 1971. "A modest proposal for a moratorium on grand generalizations: Some thoughts on the Black Legend," *Hispanic American Historical Review* 51(1): 112–127.

Henige, David. 1986. "When did smallpox reach the New World (and why does it matter?)," in Paul E. Lovejoy (ed.), *Africans in Bondage: Studies in Slavery and the Slave Trade.* Madison, WI: African Studies Program.

———. 1998. *Numbers from Nowhere: The American Indian Contact Population Debate*. Norman: University of Oklahoma Press.

Humboldt, Alexander von. [1807–11]1973. *Ensayo politico sobre el reyno de Nueva España*. México: Porrúa.

Keen, Benjamin. 1969. "The Black Legend revisited. Assumptions and realities," *Hispanic American Historical Review* 49(4): 703–719.

Kirakofe, James B. 2004. "A case of mistaken identity! Leprosy, measles or smallpox? Old World names for a New World disease: Bartonellosis," paper presented at the Annual Conference of the American Historical Association, Washington, DC.

Landa, Diego de. [1881]1968. *Relación de las cosas de Yucatán*. Madrid: Crónicas de América, Historia 16.

Las Casas, Bartolomé de. [1875–76]1951. *Historia de las Indias*, 3 vols. Mexico City: Fondo de Cultura Economica.

———. [1552]1996. *Brevísima relación de la destruición de las Indias.* Madrid: Cátedra.

Lastres, Juan B. 1951. *Historia de la medicina Peruana*, vol. II, *La medicina en el Virreynato*, Imprenta Santa Maria.

Levillier, Roberto (ed.). 1921. *Gobernantes del Perú*, Volume 1. Madrid: Juan Pueyo.

Livi-Bacci, Massimo. 2000. "Mortality crises in a historical perspective: The European experience," in Giovanni Andrea Cornia and Renato Paniccià (eds.), *The Mortality Crisis in Transitional Economies.* New York: Oxford University Press.

———. 2003a. "Las múltiples causas de la catástrofe: consideraciones teóricas y empíricas," *Revista de Indias* 63(227).

———. 2003b. "Return to Hispaniola: Reassessing a demographic catastrophe," *Hispanic American Historical Review* 83(1): 3–51.

———. 2005. *Conquista: La distruzione degli indios Americani*. Bologna: Il Mulino.

Livi-Bacci, Massimo and Ernesto J. Maeder. 2004. "The missions of Paraguay: The demography of an experiment," *Journal of Interdisciplinary History* 35(2): 185–224.

Lockhart, James. 1994. *Spanish Peru 1532–1560: A Social History*. Second Edition. Madison: University of Wisconsin Press.

López de Gómara, Francisco. [1552] 2001. *La conquista de México*. Madrid: Dastin.

López de Velasco, Juan. [1574] 1971. *Geografía y descripción universal de las Indias*. Madrid: BAE, tomo CCXLVIII, Atlas.

Maeder, Ernesto J. A and Alfredo S.C. Bolsi. 1980. La población guaraní de las misiones jesuíticas: Evolución y características (1671–1767). Corrientes: Instituto de Investigaciones Geohistóricas.

Mann, Charles C. 2005. *1491: New Revelations of the Americas Before Columbus*. New York: Knopf.

McCaa, Robert. 1995. "Spanish and Nahuatl views on smallpox and demographic catastrophe in Mexico," *Journal of Interdisciplinary History* 25(3): 397–431.

———. 2004. "Revisioning smallpox in Mexico City-Tenochtitlán, 1520–1950: What difference did charity, quarantine, inoculation and vaccination make?," in Eugenio Sonnino (ed.), *Living in the City: 14th–20th Centuries.* Rome: Casa Editrice Università La Sapienza.

McCaa, Robert, Aleta Nimlos, and Teodoro Hampe-Martinez. 2004. "The death of Huayna Capac re-examined," paper presented at the Annual Conference of the American Historical Association, Washington, DC.

Mörner, Magnus. 1975. "La emigración española al Nuevo Mundo antes de 1810," *Anuario de Estudios Americanos* 32.

Motolinia, Fray Toribio. [1858]1973. *Historia de los Indios de la Nueva España*. Mexico: Porrúa.

Murra, John V. (ed.). 1967. *Visita de la provincia de León de Huánuco en 1562.* Universidad Nacional Hermilio Valdizan, Huánuco.

Newson, Linda A. 1986. *The Cost of Conquest: Indian Decline in Honduras Under Spanish Rule.* Boulder, CO: Westview Press.

———. 1999. "Epidemias del Viejo Mundo en Ecuador," in Noble David Cook and W. George Lovell (eds.), *Juicios Secretos de Diós*. Quito: Abya-Yala.

Oviedo, Gonzalo Fernández de. [1851]1992. *Historia general y natural de las Indias*. Madrid: Atlas.

Pastells, Pablo. 1912. *Historia de la compañia de Jesus en la provincia del Paraguay*, Volume 1. Madrid: Victoriano Suarez.

Rosenblat, Angel. 1954. *La población indigena y el mestizaje en America*, Vol. I, *La población indigena, 1492–1950.* Buenos Aires: Editorial Nova.

Sahagún, Fray Bernardino de. [1938]1977. *Historia general de las cosas de Nueva España*, Volume IV. México: Porrúa.

Sánchez Albornoz, Nicolás. 1994. *La población de America Latina desde los tiempos precolombinos al año 2025*. Madrid: Alianza Editorial.

Sepp, Antonio. 1990. *Il sacro esperimento del Paraguay*. Verona: Cassa di Risparmio di Verona.

Shea, Daniel E. 1992. "A defense of small population estimates for the central Andes in 1520," in William M. Denevan (ed.), *The Native Population of the Americas in 1492.* Second Edition. Madison: University of Wisconsin Press.

Simpson, Lesley Byrd. 1966. *The Encomienda in New Spain. The Beginning of Spanish Mexico*. Revised and enlarged edition. Berkeley: University of California Press.

Suma de visitas de pueblos por orden alfabético, Ms 2800, Biblioteca Nacional, Madrid; transcribed and edited by Francisco del Paso y Troncoso, *Papeles de Nueva España*, second series, vol. 1, Madrid, 1905.

Vega, Garcilaso de la. [1609]1977. *Commentari reali degli Incas*. Milano: Rusconi.

Wachtel, Nathan. 1971. *La vision des vaincus: les indiens du Pérou devant la conquête espagnole, 1530–1570*. Paris: Gallimard.