Each morning at five-thirty, Rodrigo Cespedes eats two rolls and drinks a cup of tea heavily laced with sugar before he slings his ratty Adidas gym bag over his shoulder and leaves for work. Rodrigo lives in Potosí, the world’s highest city, perched in the Bolivian Andes at an elevation of 13,680 feet above sea level. At this altitude Rodrigo stays warm only when he holds himself directly in the sunlight, but this early in the morning, the streets are still dark. He walks with other men going in the same direction, but like most Quechua and Aymara Indians they walk along silently. The loudest sounds come from the scraping noise of the old women who laboriously sweep the streets each morning. Bent over their short straw brooms, these women look like medieval witches dressed in the traditional black garments woven in Potosí and the tall black hats native to the area.

Rodrigo reaches the main road and joins a line behind forty to fifty men waiting to board one of the dilapidated but once brightly painted buses that leave the Plaza 10 de Noviembre at a quarter before the hour. In the dawning light, he stands across the street from a small dump in which a handful of old women, two dozen snarling dogs, and a few children fight over unrecognizable chunks of food in their daily battle for garbage. When he finally boards the bus, Rodrigo squeezes agilely into the dense pack of silent and stooped men. Very slowly the old bus begins
its laboried climb up Cerro Rico, the mountain towering over the city. After ascending the mountain for only a few minutes, the bus passes the entrance to the original colonial mine founded on Cerro Rico in 1545. Workers long ago boarded it shut after exhausting that vein, and then they moved to higher veins more difficult and less profitable to mine. After another twenty minutes and a hundred meters' rise in elevation, he passes the dilapidated entrance to the massive government-operated tin mine and the scene of many bloody confrontations between miners and management. Once owned by the "Tin King" Simon Patiño, these mines were nationalized by the revolutionary regime of Victor Paz Estenssoro after the revolution in 1952, and now COMIBOL (Corporación Minera de Bolivia), a government-owned and highly unprofitable company, operates them as a way to keep the miners' leftist union tranquil. The bus chokes to its first stop at the mine opening, and most of the men leave the bus.

Even though the bus has less than half a load now, the old engine wheezes and belches up thick black diesel fumes as it struggles on to an altitude of fourteen thousand feet. Few vehicles anywhere operate at a higher altitude, and this bus probably plies the highest daily bus route in the world. Barely able to climb any higher, the bus coasts to a stop near the Heart of Jesus, a large abandoned church covered with graffiti and filled with the strong smell of stale urine, all topped by a giant concrete Jesus. The edifice and its large statue jut out on a cliff a little over halfway up the mountain. Here Rodrigo and the remaining men leave the bus, which then descends for another load.

Without a glance at the Heart of Jesus and without raising his eyes toward the immense mountain above him, Rodrigo begins to climb the long familiar path. For the next two hours he looks only at his feet and he keeps his chin tucked into his jacket and out of the mountain winds that whip around him in freezing but bone-dry swirls even though he is only a few degrees south of the equator. He does not need to look around, for as long as his legs are climbing up the mountain he knows that he is heading in the right direction. He need not fear bumping into a tree, because he is far above the timber line and because over the last four centuries millions of brown hands have already removed every bush, weed, and blade of grass searching for rocks with traces of silver, tin, tungsten, or bismuth. He need not worry about bumping into a large boulder, because generations of Indian workers have long since pounded, hammered, and shattered every boulder into millions of rocks smaller than a child's fist. He need not fear falling into a crevice, because women carrying baskets of rock and dirt have long ago filled in all the crevices with refuse from the five thousand mines that have pierced Cerro Rico in the past five centuries. If Rodrigo did look up, he would see nothing but the endless pile of rusty brown rocks that he climbs every day.

The monotony of the mountain face is interrupted only by the mine openings that pock it like the ravages of some terrestrial cancer. Rodrigo finally stops just short of the summit of 15,680 feet; the trip from his home below has taken two and a half hours. He sits down just outside the mouth of the mine he works, opens his bag, and fishes out a flat, round roll like the one he ate for breakfast. As he chews the roll, he looks down at the city spread out below him. Because the air is so crisp and clear at this dry altitude, he can clearly pick out the block of houses where he lives in the city of 100,000 people with lives much like his own. He is now half a mile above the city and three miles above the ocean, which, of course, he has never seen. In the distance a small black ribbon of railroad track connects Potosí with the outside world, hauling the tin to Arica, the port on the Chilean coast of the Pacific. The line also connects Potosí to the capital of La Paz. Twice a week passengers can ride the day trip to La Paz on the narrow-gauge railway. Straining to cross the Condor Pass at 15,705 feet above sea level near Río Mulato a few hours out of Potosí, this train operates the world's highest passenger railway. But all of this is far removed from Rodrigo's life.

Swallowing the last of his dry roll, he reaches deep inside his jacket and shirt and brings out his distinctively handwoven chuspa, a brightly colored bag of coca leaves that he always keeps on a string around his neck. Picking a few leaves, he carefully inserts them one at a time, together with a little lime, into his mouth with a well-practiced turn of his wrist. After only a few minutes of inactivity at this altitude, he begins to feel the cold, but the mildly narcotic effect produced by chewing the leaves will soon
numb that. It will also alleviate his hunger, his thirst, and the sheer drudgery and monotony of the coming eight hours in the mine. It will ease but not stop the pain which slowly begins to torture him in the morning and by the close of the shift has engulfed his whole body from head to toe.

With his quid of coca securely between his cheek and gum, Rodrigo silently joins the other miners and begins his shift, hammering out small pieces of rock for eight hours without even a meal break. They work without the aid of automated machines or even of animals to haul the heavy wagons of rock. Because Rodrigo works in a mining cooperative, he receives pay only for what he produces and not for the time it takes to produce it. Unemployed miners form cooperatives that take over old mines when the government and the private mining companies judge them too unprofitable to operate. As twenty generations of Indian miners have done before him, Rodrigo chips away at a little more and a little more of the mountain each day. The mountain is now so honeycombed that the Indians say it is nearly hollow and soon will collapse upon itself.

At the end of his shift in the mine, Rodrigo reverses his climb. Even though he does not ride the bus during his descent, the trip down takes him only two hours. He returns home exhausted from the ordeal of twelve and a half hours. Rodrigo repeats this routine seven days a week for a wage of approximately a dollar a day and under the constant threat of unemployment because his health might break down or the world economy might take some turn on commodities for reasons incomprehensible to him. He pauses in this weekly routine only for an occasional fiesta or funeral, and on those days he loses that dollar.

Rodrigo knows that the colonial town of Potosí and the mountain on which he works has a long and supposedly glorious history stretching back to Inca times. He has heard that history acknowledged many times by the priest, by politicians in speeches, and by the union officials, and he also knows many of the stories about the fabulous riches, the horrible disasters, the massacres, the revolts, the swindles, the strikes, and the wars surrounding the history of these mines. He easily and vividly relates the stories about the disasters, whereas the stories about the lives of the rich and powerful are only vague accounts of limitless food

in large, warm rooms. But Rodrigo has little time to dwell on such topics; perhaps if he lives past the average life expectancy of forty-eight years he can find out more about it.

This mountain on which Rodrigo lives and works is the richest mountain ever discovered anywhere on earth. Beginning in 1545, this mountain produced silver for the treasuries of Europe at a rate and in a volume unprecedented in human history. The Cerro Rico, which means “rich hill,” was a mountain of silver over two thousand feet high. Eighty-five percent of the silver produced from the central Andes during the colonial era came from this one mountain. The name Potosí became a synonym for fabulous and inexhaustible wealth after Miguel Cervantes used the phrase vale un Potosí, “worth a Potosí,” in Don Quixote de la Mancha. For a while the expression was even used in English and became the name of towns in Wisconsin and Missouri as well as two mountains in Colorado and Nevada and another mine in Mexico.

The Indian miners say that they have extracted enough ore from this mountain to build a sterling-silver bridge from Potosí to Madrid. It produced so much silver ore and required the labor of so many Indian slaves that for a while Potosí was the largest city in America. It was the first real city of the New World, reaching 120,000 inhabitants by 1573 and 160,000 by 1650. Potosí rivaled such Old World cities as London and Paris in size. The vain Spaniards who ruled it chose to advertise their wealth even in Potosí’s coat of arms, which ostentatiously proclaimed: “I am Potosí, the treasure of the world and the envy of kings.”

According to Quechua myth, the Inca emperor Huayna Capac first mined Cerro Rico a generation before the Spanish arrived, but the Incas called it Sumaj Orcko, “beautiful hill.” The emperor stopped the operation, however, when a voice thundered out of the mountain saying: “Take no silver from this hill. It is destined for other owners.” The prophecy certainly came true, for the people of Bolivia have never profited from their great riches. The silver of Potosí was destined for others.

The story of the silver of America seems at first to be less important and dramatic than that of gold. The early invaders of America did not show as much interest in silver as they did in
gold. Only after they had thoroughly looted all the gold they could find in America did Cerro Rico begin to play its unprecedented role.

Prior to Columbus, most of Europe's gold arrived from the place the Europeans appropriately called the Gold Coast, in present-day Ghana, Benin, Togo, and Guinea on the west coast of Africa. Two-thirds of the gold in use in Europe prior to the discovery of America came from West Africa [Wolf, p. 39]. It arrived in Europe by a long and torturous route through the tropical jungle, across the Sahel and on through the Sahara. Much of this traveled by caravans and was traded from merchant to merchant through Gao or Timbuktu in present Mali on to Fez in Morocco and then to Spain. Another route crossed the Sahara to Tunis or Tripoli, whence merchants traded the gold with Italian merchants. The Europeans traded cloth, beads, and craft items, which then made their way down the same trail. Timbuktu became so rich from this trade that it was known as the Golden City. When the Malian king Mansa Musa undertook a pilgrimage to Mecca in 1324, five hundred slaves accompanied him and a caravan of one hundred camels supposedly laden with gold. Even though the amount of gold is unknown, he supposedly gave away and spent so much of it that he caused a gold inflation on the Cairo market. This earned his kingdom and his trade cities of Gao and Timbuktu a reputation for fabulous wealth.

The Europeans sought desperately for ways to increase the trickle of gold that flowed up so slowly from the Gold Coast to Europe, and they wanted to find ways to circumvent the numerous Moslem merchants who monopolized the trade at each stage. Spain's need to find new sources of gold was made all the more desperate by the frequent disruption of the gold trade during the campaigns of Queen Isabella and King Ferdinand against the Moors. The expulsion of the Moors and the Jews from Spain in 1492 worsened the problem.

Every step in the discovery and conquest of America was spurred on by a greed for gold that overshadowed the quest for silver, spices, or souls. Columbus gave evidence of this in his diaries with the oft-repeated statement "I was anxious to learn whether they had gold" [Pendle, p. 17]. In the end, Columbus brought back only a small amount of gold, but it was enough to whet the appetite of all Europe.

When Hernando Cortés conquered the Aztecs he immediately demanded gold from their leader, Moctezuma Xocoyotzin; the conquistadores tortured and killed many Aztecs, including the next and last Aztec leader, Cuauhtémoc, to obtain more gold. On la noche triste, the sad night, in the summer of 1520 when the Spanish army fled from Axayacatl's palace via the Tlacopán causeway, so many of the conquistadores carried their loot of gold bars, chains, and idols that the tactical retreat became a bloody rout. About one-fourth of the army died on that one night. The Aztec soldiers easily killed and captured the slow-moving Spaniards burdened by their gold, and many of the conquistadores drowned because the heavy gold dragged them down when they fell from the causeway into the lake. As recently as 1981 one of the gold bars was found by excavators in what is now downtown Mexico City [Berdan, p. 169].

When the Spanish entered what is today Colombia, they heard the legend of the Indian nation around Lake Guatavita located at an elevation of ten thousand feet in the mountains. Each year their king covered himself in gold dust, took a barge loaded with golden objects out into the middle of the lake, and sacrificed the gold to the god of the lake by throwing the objects into the water. The leader himself then dove into the lake and swam around to wash away and thus sacrifice his "golden skin." This became the legend of the Golden Man, or El Dorado. The reputed location varied, but the legend remained the same: somewhere there was a city filled with the gold of this Golden Man. The conquistadores soon explored almost all of America from Kansas to Patagonia searching for this treasure of gold.

Many of the Indian nations prized gold, but they did so more in an aesthetic or religious sense than in a mercenary one. As the Inca Garcilaso de la Vega wrote in his commentaries on the life of the Incas, "there was neither gold nor silver coin, and these metals could not be considered otherwise than as superfluous, since they could not be eaten, nor could one buy anything to eat with them." He explains further that in a nation without markets or a money economy, gold and silver "were esteemed
only for their beauty and brilliance" [Vega, p. 162]. The best use
the Incas could make of them was to decorate temples, palaces,
and convents. Inca goldsmiths of Cuzco lined the walls and
columns of the great Temple of the Sun in Cuzco with beaten
gold, and they decorated the temple with five golden fountains.
The emperor owned gardens in which stood examples of almost
all his empire's animals and plants cast in gold and silver. This
included even golden lizards, butterflies, and snakes darting among
the golden flowers and corn stalks [Vega, p. 190].

When Francisco Pizarro invaded the Andes and seized the Inca
emperor Atahualpa in 1532, he demanded a room filled with gold
as ransom, and the Incas paid it. Bearers from all over the empire
gathered jewelry and stripped their temples to fill the room. The
gold of Atahualpa formed the greatest ransom ever paid. Even
though the Incas complied, Pizarro nevertheless killed Atahualpa
and continued to loot the country in search of even more gold.

Hernando de Soto crisscrossed the southeastern part of
the United States from Florida and the Carolinas to the Mississippi
River in search of gold. Francisco Vásquez de Coronado wandered
through the modern states of Arizona, New Mexico, and California
searching for the seven lost cities of gold. Francisco de Orellana
sailed two years through the Amazonian jungle searching for El
Dorado. No matter how hot, cold, wet, dry, or high the place,
some conquistador went there searching for gold.

Today, we can still see a small fraction of the gold treasure of
the Indians. The most extensive collection, belonging to the Pe-
ruvian industrialist Mujica Gallo, is in Monterico, a suburb just
outside Lima. On a tree-lined street of affluent suburban homes,
surrounded by a massive wall and armed guards, is a large
building that looks like a cross between a ranch-style home and
a bomb shelter situated in the middle of a beautiful park. On
the ground floor of this private museum, Gallo displays his large
collection of military arms from around the world. Japanese suits
of armor guard the walls next to samurai swords. Small pistols,
muskets, and pikes dangle in midair and rest in numerous display
cases. The pride of the collection of arms, however, is the sword
that Francisco Pizarro himself used in the conquest of Peru.

To see the gold that inspired Pizarro, one must leave the ground
floor and descend into a gigantic subterranean vault with massive
walls covered by sheets of seemingly impermeable steel. Visitors
enter the room today with the hushed voices and subdued move-
ments of mourners at a funeral. In the eerie underground cavern,
they walk silently from one of the thirteen thousand golden pieces
to another, staring at the small gold beads, golden masks, ear
plugs, and goblets. One of the commonest figures in the collection
is the tumi, an object possibly used as a scepter, made in the
form of a human figure standing atop a curved blade. One of the
most unusual is a set of elbow-length gloves beaten from thin
sheets of golden foil decorated with geometric designs.

Protected in their well-lit cases and set against dark back-
grounds and with few placards to distract the eye from the gold
itself, the artifacts seem to float in space. The pieces also seem
suspended in time, for no apparent history or chronology is
attached to the objects. The museum presents them for the max-
umum aesthetic appreciation of the art aficionado and the gawkers
at beauty or wealth. The displays focus on the direct aesthetic
appreciation of the objects, and this helps account for the hushed
tones of the awed visitors. Usually experts know nothing about
the artisans who created the objects, when or why they were
made, who owned them, or even who discovered them or where
they were found. Most of the pieces came to the collection from
grave robbers or their intermediaries, who conceal the location
of their crimes for fear of either prosecution or competition.
Whenever a group of such robbers finds an object, they usually
cut it into equal parts on the spot so that each man can be assured
of getting his share. Each man then sells his pieces wherever he
thinks he can get the best price. In this way most of the objects
arrive in the museum cut into pieces, and in some cases parts
of the pieces are never found. Even the famous golden gloves
arrived with the fingers cut off, and Gallo had to buy each piece
separately and have them painstakingly reassembled. Thus objects
arrive in a historical and archaeological vacuum.

The Gold Museum of Bogotá boasts about thirty-five thousand
pieces of gold, much of it from the Chibcha people and the coastal
peoples of Colombia. Estimates place the value of this collection
at approximately $150 million, by weight alone, without factoring
in the artistic and historical value of the items. The archaeological
museum of the Banco Central in Quito, Ecuador, also boasts a
small but elegant collection of golden objects. The Banco Central of Costa Rica in San José also has an exhibit of golden objects, mostly of small animals. The total value of the metal in the collection is around $6 million.

But to find the Indian gold one must look not in the banks and museums of America but in the banks, museums, and churches of Europe. The conquistadores immediately melted it, and sent it to Spain as golden bars. They shipped intact some of the more unusual objects, such as the golden sun from Cuzco, to inform the emperor about the valuable crafts of his newly conquered land. Charles V sponsored a traveling exhibit of these objects through his empire as a propaganda device to glorify his reign by displaying the wealth from his new realms of Mexico and Peru. After the public exhibit, the emperor had all the pieces melted down for use in his treasury. He minted new coins from the gold, paid some of his debts with it, gave some of it to churches, and used it to finance the expansion of his army and his palaces.

Between 1500 and 1650, the gold of the Americas added at least 160 to 200 tons to the European treasure [Braudel, Vol. I, p. 467]. This amount of gold has a contemporary value of over $2.8 billion, far more than the meager hoards in Gallo’s museum or in the banks of the other Latin American capitals. The churches of Europe still groan under the weight of American silver and gold jealously guarded but ostentatiously displayed. Once-simple churches such as those in Toledo suddenly soared to new heights, expanded, and had new windows installed to let the sun pour down on the vast collection of gold and jewels from the New World. The cathedral of Toledo boasts a five-hundred-pound monstrance made in the sixteenth century from gilded silver said to have been made from the Indian booty brought back by Columbus himself. Córdoba, Avila, and every other city in the south boast similar artifacts, even though they do not always brag about the source of the precious metals. Gold became so common in European palaces and churches that architects developed a novel style of decoration emphasizing entering light that could illuminate the gold and make it dazzle the observer. Thankful conquistadores and an appreciative monarchy filled the churches with golden crucifixes, golden statues of saints, gilded frames of paintings, golden reliquaries, and gilded tombs. The Spaniards melted the American gold to fashion golden chalices, trays, and other religious articles that still survive in the churches in Spanish cities such as Seville and Toledo.

I first saw this wealth of silver and gold in a Holy Week procession in Córdoba. The crowd in the darkened courtyard of the cathedral of Córdoba quieted as a group of young men swung open the twenty-foot-high doors of the former mosque. Out marched the members of the Pious Brotherhood of Penitents and Union of Nazarites of the Holiest Christ and Our Lady of Tears in Sorrow. Dressed in their long robes of purple and white topped by tall conical hats from which hung veils covering their faces, they looked like marchers in a Ku Klux Klan rally. The first one carried a six-foot-high cross of silver. Twelve young boys, without masks but wearing twisted lace collars several inches thick, followed him; each of them carried a golden trumpet four feet long and a foot wide at the mouth. From each trumpet hung a banner of the Hapsburg eagle, which also served as the emblem of this confraternity. Following the trumpet players marched more boys with tall silver crosses and more men with covered faces.

Slowly and clumsily, like a dinosaur with too many legs, forty young men followed in tight formation carrying on their shoulders a float of Christ on the cross. The float was awkwardly pulled through the Moorish doors and into the night air, which immediately extinguished most of the several dozen candles burning in four golden candelabra that reached up to five feet in height. As the forty men awkwardly swung their load back and forth, they entered the ancient courtyard of the cathedral where mullahs taught the Koran to generations of Spanish boys before the discovery of America. The branches of the orange trees whipped against the float, dropping leaves over the Christ and spreading the sweet smell of orange blossoms throughout the crowd. More hooded men marched behind the float with a band that alternately played marching songs and mournful dirges. Behind the band followed the float of the weeping Virgin Mary, bedecked with white gladioli and orchids and far more gold and silver than the float of Christ.

Every night during Holy Week at least three such processions wended their way through the narrow streets of Córdoba, through
the mosque-turned-cathedral, past the old synagogue of the ancient Jewish quarter, and through the alleys of the Arab merchant section. A few of the floats were made of wood, but most were either gilded wood or solid silver. Córdoba alone had twenty-nine such processions, each with two floats, and in the region of Andalusia over three hundred such processions marched during Holy Week, the largest and most emotional of all being in the regional capital, Seville.

These processions offered more than an opportunity for men to hide their identity while marching through the streets as an act of penitence for their sins of the year. Holy Week gave each neighborhood parish the chance to compete with the others in decorating the most beautiful floats and in using the most costly materials.

The processions and the churches of Europe offer the most visible reminders of the deluge of American gold that showered Europe in the sixteenth century, but the remains of this golden wave still shine in the secular buildings as well. Church and lay authorities found themselves with so much gold that they decorated their palaces with it. They put gold leaf on the ceilings, added golden cherubs in the corners, strung vines of golden grapes between them, and puffed up golden clouds to fill any unadorned spaces. The gold of America gave Europe the baroque and finally the rococo styles of ostentatious decoration for public buildings, churches, palaces, and even the homes of the rising new merchant class.

By comparison with the golden treasure, the silver of Cerro Rico provoked a less ostentatious response among the Europeans, but the eventual impact of the silver proved to be far more extensive and more profound. The exploitation of the silver in America followed very quickly that of the gold.

Once extracted, this silver did not stay in Bolivia. In the imperial mint of Potosí, craftsmen hurriedly minted the silver into sterling bars or coins that were shipped across the mountains to the sea, up the coast to Panama, across the Isthmus by mule, and onto galleons bound for Seville. In 1637 an English Dominican saw one of the mule trains carrying the silver to Porto Bello on the Caribbean coast of Panama. He described them as “laden with wedges of silver; in one day I told two hundred mules laden with nothing else, which were unladen in the marketplace, so that there were heaps of silver wedges like heaps of stones in the street” [Pendle, p. 64].

Never before in the history of the world had so much silver money been in the hands of so many people. Kings, emperors, czars, and pharaohs had always accumulated great wealth in their jewels, their hoards of gold, and their coinage, but the total amount of gold and silver was quite limited by the scarcity of the precious metals. A royal treasury guarded a hodgepodge of whatever valuable items could be collected. This changed with the opening of the Americas. Now for the first time people had massive amounts of silver and gold. Quickly and inexorably the traditional mercantile system of Europe changed. With so much money, the old system mutated into a true money economy in which large numbers of people could buy large amounts of goods, and private citizens could start their own hoards of coins. Production increased, and people began to accumulate capital in quantities undreamed of by prior generations.

The silver treasure unearthed in the bowels of Cerro Rico made this possible. Gold serves well for making jewelry, decorating palaces and churches, and making some very valuable coins, but for the thousands and millions of small daily transactions necessary to make a money economy, silver proves much more practical. A baker buying barrels of flour, a weaver selling new bundles of cloth, a fish merchant buying the catch of small fishermen, all need coins of small but consistent value. The discovery of Cerro Rico brought them into the world economy; it let them have plentiful coinage and thereby made them active players in the monetary world.

The ancient world had never enjoyed access to enough silver to assure a plentiful supply of coins. Even in Roman times the shortage of silver led to periodic debasing of the currency by alloying the silver with less valuable metals. At times the Roman emperors even resorted to silver-plating baser metals and circulating the coins or paying their armies with them under the pretense that they were sterling silver [Garraty and Gay, pp. 223-24].
In the first fifty years of the conquest of America, the amount of silver and gold circulating in Europe trebled, and the annual output from America was ten times the combined output of the rest of the world [Crow, p. 267-73]. Royal customs agents in Seville, Spain’s only official port of entry for goods from the New World, recorded sixteen thousand tons of silver entering during this time [Braudel, Vol. I, p. 467]. $3.3 billion worth in today’s silver market; illegal trade and pirating may have brought in another five thousand tons or more.

Even though Potosí was the major source, the Spanish also opened silver mines in the western mountains of Mexico. In 1546, Juan de Tolosa discovered another major silver vein in the territory of the Chichimec people, called Zacatecas; he named the mine La Bufo. Being much larger than Bolivia, Mexico yielded many more mines. After La Bufo the Spanish opened mines at Guanajuato in 1548, Taxco in 1549, Pachuca in 1551, Sombrereto and Durango in 1555, and Fresnillo in 1569 [Wolf, p. 135]. Although no single find in Mexico ever attained the unprecedented output of the fabled Cerro Rico, the total output there surpassed that of Potosí.

At the time of the discovery of America, Europe had only about $200 million worth of gold and silver, approximately $2 per person. By 1600 the supply of precious metals had increased approximately eightfold [Webb, p. 138]. The Mexican mint alone coined $2 billion worth of silver pieces of eight [Crow, p. 267].

The silver coins flowing through Europe at first promised to strengthen the feudal order, but in the end they forged whole new classes and changed the fortune of many countries. The new coins helped to wash away the old aristocratic order in which money games could be played only by the privileged few; massively larger amounts of money opened up new games to new people. Even though all the silver and gold went into Spain, it did not stay there. From Spain the money spread throughout Europe. The Hapsburg monarch Charles V occupied his throne both as emperor of the Holy Roman Empire and as the king of Spain; this facilitated the spread of the money from Spain to the Hapsburg holdings in the Spanish Netherlands and across Germany, Switzerland, Austria, and the Italian states. Three-fifths of the bullion entering Spain from America immediately left Spain to pay debts, mostly those incurred by the profligate monarchy; as Cervantes wrote in Don Quixote, Spain had become “a mother of foreigners, a stepmother of Spaniards” [Wolf, pp. 140, 114].

Precious metals from America superseded land as the basis for wealth, power, and prestige. For the first time there was enough of some commodity other than land to provide a greater and more consistent standard by which wealth might be measured. This easily transported and easily used means of wealth prepared the way for the new merchant and capitalist class that would soon dominate the whole world.

The impact of this new money showed clearly in the port of Antwerp, which had belonged to the Duke of Burgundy before he became Emperor Charles V. Writing in 1560 about the great trading city of Antwerp, a Florentine diplomat, Ludovico Guicciardini (1483–1589), wrote that he found in the market “innumerable kinds of merchandise, precious stones, and pearls of various quality and prices, which the Spaniards bring from their West Indies and from Peru called ‘America,’ and the New World.” In particular they bring in “a large amount of gold, of pure silver in bullion and hand-wrought, which is likewise for the most part from that new and happy world” [Ross and McLaughlin, p. 185]. By 1555, Antwerp had grown to a city of over 100,000, even though at the time of the discovery of America it probably still had less than 20,000 [Wolf, p. 114].

Jean Bodin (1530–1596), a French lawyer, writing in 1568, first realized the inflationary effect of the American money. He concluded that there were several reasons for the rising prices in the sixteenth century but that “the principal and almost the only one (which no one has referred to until now) is the abundance of gold and silver, which is today much greater in this kingdom than it was four hundred years ago” [Ross and McLaughlin, p. 202].

The tremendous volume of new currency influenced the economy of all Europe. For example, in Naples there were only 700,000 ducats in circulation and in savings in 1570. In less than two centuries, by 1751, there were eighteen million ducats. These eighteen million ducats, moreover, could be used many times in a year for various types of transactions. The total number of
ducats used in buying and selling would be approximately 288 million. Similarly, in France, which received its wealth from the New World much later than Spain, approximately 120 million francs circulated in 1670, but by 1770 there were two billion in circulation, a fifteenfold increase in a century [Braudel, Vol. I, p. 464].

The American silver traveled around Europe very quickly, and it made a quick and heavy impact on the economy of neighboring parts of the Old World, such as the Ottoman Empire, which controlled Turkey and Greece and most of the Near East, North Africa, and large parts of eastern Europe in the sixteenth century. The Ottoman silver akce coin suddenly fell to half its former value before the end of 1584 in a bout of uncontrolled inflation. The coin lost its important place in world trade and never regained it [Garraty and Guy, p. 613]. After centuries of struggle between the Moslems and the Christians, American silver probably did more to undermine Islamic power for the next half a millennium than did any other single factor.

In The Wealth of Nations, Adam Smith discussed at great length the impact of American silver in causing worldwide inflation. He wrote that within a generation of the opening of the mines of Potosí, the silver from them started an inflation that lasted for approximately a century and caused silver to fall to its lowest value in history [Smith, pp. 191–202]. The new wealth in the hands of Europeans eroded the wealth of all the other countries in the world and allowed Europe to expand into an international market system.

The silver of America made possible a world economy for the first time, as much of it was traded not only to the Ottomans but to the Chinese and East Indians as well, bringing all of them under the influence of the new silver supplies and standardized silver values. Europe’s prosperity boomed, and its people wanted all the teas, silks, cottons, coffees, and spices which the rest of the world had to offer. Asia received much of this silver, but it too experienced the silver inflation that Europe underwent. In China, silver had one-fourth the value of gold in 1368, before the discovery of America, but by 1737 the ratio plummeted to twenty to one, a decline of silver to one-fifth of its former value [Weber, p. 5]. This flood of American silver came to Asia directly from Acapulco across the Pacific via Manila in the Philippines, whence it was traded to China for spices and porcelains.

Asia experienced a temporary gain from the discovery of America, but Africa suffered. America had all the silver and gold Europe needed, and this destroyed the African gold markets and the dependent trade networks. Cities such as Timbuktu and the Songhai Empire of which it was a part crumbled as merchants abandoned the ancient trade routes. To replace the Mediterranean trade of cloth, beads, leather, and metals upon which the Africans had become dependent, the Africans now had only one commodity that the Europeans wanted—slaves. For centuries the African merchants had sold a small but steady number of slaves to the Middle East, but with the decline of their traditional European trade and with the opening of America, the slave trade became a boom. The Africans thus became victims of the discovery of America as surely as did the American Indians.

In the first few years after the discovery of Potosí, the Spaniards brought in six thousand African slaves to work the mines, but they soon died at that high altitude. The colonial administration then turned to the Indians to work the mines without pay as a form of forced labor, or mita as it was called in Quechua, the Inca language. Indians had to walk from hundreds of miles away in every part of the highlands of Peru and Bolivia. They worked for approximately one in each four years, even though by law they were not required to work more than one year in each seven. Each miner’s family supplied him with his food and with the candles he needed for light inside the mines. The Indians entered the mines on Monday morning and did not emerge again until Saturday. Each man had to chisel out his daily quota of one and a quarter tons of ore. He then loaded it in bags of a little over one hundred pounds and carried it up to the main tunnel. This required that he drag and push the bag through a labyrinth of small tunnels barely large enough to squeeze through, and then carry it up ladders at odd angles for hundreds of feet. In the first decades of this system, four out of five miners died in their first year of forced employment in the mines [Crow, p. 269].

In the modern era, with a battery-powered light on my head, I had great difficulty maneuvering through the older channels
even without trying to haul a quintal of silver ore. As I climbed ladders from one level to another, mud constantly dripped down on me from the boots of the man ahead of me. I had to grasp the rungs tightly to keep my hand from slipping off in the mud, but slivers of wood then embedded themselves in my fingers. When I could walk, I was constantly standing in water up well above my ankles, and even though I wore modern miner's boots, the moisture still managed to get through to my socks. All the while the temperature inside was so cool that I could see my breath whenever the dust subsided enough for the air to clear. All of this was made all the more difficult by the thin air at well over fourteen thousand feet above sea level, almost three times the altitude of Denver, Colorado.

Despite these working conditions, if the Indian worker failed to fill his quota the Spanish overseers forced him to work on Sundays, held him over for a longer mita, or forced his family to pay in goods or other services for the work he had not been able to do. Thus several members of a family, including women and children, often worked to fulfill what was supposedly the obligation to supply a single person [Werlich, p. 43].

Even though the Indians made possible the greatest economic boom in the history of the world and even though this boom gave rise to the great capitalist world economy, they still languished in poverty. They live in a struggling country in which prices sometimes increase by the hour, and where the value of a day's pay can plummet by a fourth overnight.

Today a second mountain rises up from the valley floor next to Cerro Rico in Potosí. This artificial mountain arose from the millions of tons of crushed rock residue that remained after the precious metals were extracted. The people call this artificial mountain Huakajchi, the mountain that cried. This new structure of refuse is a giant mountain turned inside out and made from the core of Cerro Rico. It too is being mined now, or more precisely "picked over." Now that the wealth of the Cerro Rico has been nearly exhausted, the Indian women who still live in the area have turned to searching through the mountain of rubble for small bits of metal that were overlooked in the original mining. They are forced to scavenge from the garbage of their ancestors.

Potosí, the city which supplied the silver for the rise of capitalism, is now out of silver, and the miners mine only tin, but the price of tin has dropped to almost nothing as the plastic revolution spread around the world. The great mint of Potosí that swallowed eight million Indian miners and turned out billions of coins from the sixteenth century into the twentieth century operates now as a museum for visiting schoolchildren [Gaiano, p. 50]. Bolivia has no more coins. Now robbed of its wealth, Bolivia uses only cheap paper money that must be imported. In the middle and late 1980s, with inflation running at an annual rate fluctuating between 2,000 and 15,000 percent, paper currency in denominations of millions of pesos printed by companies in Germany and Brazil composed Bolivia's main import.

Europe also paid the price for its greed. Spain, the greatest beneficiary of the Potosí silver, soon bankrupted itself. By 1700, Spain was reduced to a minor power of neither economic nor political importance, and even the Hapsburg dynasty lost Spain to the Bourbons. Since then Spain has continued to sacrifice occasional generations of its young men in bloody foreign and civil wars. Spain, which had ruled an empire larger than any in the world today, degenerated into a poor hinterland of Europe. It lost huge chunks of its American holdings to Portugal, England, France, and even Sweden and the Netherlands, and the admittedly vast areas to which Spain retained a nominal claim were being ransacked by merchants and companies from England, the Netherlands, and France. By the time of the American Revolution, the English-speaking colonies of North America had more Mexican silver dollars circulating within them than Spain itself did [Fehrenbach, p. 294].

The silver of Potosí helped to destroy Spain, almost as though it carried with it a curse written in the blood of the legions of Indians who died to supply it. And the curse did not stop with Spain. The money passed into the hands of the greedy Dutch, British, and French traders and pirates, and for a while it seemed that they were able to use it more wisely and profit from it more than the Spanish had done. They used it to build large modern navies and armies that colonized almost every country in the rest of the world, dividing Africa, Asia, and the Pacific islands among themselves to make vast new empires on which the sun
never would set. But they also fought with one another in war after war. By the middle of the twentieth century, these empires too had fallen, leaving the British no better off than the Spanish. By then, economic power on the European continent had shifted to Germany and the Soviet Union, the two nations that had participated in and profited the least from the blood money of Potosí.

Cerro Rico stands today as the first and probably most important monument to capitalism and to the ensuing industrial revolution and the urban boom made possible by the new capitalist system. Potosí was the first city of capitalism, for it supplied the primary ingredient of capitalism—money. Potosí made the money that irrevocably changed the economic complexion of the world.
flurry of development that radically altered the traditional way of life of the whole world.

Without European technology and organization, the industrial revolution would never have started in America; without American precious metals and methods of processing, the industrial revolution would never have spread to Europe.


There is only one Machu Picchu, but it guards many mysteries. The ruins of this ancient Peruvian city sit perched eight thousand feet above sea level on a mountain overlooking the Urubamba River. Even though in size Machu Picchu barely surpasses a village, the ruins show a complexity indicative of a much more important place. The stone houses with trapezoidal doorways and simple lintel construction do not resemble the houses of the puric, the common peasants, and the public buildings surpass any administrative or religious building one might expect to see in a town of comparable size. The ruins show precision-crafted buildings with the neat regular lines, beveled edges, and mortarless seams that characterize the best of Inca architecture.

The spectacular setting combined with the exquisitely wrought buildings evoked much speculation and much romantic rubbish about the purpose of the city. The North American discoverer Hiram Bingham erroneously assumed that he had found Vilcabamba, the holdout capital of the Inca Empire after the fall of Cuzco. Lacking an explanation, many people assume that the purpose must have been religious and thus have dubbed the place "the sacred city of the Incas." Others claim that it was built as a city to protect the noble women from the Spanish, or that it
served as a monastery associated with the sacred coca plant, or as a cult center.

None of this agrees with what we know about the Incas. Unlike the superstitious Aztecs, the Incas did not build large pyramids to perform massive blood sacrifices or pursue long wars to please their gods. Unlike the mystical Mayas, they did not build observatories to watch the endless patterns of the stars or write long, philosophical poems on the creation of the world. They displayed an austere practicality in every aspect of their lives, and they show little hint of religious fervor, no penchant for meditation, no tendency toward either the sentimental or the superstitious.

The supposedly practical peoples of ancient Rome, traditional Germany, and the contemporary United States seem almost like mystics compared to the Incas, and ancient Sparta seems like the home of the frivolous. The Incas' practicality shows in the precise and very angular style they used to construct buildings, in contrast to the more haphazard and rounder style of their predecessors. This same practicality and passion for organization shows in their economic system, which lacked money, markets, or merchants and yet managed to avoid the famine that stalks so many great empires.

In light of this practicality the very existence of Machu Picchu seems all the more puzzling. Why would the Incas build a city and line the mountain with terraces even though there was very little soil there? The builders used the best techniques known to them to make terraces that would last for eternity. Then the workers added layers of rock and clay as subsoil, and from the river below them they hauled up rich dirt over steep embankments half a mile deep. This task would be the equivalent of hauling dirt from the Colorado River to plant fields on top of the Grand Canyon.

The Incas built hundreds of the terraces, all of them quite small for any kind of extensive agriculture. Some of them narrow to as little as six inches in width. Yet these terraces climb up and down the mountain to great distances, and the Incas even built small terraces high up on the facing peak of Huayna Picchu, an hour's steep climb from the city. Such an arrangement makes no more sense than if Americans today decided to start farming the face of Mount Rushmore with plots the size of large flower boxes.

A hint of the possible function of Machu Picchu came to me while hiking around the area for two days with Charles Laughlin, a plant scientist from the University of Georgia. On one of our excursions, we returned to the ruined city by way of the Inca trail from the south. This trail enters the city through Inti Punu, the stone gate of the sun, perched high up in the saddle of the mountain dividing the Machu Picchu side of the mountain from a dry inland valley. Standing in the gateway one sees two worlds, the brown and lifeless valley to one side and on the other side the lush, emerald-green valley watered by the thick fogs and mists of the Urubamba River far below the city ruins.

As we descended toward the city from this high pass, I stared out at the spectacular landscape. Why had the Incas built the city here at this point? Was it to guard the river? But what was there to guard? Perhaps it was a place to trade coca. But why would they need a monumental city for that? Why had they built the city up so far from the water of the river?

All the while I searched up and down the long vistas of the Urubamba and the surrounding mountains, Chuck was looking at the vegetation and naming everything growing along the path. I found this distracting from the big picture, but as we descended the mountain and passed from one terrace to another, the plants that he named changed. We were passing through a series of ecological layers, as one does on many mountains in the Andes. The mountainside is laid out in strips of vegetation and microzones. The place is a scientist's dream—the perfect place for all kinds of controlled experiments. Viewed in that context, the small terraces took on new meaning as experimental patches at a range of altitudes and built at so many different angles facing the morning sun, the evening sun, constant sun, or no sun. They are like a scientist's set of experiments all laid out in a field.

In my mind, Machu Picchu suddenly became an agricultural station. In that sense it was a sacred spot, because agriculture was a sacred activity for the Incas, who worshiped the life-giving Pachamama, the earth mother, and Inti, the sun, who together made the plants grow.
The ancient Peruvians had been among the world's greatest experimenters with agriculture, and they built numerous experimental areas where crops could be grown in different ways. It would not be surprising if they devoted a place such as Machu Picchu to just such activity. Whether this site actually functioned as an ancient experimental agricultural station or not, the Indians of the Andes probably did more plant experiments than any other people anywhere in the world.

Starting thousands of years before the Incas, the natives ascertained how to produce extremely high yields of potatoes from small plots of land. In the modern world, producing high yields has come about primarily through developing plants that can grow in different types of environments and, when necessary, through the manipulation of the immediate environment of the plant to ensure that it has just the right amount of moisture, nitrogen, and other requirements for maximum growth. Peruvians seem to have approached the problem in the opposite way. They sought to develop a different kind of plant for every type of soil, sun, and moisture condition. They prized diversity. They wanted potatoes in a variety of sizes, textures, and colors, from whites and yellows through purples, reds, oranges, and browns. Some tasted sweet and others too bitter for humans to eat, but the latter were useful as animal fodder.

They did not seek this diversity merely for the aesthetic pleasure of having so many shapes, colors, and textures, but rather for the practical reason that such variations in appearance also meant variation in other, less noticeable properties. Some potatoes matured fast and some slowly, an important consideration in a country where the growing season varies with the altitude. Some potatoes required a lot of water and some required very little, which made one variety or another more adaptable to the highly variable rainfalls of different valleys. Some potatoes stored easily for long periods of time, others made excellent food for livestock.

In addition to the potato, the Incas produced other tuber and root crops, such as oca, ahu, achira, papo liza, luki, and maca, none of which even have names in English. The Peruvians grew corn in just as many varieties and diverse habitats, and they cultivated the native American grain crops that in Quechua they called kiwicha (or amaranth, Amaranthus caudatus) and quinoa (or quinoa, Chenopodium quinoa).

The success of these early experimenters remains visible today, not only in the variety of food crops but in the extensive agricultural ruins of the Urubamba Valley stretching from Machu Picchu to the Inca capital city of Cuzco. As one goes along the valley, one is constantly in sight of Indian ruins remaining from the Spanish conquest. Crumbling watchtowers dot the high ridges like a row of decaying teeth, and empty citadels loom over nearly deserted villages. Irrigation canals once brought water down from the melting snows high in the mountains to the terraces. But the terraces now lie broken, and rock or mud long ago filled in the canals. It taxes the mind to imagine how magnificent this valley must have been before the conquest. Green terraced fields continued for miles, punctuated by filled warehouses; now, parched parcels of land, crumbling terraces, and destroyed bridges are all that remain to be seen.

As the Spanish armies, clergy, and diseases swept through the river valley, whole villages died or were taken away to work the mines of Potosí, and the rich valley soon gave way to decay and dim memories. This valley of the Urubamba River, which may have supported millions, now has only a fraction of its former population. While these fields lie neglected, the government of Peru, the land of the potato, imports potatoes from the Netherlands to feed the people.

Indians of the Andes have cultivated the potato on their mountain slopes and in their valleys for at least the last four thousand years. Apparently the potato descended from a tuberous Solanum that grew wild throughout the Americas and was used by Indian groups as far north as the southwestern United States, where the Navajos made it a major part of their diet. The Indians of the United States and of Mexico apparently were in the process of domesticating their own varieties of this potato when the Spanish arrived in the sixteenth century [Salaman, p. 1].

At the time of the Spanish conquest, Andean farmers already were producing about three thousand different types of potatoes in the Andes. This contrasts with the mere 250 varieties now grown in North America, and of those no more than twenty
varieties constitute three-quarters of the total potato harvest in the contemporary United States. Under the guidance of the Indian farmers of the Andes, the potato became the basis for several great Andean empires, the last of which was that of the Incas whose empire fell to Francisco Pizarro in 1531.

The Andean farmers also devised and perfected the first freeze-dried method of preserving the potato. At night, farmers put their potatoes out in the freezing air of the high mountains. During the day the sun thawed the potatoes, and the farm family walked over them to press out the melting moisture. After several repetitions of this process, the potato dried into a white chunk which very much resembled modern plastic foam. In this very light form the Incas easily transported great numbers of potatoes to distant storehouses, where they could be preserved for five or six years without harm. When needed, the potato could be reconstituted by soaking it in water, and then it could be cooked. Cooks also ground it into meal for making soups and other dishes. Today this entire procedure continues exactly as before in thousands of hamlets scattered throughout the Andes. The resulting ch’uño, as the dried potatoes are called in Quechua, still serves as a staple of Andean cuisine throughout the year.

The Incas also used drying techniques on a variety of other vegetable crops and even on meat. The dried meat, or charqui as it was called in Quechua, also found favor among the Europeans as a convenient and light way to preserve and transport meat. The name charqui was taken over and corrupted into “jerky,” one of the few English words derived from Quechua.

Just as the silver of Potosí spread to Europe and then on to the Ottoman Empire, Timbuktu, and China to cause a major change in the world’s economy, the humble potato spread to the rest of the world. The potato spread far more slowly than the silver, but in the end the potato and the other native crops of America have produced a far greater impact than the mountain of silver.

It is difficult to imagine what Ireland would be today without the potato. What would the Russians, the Germans, the Poles, and the Scandinavians eat? Without the potato the Soviet Union might never have become a world power. Germany would not have fought two world wars, and northern Europe and the Benelux countries would not have one of the world’s highest standards of living.

Before the discovery of America, the Old World depended primarily on grain crops of domesticated grasses such as wheat, rye, barley, and oats in Europe and the Near East, rice in the Far East, and millet and sorghum in Africa. All of these plants, however, face numerous problems in their growing cycle. Because they grow on high stalks above the ground, they are easy prey to the destructive elements of wind, hail, heavy rain, and snow as well as to birds, insects, and animals.

For centuries the northern countries such as Russia and Germany suffered periodic famines when the grain crop failed because of unsuitable weather. For as long as the Old World depended on grain crops, the great population and power centers remained in the warmer southern nations around the Mediterranean, where the grains flourished. Greece, Rome, Persia, and Egypt all had successful empires primarily because of their control of grain production. Even a nation as far north as France was able to become a world power and a reasonably good producer of grain. But the unpredictable weather and food supply set as a permanent burden on the German states, England, and Scandinavia, and on Russia, which sometimes exported grain and then sometimes imported it. These were all societies waiting for their chance to act on the cultural and political stage of world, but first they needed a consistent supply of nutritious and cheap food to sustain them.

This food finally arrived in the somewhat ugly form of the Andean potato. Together with maize corn from Mexico, potatoes were what French historian Fernand Braudel called “the miracle crops” [Braudel, Vol. I, p. 74]. The Europeans by no means greeted this new plant with general enthusiasm. The peasants of Europe despised the new plant. Aside from the occasional side dish of parsnips, turnips, and carrots, Europeans did not eat root crops. They certainly did not want to adopt one as a staple of their daily diet. For them the staples were the grains that they could mill and then bake into bread or more commonly could eat as a porridge, such as the oatmeal of the Scots and Irish or the gruel
of the English. This was real food to the European peasant, not a knotty tuber grown by American savages.

European legends claimed potatoes caused leprosy because the potato grew in such a misshapen and ugly form. Some Orthodox sects in Russia called it the devil’s plant and decreed it a sin to eat the potato, the tomato, and sugar, because they were not mentioned in the Bible. Even as authoritative a source as Denis Diderot’s Encyclopédie of 1765 accused the potato of being tasteless and of causing excessive flatulence in the peasants who eat it [Braudel, Vol. I, p. 170].

Adam Smith wrote one of the first defenses of the potato and theorized about the tremendous importance that its adoption portended for Europe. He accurately predicted that increased cultivation of potatoes would cause an increase in production, an increase in population, and an increase in the value of land. Based on his observation of Ireland, which was at that time the only country where the potato was already widely cultivated, Smith judged the tuber to be an excellent food, especially for the lower classes. In his opinion, the potato made men stronger and women more beautiful, and he based this opinion on his observations of the prostitutes and laborers imported from Ireland to London. Despite Smith’s strong advocacy of potato cultivation, he doubted that potatoes would become very widespread because of the difficulty of preserving them for longer than a season [Smith, pp. 160–61].

For its first two centuries in Europe, the potato was little more than a curiosity grown in herbal gardens around monasteries and universities and eaten by the upper and middle classes as a novelty food; the masses steadfastly ignored the interloper. Not until the second half of the eighteenth century did the potato finally take root in fields of northern Europe. The peasants grudgingly accepted it only after their rulers forced them to plant it. Frederick the Great in Prussia, Catherine the Great in Russia, and similarly enlightened monarchs forced the peasants to grow potatoes or starve following a series of eighteenth-century famines, epidemics, and wars.

The archbishop of Mainz broke the dependence of the villagers of Kahl on grains through a number of strenuous laws. In Kahl and other villages, he outlawed construction of new home ovens and provided each village with only a single communal oven that the village women used in shifts. The large beehive-shaped oven still stands in the oldest part of Kahl near the church as a historical talisman uniting the contemporary villagers with the ancient community of their ancestors. The building of the communal oven markedly reduced the bread and baked goods available, because each housewife had only one turn per week at the oven, and she had to pay tax on each tray of foods she baked. Taxes on mills further reduced dependence on flour, and additional taxes on bakers and ovens raised the cost of bread. The peasants had to grow potatoes or face severe financial strain and possible hunger.

The monarchs and Adam Smith knew what the peasants would soon learn: a field of potatoes produces more food and more nutrition more reliably and with less labor than the same field planted in any grain. Even today, a hectare of land planted in potatoes produces 7.5 million calories. The same land planted in wheat produces only 4.2 million calories. The cultivation of potatoes also consumes far less calories or energy than does that of wheat. This means that each farmer could produce more hectares of food per worker, or that some of the workers could be freed for other tasks. The potato needed only three to four months to grow compared to almost double that for grains. The potato also needed far less attention and care while growing, and it grew in a variety of soils that were not otherwise productive [Farb and Armelagos, p. 76]. Farmers found that the potato required none of the extensive milling and processing of grains, which necessitated a large capital investment in equipment and transportation. By contrast, potatoes could be pulled from the fields for immediate consumption or stored in the basement for nearly a year before being cooked.

The potato could be used for bread, although that was usually not necessary, since enough grain existed for the making of bread. Instead, cooks could make the potato into many new dishes to replace the limited breads, noodles, gruels, and porridges that could be made from grains. The potato could be served baked, boiled, roasted, or fried or could be made into soups, pancakes, dumplings, soufflés, and pies.
Once introduced into the fields of the European farmers, the potato thrived. Accustomed to the cool and often damp highland valleys of the Andes, the potato adapted easily to the cool and damp climates of Ireland, Germany, Poland, Russia, Scotland, England, the Netherlands, Belgium, and Scandinavia. Of the approximately three thousand varieties of potato grown in America, comparatively few were transplanted to Europe, but there were enough varieties to ensure that whatever region of Europe wanted a potato, at least one type possessed the traits that made it ideal for that climate and soil condition. In Europe only the warmer areas of the Mediterranean proved inhospitable to the potato; there the natives continued with their traditional grains.

In the northern climates, where long winters without fresh vegetables were the rule, the potato offered a new source of vitamin C that greatly improved the health of the population. For a reason still not adequately understood, potatoes do not produce tooth cavities nearly as much as grains. When eaten as processed flour, the finely ground starches from grains stick to the teeth and rot them. On the other hand, when eaten as tough grains, they are very abrasive and wear out the teeth. By eating more potatoes, the northern Europeans retained strong teeth until an older age, and this improved their general health. Nutritional diseases declined steadily, and by early in the eighteenth century, they virtually disappeared as causes of death in Europe except during war [Petersen, p. 442].

In its gradual conquest of Europe the potato moved primarily from west to east. Ireland was the first nation to make an enthusiastic conversion to potato farming. As is often the case when reliable historical information is scarce, various legends arise to account for the origin or introduction of the potato. According to one such legend, Sir Walter Raleigh introduced the potato to Ireland in the sixteenth century on his way back to England from the Caribbean. Another legend claims that the Irish peasants discovered the potato in galleys of the ships of the Spanish Armada washed up on Irish beaches in 1588 after the Armada was attacked by the English navy and dispersed by a great storm. The timing for both legends seems more or less accurate; the latter half of the sixteenth century is usually accepted as the date of introduction. But another century passed before the plant took hold and won the widespread and fanatic devotion which the Irish have had for it ever since. By the end of the seventeenth century, it was the staple food of Ireland [Salaman, p. 222].

From Ireland, the potato as a staple crop of the field, rather than as a mere curiosity of the garden, spread through England, Scotland, and Wales, across the low countries and France, and through Germany and eastern Europe. The Russians did not adopt it very widely until the 1830s and 1840s, but then became no less devoted converts than the original Irish.

Despite the difficulties of introducing the potato to Europe, once the peasants became accustomed to it they loved it. In Flanders, between 1693 and 1791, grain consumption fell from 756 grams per person per day to 475 because of the introduction of potatoes. This meant that potatoes replaced about 40 percent of the cereal consumption of Flanders [Braudel, Vol. I, p. 170]. The nutrition of the people improved markedly and the population grew accordingly.

One major problem encountered when tracing the history of the potato derives from its being misnamed from very early in the English-speaking areas. The Indians of the Andes have called it and still call it the papa. The word “potato” first came into English as the name of a very different plant imported from the Caribbean islands. The word batata came from the Taino Indians of what is now the Dominican Republic and Haiti; the Spanish made it potato, whence came the English “potato.” This plant has since been called the “sweet potato” in English, but at the time of its introduction it was known simply as the potato. When the papa arrived from the Andes the English mistook it for the Caribbean sweet potato and consequently have called it “potato” ever since. To distinguish between the two unrelated tubers, one is often called the “sweet potato” now and the other is the “common potato” or sometimes the “white potato.” In reading the early chronicles of plants and agriculture, it is often impossible to ascertain which of these plants is designated by the name “potato.”

With the new calorie source and the new source of nutrition, the potato-fed armies of Frederick of Prussia and Catherine of Russia began pushing against their southern neighbors. During the Age of the Enlightenment these northern cultures wrestled
free from the economic, cultural, and political domination of the south. Power shifted toward Germany and Britain and away from Spain and France, and finally all were eclipsed by Russia. Russia quickly became and remains the world’s greatest producer of potatoes, and the Russians are among the world’s greatest consumers of the potato. Their adoption of the potato as their staple food preceded their rise as a world power.

American foods brought about the miracle that centuries of prayer, work, and medicine had been unable to do: they cured Europe of the episodic famines that had been one of the major restraints on the population for millennia. Even France, the richest country of Europe, suffered acutely from numerous general famines and even more regional ones. The number of general famines in France varied from as few as two in the twelfth century to as many as twenty-six in the eleventh century. Even as recently as the eighteenth century, France succumbed to sixteen general famines, bringing the total number of famines to 111 for the years between 1371 and 1791 [Braudel, Vol. I, p. 74].

As little as an acre and a half sufficed to nourish the average family if they planted the land in potatoes and supplemented these with milk, butter, or cheese. With the revolutionary crop, the population of Ireland expanded from 3.2 million in 1754 to 8.2 million less than a century later in 1845. During this same century an additional 1.75 million Irish left Ireland for the New World. Thus in the first century after the introduction of the potato, the population of Ireland effectively tripled [Crosby, p. 183]. Then when the potato blight hit, thousands of Irish starved or emigrated, because without the potato Ireland could not support such a massive population. Had the Irish followed the Indian technique of planting many different types of potatoes rather than just a few, the effect of the blight probably would have been considerably lessened.

Despite the Irish famine, the population of each country boomed as it adopted the potato. Possibly it was because of this effect of the potato on population that so many people accepted the notion that the potato was an aphrodisiac. The reputed aphrodisiac powers of the plant may also have been due to the tuber’s somewhat phallic shape. Its erotic reputation further grew because of its similarity to the truffle, an extravagantly expensive delicacy

associated with the rowdy and gluttonous life of the rich and aristocratic.

If we look at the larger population picture since the spread of American crops around the world, we see much the same process. In the three centuries between 1650 and 1950, the population of Europe (including the Soviet Union) climbed from just over 100 million to almost 600 million, a sixfold increase. In 1650 the population of Africa was probably about the same as that of Europe, but Africa’s population only doubled, from 100 million to about 198 million in 1950. This comparatively slow growth reflects the slower incorporation of American food crops as well as the depopulation caused by the slave trade and colonization. Asia’s population did not increase as rapidly as Europe’s but did grow faster than Africa’s. Asia went from 327 million to 1.3 billion in the same three centuries. In all, the Old World of Europe, Asia, and Africa increased in population from about half a billion people in 1650 to over two billion by 1950. In addition, tens of millions of people left Asia, Africa, and Europe to live in the New World as colonists or slaves [Crosby, p. 166].

On the world scene, the total population in 1750 has been estimated at 750 million. It reached a billion in 1830, two billion in 1930, and four billion in 1975 [Farb and Armelagos, p. 75]. In recent decades, medical advances have accounted for some of the increase in population, but most of the population growth preceded the medical innovations. Improved nutrition accounts for most of the growth prior to this century. Only later did improvement in public health and sanitation have an impact, and only in the past century have any real gains in medicine affected the population.

The potato alone cannot claim full responsibility for the great population and health boom of the Old World. The American Indians cultivated over three hundred food crops, and many of these had dozens of variations. The people of the Old World gradually transplanted many of these crops from America, and each in turn contributed in various ways to improving the world diet in both quantity and quality of foods. The Indians gave the world three-fifths of the crops now in cultivation. Many of these grew in environments that had formerly been inaccessible to
agriculture because of temperature, moisture, type of soil, or altitude.

Some of these plants spread through the world by way of Europe, but most of the tropical plants crossed directly to Africa and Asia. The African slave trade sent hundreds of ships laden with humans across the middle Atlantic to Brazil, the Caribbean, Virginia, and the Carolinas, but they had less cargo with which to return. In carrying food and supplies with them on the return voyage to Africa, the crews also carried American Indian foods and spices, many of which quickly took root in the similar soil and climate of Africa. At a slightly slower pace the tropical American foods spread to Asia aboard Spanish ships sailing from Acapulco, Mexico, to Spain’s major Asian port at Manila in the Philippines. Other products were brought to Asia from the opposite direction by the Portuguese, who carried products from their Brazilian colony to their scattered holdings in Africa, around to Goa in India, and on to their easternmost colony of Macao in southern China.

The protein supply of the Old World also increased with the great variety of beans brought in from America, principally from Mexico, where beans, corn, and squashes had been the mainstay of the Indian diet. Different parts of the Old World eagerly adopted one or more of the American beans, including kidney beans, string beans, snap beans, the Mexican frijole, the common bean, butter bean, lima bean, navy bean, and pole bean. In addition, American Indian beans included many which took on very un-American names, such as the French bean, Rangoon bean, Burma bean, and Madagascar bean [Crosby, p. 172].

In Africa the American peanut or groundnut also helped to increase the protein intake. The peanut found a large following in Asia as well as in Africa, but in Europe it never became anything more than a novelty snack, a source of oil, and animal fodder. Even a food as common in the diet of the United States as peanut butter never found a European following, but it became common in West Africa, where peanut butter is mixed with hot peppers and sold in the streets as a tasty and nutritious snack.

Farther north in Europe where the cold hampers peanut cultivation, large amounts of oil and animal feed are made from another American staple, the sunflower, which is native to the United States plains and was domesticated by the Indians of North America. Next to the potato the sunflower is probably the most important plant that America gave to Russia. Neither olives nor oil-producing grains grew very well in Russia, and thus the sunflower finally gave the Russians a reliable source of edible oil. As with the potato, the Soviet Union is today the world’s largest producer and consumer of sunflowers.

Of the many types of American grains, only maize corn found a use among the Europeans. The European farmers learned to grow corn, but most of them never learned to eat it. Only in a few areas of southern Europe, such as Italy, Greece, Yugoslavia, and Romania, is it sometimes used as a substitute for grains in making soupy porridges. Otherwise, the Europeans have largely ignored it. But corn did have a role to play. Many important products such as oil can be made from it, and it makes a nutritious food for most domesticated animals. Potatoes may be eaten by some animals, such as pigs, but not by others, such as cows or chickens. Corn, however, could be fed to all of these animals. Corn did for the animal population of Europe what the potato did for the human population. The new animal food not only increased the supply of meat and lard but also increased the supply of eggs, milk, butter, cheese, and all the animal products that constitute so important a part of the European diet. These foods substantially increased the European intake of protein.

The population impact of maize corn was much stronger in southern Europe than in the north. During the eighteenth century, when corn and other American crops were being widely cultivated in southern Europe, the population of Italy grew from eleven million to eighteen million, and the population of Spain doubled [Farb and Armelagos, p. 76]. The impact on Africa is more difficult to measure, but corn grew more reliably than did the traditional African staples of millet and sorghum.

Corn grows easily in soils that receive too much or too little moisture for wheat or rice. While rice grows best in semitropical zones and wheat flourishes primarily in temperate zones, maize corn thrives in both. Indians cultivated rapid-growing varieties in areas as cold as Canada and Chile, while other types of corn flourished in the heat of the Amazon. Inca farmers cultivated it on the terraced sides of Andean mountains, and Hopi farmers...
irrigated it and made it grow in the hottest and driest deserts of the United States.

Even though the whites adopted corn slowly in comparison with the Chinese and Africans, they have not stopped finding new uses for it. The many varieties can be eaten directly or made into flour, starch, or syrup for cooking in other products. Particularly in its use as dextrose or as corn syrup it has steadily replaced cane sugar in processed foods. Unlike cane sugar, corn syrup can hold its moisture and thereby prevent crystallization of itself as well as any other sugars with which it is mixed. This unique resistance to drying out and crystallizing creates unusual uses for corn syrup, as in motion-picture studios, where special-effects artists dye it red and use it for blood in their films, since it will retain the appearance of fresh blood for hours of rehearsals and film shootings. This same quality has more practical applications, making corn syrup the ideal ingredient for sweetened drinks from baby formulas and chocolate milk to colas as well as for ice creams, catsup, syrups, candies, salad dressings, pies, and any dish for which moisture is desirable. Corn syrup can also do all of this much more cheaply than other sugars.

In Africa, maize corn and cassava together underlie the great population explosion which started in the last century and has continued throughout the twentieth century. Cassava assumed a particularly important role in Africa because it grows in poor soils that will not produce any other food crop; thus it does not compete with corn or the grains for land. Cassava has the added advantage that its roots can be harvested at any time within a two-year period after becoming mature. Thus they make an excellent food bank that can be preserved in the ground for times of scarcity. The climate and the numerous animal and insect pests of tropical Africa make food storage precarious. Cassava has one major drawback in that unlike the potato and corn it lacks substantial nutrition. Since the cassava root is almost pure starch, one hectare of land planted in cassava produces almost ten million calories, compared with less than half that for grains and three-fourths that for rice and potatoes. Cassava became a major source of calories and an important crop in preventing famine, but it did not improve the nutrition of the African diet.

Asians adopted the sweet potato with the same eagerness that Africans adopted cassava, and it had much the same impact on their diets as the common potato had on the Europeans'. Even though rice offers more nutrition than most grains, it still suffers from many of the shortcomings of the grains. It also showed high susceptibility to both droughts and floods, which caused frequent famines in China. The sweet potato enabled the Chinese to ameliorate the cycle of feast and famine that their dependence on rice had so long made inevitable. The sweet potato yields three to four times as much food as would rice planted on the same area of land, and the sweet potato thrives in weather and soils that kill rice [Crosby, p. 172].

Even though the stereotype of Oriental food is that it is all rice-based, the common people depend heavily on the sweet potato as well. China is the world's largest producer of sweet potatoes; the Chinese enjoy them plain or ground into flour to make noodles, dumplings, and other dishes. Rice is the prestige food of the Orient, but the sweet potato is the daily food for many of the peasants.

America also gave the world some new grains that offered more nutritional value than any of the Old World grains. For the most part the Europeans ignored the amaranth from Mexico and quinoa from the Andes. In the last years before the conquest of Mexico, the Aztec capital of Tenochtitlán received an annual tribute of twenty thousand tons of amaranth grain from its seventeen provinces (mostly in native Mexican varieties of Amaranthus hypochondriacus and A. cruentus). Because of its high protein content of 16 percent, compared with 7 percent for rice and 13 percent for wheat, amaranth is considerably more nutritious than most grains. It also has twice the lysine found in wheat and as much as is in milk, making it far more balanced in proteins than most plant foods. The Aztecs respected the grain so highly that each year they publicly celebrated it by eating amaranth cakes made with honey or human blood shaped into the forms of the gods. The Spanish interpreted this as a black mockery of the holy communion of the Christian church and consequently forbade
the cultivation, sale, or consumption of amaranth under penalty of death [National Academy of Sciences, pp. 1–4]. No matter how nutritious it might be, they already had enough grain crops and did not want more.

In the twentieth century, scientists discovered that Indian farmers in the high valleys of the Andes and in remote parts of Mexico still cultivate amaranth. Now international research organizations such as the National Academy of Sciences of the United States and UNICEF encourage its dissemination to help feed the Third World nations. Amaranth went on sale in health-food stores in the United States in the 1970s, and quinoa followed in 1986, but the great potentials of these two miracle grains of the Indians have not yet been tapped.

Amaranth has become one of the most important cereals in the diets of highland peoples in India, China, Pakistan, Tibet, and Nepal. Cultivation has spread so widely in the past century that Asia now cultivates and consumes more amaranth than do the Americas.

In the marshy ponds that dot the terrain of Minnesota and Wisconsin, the Indians for centuries gathered a water-grown grain which the whites later called “wild rice”, even though it is not an Old World rice. Despite the emphasis on “wild”, the plant grew under human care, for during the harvesting the Ojibwa farmers dispersed the seed for the next year’s crop. The Ojibwas also introduced wild rice into ponds where it had not grown. In this way they spread the plant into new areas, but they also controlled the type of plant grown in ponds by selecting for particular characteristics preferred by various groups of Ojibwas. Thus lakes and ponds became associated with particular types of wild rice.

Unlike regular rice, which grows in semitropical areas, wild rice thrives in the coldest parts of the northern great plains. It grows after passing the winter in lakes that freeze for four or more months each year. This unusual crop has become popular as a luxury food, and cooks often mix it with white rices to accompany gourmet dishes. The full food potential of the plant is yet to be explored. Just as the potato was eaten only by the rich for the first two hundred years after its introduction to Europe and only later became a staple for common people, perhaps one day wild rice may find its role in the feeding of large populations in cold swampy areas such as the Siberian tundra which have shown little agricultural potential thus far.

Today the agricultural experimentation that began many centuries ago in the Andes continues at the International Potato Institute, located in the suburbs of Lima. The modern buildings of the institute spread out over the countryside like the new campus of a community college. Immaculate beds of potatoes in small, neat rows surround and run between the buildings. The site looks almost as though the beautiful mountain terraces of Machu Picchu had been flattened out and arranged in military formations across the plain. Funded by various international agencies, the institute serves as a bank of germ plasm for the approximately ten thousand varieties of domesticated and wild potatoes found in the Andes. In addition to the beds at this lowland center, the institute maintains a highland center and one in the jungle as well. In the bins of the institute one sees yellow, red, and purple potatoes as well as white, blue, green, black, and brown ones. Some are round or oval, others horn-shaped or squash-shaped. Some have smooth skins and others have gnarled skins. No matter how beautiful or ugly a potato may be, each one is carefully protected and nourished for the future treasure it may give the world.

The full array of scientists from agronomists and anthropologists through botanists, cartographers, demographers, economists, and through the alphabet to zoologists all work together to study every aspect of the potato and its place in the environment and in human society. They study the way it grows, how the peasants prepare the soil, how it is harvested, and the ways of storing it in diverse climates. Looking at so many scientists puttering around the potato beds, working in the lab, confering around coffee pots, and experimenting with diagrams on computers, I could not help but think of what it must have been like at Machu Picchu five hundred years earlier. I have no special knowledge of exactly what went on at Machu Picchu then, but perhaps the work done there now continues at this institute.
Like their predecessors, these scientists work to expand the range of the potato into new environments such as the tropics, to find ways of growing potatoes from seed rather than from the root, and to develop ways to preserve its nutrition longer. They hope that one day the potato might feed the peoples of Brazil, Botswana, or Bangladesh as it already feeds the peoples of Germany, Ireland, and Russia.

The seaplane dropped out of the clouds to pass over a small cluster of houses on a high bank of the Ucayali River an hour’s flight upstream from where the Ucayali joins the Amazon. All the way to the horizon on every side we could see nothing but the endless stretch of high jungle. We circled the village once as the pilot tried to make sure that this actually was the community of Genaro Herrera. His government map indicated that the closest village should be San Filipe and that Genaro Herrera lay farther upstream, and even though this air force captain had fifteen years of experience flying the Amazon and tributaries, he had never been to this particular community. Convinced that even his military maps were inaccurate, the pilot gently set the plane down in the middle of the river as a swarm of villagers rushed to the banks to watch us. This was the first visit by a seaplane in many years, and most of the children had never seen one. After nudging aside a cluster of dugout canoes and hastily devising a makeshift dock, we climbed up the muddy bank to be officially welcomed by the apparently bewildered mayor, who stood barefooted in the mud surrounded by excited children and boys clutching machetes. We had landed in Genaro Herrera, the right village.

Genaro Herrera is a small jungle village like thousands of others scattered up and down the rivers of the Amazon Basin. About a