

closely intertwined are diseases that can enable a better understanding of such as the potato blight, tuberculosis (chapter 7), and AIDS (chapter 11). When we look here were no possible inter-relationships and hemophilia, we can see the effects of millions of people for whom we are present at a critical time, the effects of immigration policies, the remainder of society, and the need to promote new strategies to ensure the well-being of individuals with porphyria, hemophilia, and sickle cell anemia: they tempt speculation that past 150 years might have prominent members of royal families.

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The Irish Potato Blight

Grosse-Ile, lying in the middle of the St. Lawrence River, is a picturesque island with a background of majestic peaks. Grosse-Ile is also a place where thousands upon thousands of men, women, and children were detained and died. The Grosse-Ile station came into being when reports to the colonial government in Canada told of sick people from the Old World, especially the Irish, who were about to arrive via the St. Lawrence River. In response, the Assembly of Lower Canada (as Quebec was then called) passed a resolution on 23 February 1832 that made Grosse-Ile a detention station for sicknesses commonly believed to originate "in the homes of the human riff-raff."

The writer Susannah Moodie, who emigrated to Canada from England in 1832, described her own impression:

"I looked up and down the glorious river; never had I beheld so many striking objects blended into one mighty whole! Nature had lavished all her noblest features in producing that enchanted scene. The rocky isle in front, with its farmhouses at the eastern point, and its high bluff at the western extremity, crowned with the telegraph . . . the middle space occupied by tents and sheds for cholera patients and its wooded shores dotted over with motley groups added to the picturesque scene . . . Never shall I forget the extraordinary spectacle that met my sight the moment we passed the low range bushes which formed a screen in front of the river. A crowd of many hundred Irish emigrants had been landed during the present and former day and all . . . men, women and children, who were not confined to the sheds (which resembled cattle pens) . . . were employed in washing clothes or spreading them out on rocks and bushes to dry. The people appeared perfectly destitute of shame or a sense of common decency. Many were almost naked, still more partially clothed. We turned in disgust from the revolting

scene . . . Could we have shut out the profane sounds which came to us on every breeze, how deeply we should have enjoyed an hour amid the tranquil beauties of the . . . lovely spot."

Although the detention of immigrants at Grosse-Ile was presumably instituted as a means of protecting the public health, in actual fact it served as a vehicle for maintaining class distinctions and scapegoating the "wretched refuse" of Ireland.

In 1833, as the number of sick immigrants arriving in Canada dwindled, the Grosse-Ile detention station fell silent. A decade later, however, it once again became active due to the changes that were taking place in Ireland. Indeed, between 1845 and 1849 the population of Ireland would decline by over 2 million. Half of these would die of starvation, disease, and malnutrition, while the other half would emigrate. The United States was traditionally the route for Irish immigrants, but in 1847 the United States enforced an increase in the cost of passage and ships that were overloaded were to be confiscated. This opened up new routes to the United States from Canada as ship owners sought a cheaper option. Hundreds of thousands of Irish were crowded aboard unsanitary sailboats unfit for transporting human beings. During the voyages of these "pest ships," people who died, along with their possessions, were hastily wrapped in canvas and thrown overboard as if they were dead birds or garbage.

Although ships usually took 45 days to cross the Atlantic Ocean, 26 of those that set sail in 1847 took over 60 days to reach Grosse-Ile. In 1847, over 5,000 people died en route, and a like number were buried in a mass grave on the island. Four physicians at Grosse-Ile, aided by a crew of eight, worked from dawn until dark every day digging trenches and burying the dead three deep. By August, dirt had to be imported to the rocky island to bury more bodies. In spite of this, rats were coming off the ships to feed on the cadavers. All told, the number of deaths on Grosse-Ile probably exceeded 9,000, and many thousands more died elsewhere in colonial Canada during that "summer of sorrow." The epidemic disease that prompted the Irish to leave their homeland and choose immigration and almost certain death in the passage to a foreign land was the disease known as "late blight."

Politics and the Great Hunger

The earliest settlers in Ireland came from mainland Europe about 6000 BC, and about 400 BC the Celts from Britain and Europe arrived. In about

AD 400, St. Patrick introduced the Roman alphabet and Latin, and Ireland's valuable natural resources included coal, tin, and iron ore, and it had a rich supply of iron. About AD 795 the Viking invasions began, and Ireland could do little to defend itself. In 1014, the Irish King Brian Boru was killed at the Battle of Clontarf, and the Vikings controlled Ireland, and by 1171 Henry VIII began to try to bring Ireland under English control. He forced Ireland's parliament to accept English law. Throughout the later 1500s, the English held and controlled Ireland. In 1534, Henry VIII outlawed Roman Catholicism, and priests were persecuted. The porphyritic Elizabeth I, continued to support a system known as "planting the English," and established the majority of the population in Northern Ireland.

Under the Protestant Act of Union, James II, and succeeded James II), the English Catholics from the military were denied the vote and could not convert to Protestantism. In the 17th century, Irish revolts, but these were suppressed; by the 1700s there were no revolts. In 1707, Ireland was subjected to the restrictions, a Parliament. The Catholics were granted a share of the land, but were granted no political rights, and an unsuccessful rebellion, and in 1707, Minister William Pitt persuaded the British to pass an Act of Union with the United Kingdom. This would send its representatives to the British Parliament. Irish Catholics were permitted to hold office, but in the 1800s there were severe restrictions. Ireland would remain a part of the United Kingdom.

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AD 400, St. Patrick introduced Christianity to this island, along with the Roman alphabet and Latin literature. Ireland, save for fish, is without any valuable natural resources, such as gold or silver, gemstones, oil or natural gas, or iron ore, and it has an unproductive soil and miserable weather. About AD 795 the Vikings began raiding Ireland. At first the people of Ireland could do little to defend themselves, since until AD 1000 the lack of iron (as well as copper and tin) left Ireland a Stone Age economy. In 1014, the Irish King Brian Boru organized the princes of several kingdoms and drove out the Vikings. Beginning in 1160, the Normans increasingly controlled Ireland, and by 1300 they were in complete control. In 1534 Henry VIII began to try to regain Ireland from the Normans, and in 1542 he forced Ireland's parliament to declare him King of Ireland. Henry tried to introduce Protestantism into Ireland, but without much success. Throughout the later 1500s Henry VIII's daughter Elizabeth I strengthened the English hold and attempted to establish Protestantism. Elizabeth I outlawed Roman Catholic services and executed a number of bishops and priests. The porphyric King James I (see p. 2), who succeeded Queen Elizabeth I, continued to seize land in Ireland and give it to the English—a system known as "plantations." This occurred especially around Ulster and established the majority of Protestants, whose descendants still live in Northern Ireland.

Under the Protestant King William III (who reigned from 1689 to 1702 and succeeded James II), Penal Laws were instituted. These laws barred Catholics from the military, commerce, and civic office; they were also denied the vote and could not purchase land. However, Catholics who converted to Protestantism were given land. In the early 1600s there were Irish revolts, but these were quickly put down by a succession of English kings; by the 1700s there was tight control by Britain. Irish Protestants objected to the restrictions, and in 1782 Britain granted autonomy to the Irish Parliament. The Catholics were given the right to hold land and to worship, but were granted no political power. In 1798, the Irish staged an unsuccessful rebellion, and although it was put down, the British Prime Minister William Pitt persuaded both the Irish and the British Parliaments to pass an Act of Union in 1801. As a result, Ireland became a part of the United Kingdom. This ended the Irish Parliament, and now Ireland would send its representatives to the British Parliament in London; later, Irish Catholics were permitted to serve in the British Parliament. During the 1800s there were several attempts to institute home rule, under which Ireland would remain a part of the United Kingdom but would have its

own parliament to govern domestic affairs. The Protestants in Ulster, however, were opposed to home rule, fearing that Catholics would dominate Parliament, and so the British remained in control. In effect, Ireland became a British colony.

The attitude toward the Irish was described by one English writer: "Ireland is a little island at the edge of Europe with a Stone Age culture . . . its inhabitants wild, feckless, and charming or morose, repressed, and corrupt, but not especially civilized." Benjamin Disraeli, the beloved Prime Minister of Queen Victoria, had a stronger opinion: "The Irish hate our order, our civilization, our enterprising industry, our pure religion." Britain maintained Ireland as an agricultural colony and prevented manufacture of anything the British produced; Irish culture was suppressed save for music and dance. The British colonization of Ireland introduced a tenure system that gave Protestant landlords control of 95% of the land.

The landlords (most of whom were absentees) subdivided their land into 5-acre lots that were rented to estate agents. These lots, in turn, after being subdivided into smaller ones, could then be rented again at higher rates. At the base of this economy were 3 million tenant farmers who might have one quarter of an acre of land. On this small plot, the tenant farmer and his family cultivated a small garden and lived in a tiny one-room mud cottage with neither floor nor windows, only a door and a hole in the thatched roof to let out the smoke from the turf fire. On average, there were 10 people per cabin, which they shared with the family pig. The tenant farmers had another 5 acres that were used for growing cash crops such as wheat, oats, and barley.

The potato, introduced into Europe by the mid-18th century, was never a cash crop; however, because it was better adapted to the cool, moist conditions in Ireland than other crops, most of the Irish population was dependent on it as a supplemental food source by 1800. The Irish tenant farmers were forced to pay exorbitant taxes and to export their cash crops as well as butter, eggs, pork, and beef in order to produce sufficient income to pay the landlords for the use of the land and to avoid eviction. Some of those evicted were relocated to less fertile areas where essentially only the potato could be grown, but even these lands remained under the control of absentee British landlords. The Irish peasants on the worst land came to rely almost exclusively on potatoes to store over the winter and to feed themselves and their livestock, especially the pigs. The potato became the staff of life for the Irish peasant. A family of 10 needed a ton of

potatoes per month to supplement their diet. The potato was eaten per day supplemented with other food.

In 1845 a "queer mildew" appeared on the potato leaves, turning them black as soot. The blight, a fungus, destroyed the potato crop, giving off an odor that was so offensive that the potato crop was completely ruined. The tenant farmers and the poor had no other crops, and the remainder of the year they had to make flour from the grain and berries; they dug for ferns and other plants from the trees. The streets were full of the dead, and the people starved. The blight was not the only cause of the famine; it was also the result of the landlord's refusal to reduce rents and the government's failure to provide relief. The Great Famine was not a natural disaster, but "The Great Famine was preventable and avoidable."

When the fourth year of the famine came, the Victorian historian Charles Dickens was so appalled by the human condition in Ireland that he wrote, "I don't believe that any other country in the world has ever seen so many more of them than we have. They were comfortably fed and lodged before the Great Famine gripped Ireland. They were felled from starvation and death because of malnutrition and disease, such as typhus, cholera, dysentery, and other diseases. The virulent racism and prejudice of the time, the failure of the government to provide relief, the people of Ireland, and the course of their history were all factors in the Great Famine."

Bite of Blight

Many of the great civilizations of the world who settled down and cultivated crops were rice, in Europe it was wheat. The Aztecs in Central America and the Incas cultivated a plant that was grown in high valleys and cold mountains. The stems above and below

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 per day supplemented with buttermilk.

In 1845 a "queer mist" came over the Irish Sea and the potato stalks
 turned black as soot. The next day the potatoes were a wide waste of pu-
 trefaction, giving off an odor that could be smelled for miles. About 40%
 of the potato crop was destroyed. In areas where the blight was most se-
 vere, tenant farmers and their families frantically scoured the land and
 bogs for stray potatoes. They washed away the rotted parts and grated the
 remainder to make flour. Children searched the woods for nuts and
 berries; they dug for fern and dandelion roots and ate the leaves and bark
 from the trees. The streams were fished for eels and trout, and the peasants
 trudged many miles to get to the shore, where they scraped mussels,
 limpets, and seaweed from the rocks. Many died from eating poisonous
 plants, but "The Great Hunger" forced them to try anything that seemed
 edible.

When the fourth rider of the Apocalypse, Famine, rode into Ireland,
 the Victorian historian Charles Kingsley described what he saw: "I am
 daunted by the human chimpanzees I saw along that 100 miles of horrible
 country. I don't believe they are our fault. I believe that there are not only
 many more of them than of old, but that they are happier, better and more
 comfortably fed and lodged under our rule than they ever were." As the
 Great Famine gripped Ireland, thousands of Irish died each day. Few were
 felled from starvation alone: death invariably was visited upon the Irish
 because malnutrition made them more susceptible to diseases such as
 typhus, cholera, dysentery, and relapsing fever. Desperate to escape from
 virulent racism and prejudice, as well as starvation caused by the potato
 failure, the people of Ireland began a process of migration that changed
 the course of their history and that of Canada, the United States, and
 Great Britain.

Bite of Blight

Many of the great civilizations of the world were established by people
 who settled down and cultivated a staple food crop. In Southeast Asia it
 was rice, in Europe it was grain (wheat and rye), and for the Mayans and
 Aztecs in Central America and Mexico it was corn. The South American
 Incas cultivated a plant that grew well above the 10,000-ft level in the
 high valleys and cold plateaus of the Andes mountains. This plant had
 stems above and below ground level, and the swollen underground

stems—called tubers—were highly nutritious. These tubers, which the Incas called “papas,” we call potatoes. The potato tuber is nutritious because it contains proteins, starches, and vitamins. The potato was the staple food source on which the Inca civilization was built, and even today it is one of the most important food crop plants in the world. Although rice, maize (corn), and wheat are the top three food plants, the potato ranks fourth. Indeed, one-fifth of the world’s people use the potato as their primary food source today.

The Incas first cultivated the potato over 6,000 years ago. When the Spanish Conquistadors under Pizarro came to the Americas in search of treasure, they destroyed the Inca civilization but discovered something more valuable than gold, silver, and jewels—the potato plant. This plant, perhaps the most priceless possession of the Incas, the Conquistadors did not even bother to record. By the late 1500s the sailors on Spanish galleons accidentally introduced these plants into Europe, where they were considered more of a curiosity than a foodstuff. They may have been rejected as a food because the potato is a member of the poisonous nightshade family. It was also claimed to cause leprosy, and even its reputation as an aphrodisiac did not make it acceptable. (The seductive Marie Antoinette, it is claimed, wore potato blossoms in her hair.) It was widely believed that eating potatoes caused flatulence, and so initially the tubers were fed to farm animals; however, since this caused no harm, the potato came to be accepted as a food fit for humans. By the 1800s, with an increase in the population of Europe and the inability of grains to support this population, the potato became a regular part of the diet. Easy cultivation and high yields in cool climates led to a major dependence on potatoes by populations on the high cold plateaus of Spain, the dank flatlands of Germany and Poland, and the soggy bogs of Ireland. The British landowners encouraged cultivation of the potato in Ireland since it saved the grain for export and for their own use. Furthermore, only in the southeastern part of Ireland is the soil suitable for growing grain (rye or wheat) from which bread can be made, but potatoes can be grown even in the poorest soils.

The Irish invented a highly efficient method of potato cultivation, called the “lazy bed.” The lazy bed is one in which the seed potatoes (“eyes” of the tuber) are placed helter skelter on the ground and covered with manure and seaweed, and then the soil dug from lateral trenches is piled on top so that long, narrow beds of soil are raised 2 to 3 ft above the surrounding ground. This protects the tubers from excess moisture. The cultivation of potatoes produces a high-yield crop (~30 tons/acre).

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over 6,000 years ago. When the potato was first brought to the Americas in search of new crops, the Incas discovered something new—the potato plant. This plant, which the Incas, the Conquistadors did not know, was brought to the Americas by the sailors on Spanish galleons. The potato, which they were considering as a food source, may have been rejected as a poisonous nightshade family member because of its reputation as an extremely seductive Marie Antoinette (the French queen's hair.) It was widely believed that the potato was so initially the tubers were fed to the poor. Although no harm, the potato came to the Americas in the 1800s, with an increase in the population. The rains to support this population led to the potato diet. Easy cultivation and dependence on potatoes by the population of the dank flatlands of Germany. The British landowners encouraged the potato since it saved the grain for export. The potato is grown in the southeastern part of the United States (rye or wheat) from which the potato is grown even in the poorest soils. The method of potato cultivation, which is known as the "mound" method, in which the seed potatoes are planted on the ground and covered with soil. The tubers dug from lateral trenches in the soil are raised 2 to 3 ft above the ground to protect them from excess moisture. The potato is a high-yield crop (~30 tons/acre).

Potato plants mature faster than most crops, taking 90 to 120 days, and edible tubers can be harvested in 60 days. The potato tuber is higher in protein than soybean, and half a potato can provide half of the human daily requirement of vitamin C.

Feudal systems tended to favor high birth rates because under such a system the number of dependents was a measure of a person's wealth. Children were a cheap and expendable source of labor and could be relied on to provide assistance in one's old age. In Ireland this led to a massive increase in the birth rate, and after the middle of the 17th century more newborns survived because there was a reduction in the death rate due to reduced infant mortality, tribal warfare, murder, and mayhem. In 1660 the population of Ireland was 500,000, but by 1688 it had doubled to 1.25 million. Between 1760 and 1840 it grew from 1.5 million to about 8 million. This explosive growth in the population of Ireland strained the economy and left many peasants living under bare subsistence conditions. As the Irish population grew, the land was further subdivided and living standards declined. The British government attempted to consolidate these small plots as a way of increasing grain output and also instituted Penal Laws which denied the Irish peasant population freedom. They were forbidden to speak their own language and practice their faith, to attend school or hold public office, to own land, or to own a horse worth more than £5. A peasant earned £7 per year, of which two-thirds was paid as rent. A pig, valued at £4 when sold, served as financial security for the peasant; it is from this that the term "piggy-bank savings" comes.

The English clergyman Thomas Malthus (1766 to 1834) wrote *An Essay on the Principle of Population* in 1798, in which he stated that a population that is unchecked increases in geometric fashion. The consequences of unrestrained population growth, in Malthus' words, would lead to "misery and vice." These would tend to act as "natural restraints" on population growth. Today we understand that there are at least two kinds of checks to set the upper limit for a population: external or environmental factors (including limited food, space, or other resources) and self-regulating factors (such as fewer births, deliberate killing of offspring, or an increased death rate due to accidents or disease). Agriculture in its most efficient form can change the environmental restraint so that far larger human populations are possible; however, even here there are limits. It is estimated that without the potato as a food source, all the land in Ireland could support a population of only 5 million if the people were fed on bread. Compounding the problem caused by potato blight, there was a

worldwide shortage of bread grains at a price the Irish could afford. Between 1798, when Thomas Malthus' *Essay on Population* was published, and 1845 there were 20 failures of the Irish potato crop, all leading to starvation, disease, and debility. These were true famines. During the same period, only three famines occurred in England. According to Malthusian doctrine, any increase in the Irish population would be due to their carnal and vicious nature. Famine would control this population explosion, and in Malthusian terms this was deserved. The Irish, the British opined, were hopelessly inferior and incurably filled with vice and so they deserved the famine, which would exert control over their excessive breeding. In effect, the Malthusian theory was used to reinforce British prejudice against the Irish and to justify the British failure to provide relief. There was also a laissez faire economic policy under which the British government adopted a hands-off policy. The attitude in Great Britain was to let the market run its course. By the end of 1846, not a single potato was left in Ireland. In addition, that year had one of the coldest winters on record. The level of starvation among the people soared.

Although in 1845 to 1846 Britain's Prime Minister, Robert Peel, attempted some countermeasures, including the importation of corn for resale in Ireland, no one knew how to cook it, and in return the starving and enfeebled Irish were required to perform public work by building roads, walls, piers, and bridges. It helped only a little. Soup kitchens were started, but they dispensed essentially flavored water. The churches offered little hope since the Church of Ireland was entitled to collect taxes from tenants regardless of their religion. Indeed, the Catholic Church increased its ownership of property in Ireland during the famine. The Church was vehemently on the side of the absentee English landlords, and it was left to the Quakers to seek long-term relief for the Irish.

In late 1846 the British Parliament came under the control of a new Prime Minister, John Russell, who reduced the British financial commitment to Ireland. This placed a greater burden on landlords and private charities. The public works schemes were inefficient and bureaucratic, and the wages paid were very poor and very late. Tenant farmers held short-term leases that were payable each 6 months. If the tenants failed to pay their rent, they were evicted and their homes were burned.

There was a severe winter in 1846 to 1847. In the early months of 1847—called Black '47 (now an Irish Rock Group)—there were reports of dogs eating dead bodies in the streets. Public works projects were abandoned, and poorhouses were established. The poorhouses (also called

workhouses) were mismanaged and were forced to wear prison clothes and eat prison meal. To limit the number of people in the workhouses, the Poor Law Amendment Act was passed in 1847. The Act required that a quarter of an acre of land from the workhouse be planted with potatoes. If the potatoes died of starvation or disease, the workhouse was closed for that year. Indeed, the workhouse was closed for the first time in 1847. The workhouse was never to return.

Conditions were made so bad that the government had to placate the politically powerful landlords by allowing the export of food from Ireland. The British idea of free trade was abandoned. The resolve of the Irish people was to fight the famine economically: extract the greatest benefit from the colonies, thereby benefiting the British. The *London Times* stated that the government's policy would be as ineffectual as throwing money at the famine. The Chancellor of the Exchequer stated that the famine and starvation could not be stopped. The only thing approaching quiet was the death of the people. The workhouses were so weak from starvation that they could not stand. Compounding this was the fact that the workhouses were in order to meet their losses. The workhouses, which in turn led to the death of the tenant farmers, were evicted. Thousands of people died and homelessness became a permanent feature of the landscape.

At first the potato famine was blamed on the excesses of the people. The "late blight," a disease caused by a fungus that leaves that occurs in the late summer or early September. Late blight replaced the early blight of 1849 was as bad as the early blight. The only solution. According to the peasants who were sent to the workhouses. Some landlords, hoping to profit from the famine, sent the peasants to Canada, Australia, and England—1.5 million people were sent to America and Birmingham—where

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workhouses) were mismanaged, overcrowded, and filthy, and the inmates were forced to wear prison-like uniforms. They subsisted on a watery oatmeal. To limit the number of people seeking relief, the Poor Law Extension Act was passed in 1847. This prevented tenant farmers with over a quarter of an acre of land from receiving assistance. In 1847 more than a million died of starvation or diseases such as typhus and cholera; this was a peak emigration year. Indeed, during the next 4 years, 2 million Irish emigrated from Ireland, never to return.

Conditions were made worse because the British government tried to placate the politically powerful landowners and allowed continued export of food from Ireland while preventing importation of food. The British idea of free trade led to the notion that assistance would weaken the resolve of the Irish peasants. The primary goal of the British was economic: extract the greatest amount of resources and exports from their colonies, thereby benefiting the bankers and landowners. One letter writer to the *London Times* stated that "Giving more money to Irish relief would be as ineffectual as throwing a sackful of gold into their plentiful bogs." A Chancellor of the Exchequer said, "Except through purgatory of misery and starvation I cannot see how Ireland is to emerge into a state of anything approaching quiet or prosperity." In addition, the Irish peasants were so weak from starvation and disease that they could not work the land. Compounding this problem were economic factors: the landowners, in order to meet their losses due to the famine, raised the rents of the tenants, which in turn led to nonpayment, eviction, and destruction of the houses of the tenant farmers. Between 1849 and 1854, at least 500,000 people were evicted. Thousands more were thrown out without official sanction, and homelessness became as much a problem as hunger.

At first the potato failure was believed to be due to God's anger over the excesses of the people. Later, it was shown that the failure was due to "late blight," a disease causing large necrotic areas (called blight) on potato leaves that occurs in the late part of the growing season, e.g., August and September. Late blight reappeared again in 1848 and 1849, and in some places 1849 was as bad as 1847. Many people saw emigration as their only solution. According to the Poor Laws, the landlords were to support the peasants who were sent to the workhouse. This cost £12 a year per person. Some landlords, however, economized and paid for the passage of the peasants to Canada, which cost only £6 a head! The very poor migrated to England—1.5 million went to Liverpool, London, Manchester, and Birmingham—whereas those who were slightly better off and could

afford the cost of passage emigrated to the United States. Only about one-fifth of the migrants survived the trip across the Atlantic because of their poor health, the fact that it took weeks to months to cross, and no food was provided on board ship. These were not passenger ships: they were ships ordinarily used for hauling timber and cattle. There was no place to cook and no place to put the sick, and there were no proper latrines. The filth and stench below deck were overwhelming. Many of the passengers carried lice and were infected with typhus. Because of the high death rate on board, they were called "coffin ships." And it is a bitter irony that in Ireland during this period, while people were starving, grain was still being exported. The potato famine changed the structure of landholding in Ireland—the poorest were evicted, but the landlords were also financially ruined, crushed by the burden of falling income and higher taxation. Many landlords sold out to larger landowners, who in turn were also unpopular with their tenants.

The Great Hunger's Cause

The perils of a single-crop economy have seldom been better illustrated than in Ireland in 1845 to 1849, for at that time without the potato the Irish economy could not survive for very long. While other regions of Europe may have been able to turn to alternative food sources, this was not possible for the Irish. The potato blight was an ecological disaster compounded by the failure of government. Some consider it to be equal to the holocaust. Although theories as to the cause of late blight were many, including an act of God, introduction of the steam locomotive, and excessive uptake of soil water that the potato could not expel, it was the Reverend Miles J. Berkeley who in 1846, after making careful microscopic examination of diseased plants and seeing a whitish felt on the leaf surface (resembling that in moldy bread), proposed that it was none of these but instead was a fungus. Berkeley was mocked, and his contention gained little support. Indeed, the prevailing opinion of the time was that a cold and damp miasma resulted in blight.

A critical question regarding blight was: which came first, decay followed by fungus or fungus and then decay? In 1861 the great German biologist Anton de Bary clearly showed that late blight was caused by the fungus he named *Phytophthora infestans*, the "plant destroyer." To confirm the role of the fungus, de Bary did a simple experiment: he grew healthy potato plants in pots, divided them into two groups, and deliberately

dusted spores from the plant group of healthy plants; he was certain that spores could not survive in a cool, moist environment. A few days the telltale sign of blight appeared: the fungus-inoculated plants wilted and died. Clearly, potato plants took up too much water, and spores ride on the stormy winds to get them on to the leaves. In 1861 de Bary's work led to a novel understanding of the disease. Today de Bary's pioneering work, yet their theory of disease by nearly

In late blight, the signs are leaves in the form of brown blotches that enlarge quickly and the plants are barely visible, appears in the form of long tube-like structures (called hyphae) divide and multiply as they penetrate the plant tissue. The fungus to "drink" the rich nutrients from the stem are literally sucked out of the plant. A filament a swelling develops, and millions of spores are produced. Millions of spores are produced. Each spore is so tiny that it is invisible to the eye. At the end of this slender tube-like threads or swarms of tubes enter the leaf through the stomata. The tissue is eroded by digestive enzymes. Spore formation and germination are rapid. How does blight on the healthy potatoes in the soil? The spores on the soil surface, and gently washed down, and when they reach the plants. Clearly at harvest time the plants are so small that the fleshy tuber itself is covered with brown-purple blotches re

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dusted spores from the plants with blight onto the moistened leaves of a group of healthy plants; he left the other group ("controls") alone, making certain that spores could not reach them. Both groups were exposed to a cool, moist environment where the miasma could do its work. In a few days the telltale sign of blight—spots of decay—appeared on the leaves of the fungus-inoculated plants. The control group showed no sign of disease. Clearly, potato plants did not rot because of a miasma or because they took up too much water. de Bary suggested that the microscopic spores ride on the stormy winds and that blight results when rain splashes them on to the leaves. In this way the infection spreads from plant to plant, field to field, and country to country. The significance of de Bary's work led to a novel understanding of sickness: parasites can be the cause of a disease. Today de Bary and Berkeley are rarely recognized for their pioneering work, yet their experiments anticipated Louis Pasteur's germ theory of disease by nearly a quarter of a century.

In late blight, the signs of impending disaster first appear on the leaves in the form of brown-black spots. Under moist conditions the spots enlarge quickly and the plant has a pungent odor. A white fuzzy growth, barely visible, appears in the spots; under the microscope, these are seen to contain the long tube-like threads first seen by Berkeley. The threads (called hyphae) divide and twist like snakes to form an extensive network; they penetrate the plant tissues and act like "soda straws," allowing the fungus to "drink" the rich nourishing sap of the potato until the leaf and stem are literally sucked dry. This takes only 3 to 5 days. At the tip of each filament a swelling develops; within the swelling, microscopic spores are produced. Millions of spores can be produced on an infected leaf, and each spore is so tiny that 500 of them would be no larger than the period at the end of this sentence. The spores germinate, giving rise to either tube-like threads or swimming spores that can also form threads. The tubes enter the leaf through its microscopic pores (stomata), or the leaf tissue is eroded by digestive enzymes released by the hyphae. The cycle of spore formation and germination is favored by moist, cool conditions. But how does blight on the leaf produce rotten potatoes? de Bary buried healthy potatoes in the soil, shook the spores from blighted leaves on the soil surface, and gently watered them as if it were raining. The spores washed down, and when the potatoes were dug up, they too were blighted. Clearly at harvest time millions of spores are washed from the leaves so that the fleshy tuber itself becomes infected. Its skin is discolored with brown-purple blotches resembling bruises, and as the microscopic threads

of the fungus penetrate deeper, the tuber begins to rot. Dry rot of tubers by *Phytophthora* is followed by wet rot of the potato due to other microbes in the soil.

One of the mysteries concerning the late-blight fungus was how it was able to survive the cold of winter. Did it overwinter in the soil or in the tuber? Although observations of the hyphae under freezing conditions showed that they were too fragile to withstand low temperatures, within the tuber itself the fungus was protected and able to survive very low temperatures. Since only the tuber was kept through the winter, the blighted potatoes provided the source of infection for the next season's crop. Because in a single growing season it is possible to get many cycles of late blight, it is considered to be a compound-interest disease with great powers of amplification that can lead to an explosive outbreak. As a result, an entire potato crop can be quickly destroyed. Indeed, one infected tuber per 2.5 acres can cause an epidemic of late blight, especially when the weather is right: cool, with high rainfall and humidity.

Where did the "plant destroyer" come from in the first place? Most likely *P. infestans* was introduced with tubers brought to Belgium from Peru. The disease was first reported in Belgium in July 1845, and it soon spread throughout Europe. Once introduced, it became a menace. Although today topical fungicides such as Bordeaux mixture (made from copper sulfate and lime and developed in the 1890s) may be sprayed on leaves before the disease begins or Ridomil, a systemic fungicide developed in the 1970s, may be applied to the soil, none of the fungicides eradicate blight—they simply reduce the amount of defoliation so that tubers can be harvested in respectable quantities. However, in 1845 to 1849, none of these were available.

Consequences

The social and political impacts of the Great Hunger or the Irish Potato Famine (1845 to 1849) were profound. The mass immigration to the United States was so great that today 1 of every 10 Americans is of Irish descent. By 1914 there were more than 5 million Irish-Americans. These immigrants were no longer agricultural peasants working the lazy beds of the bogs but were urban dwellers who came to occupy key positions in railroading, mining, civil engineering, law enforcement, and politics.

Before 1840 the Caucasian population of the United States consisted of Protestants, most of whom came from Britain, The Netherlands, Germany,

and Scandinavia; a smaller number came from Switzerland, and Germany. The total number of Irish Catholics in the United States between 1810 and 1840 was 1 million. The blight-caused famine created a massive influx of immigrants, with numbers exceeding 100,000 in 1847, especially in Boston and New York City. In these urban centers they clustered together in tenements. These poor, unskilled immigrants often turned to their Irish friends and counselors on Sunday for support and care. They formed a voting bloc that could be counted on in which they lived. Through the efforts of Irish immigrants, the poorest of the Irish in the United States, changed political participation. The Irish Democratic Party—a legacy that persists to this day (and isolationism) were fostered by the Irish (which delayed U.S. entry into World War I). In the position of the Irish, the first affected Northern attitudes during the Civil War and thereafter were not because they were anti-South but because they were anti-white Anglo-Saxon Protestants in the South.

Could there be a repeat of the Irish famines, smaller in scale than the Irish Potato Famine, have been inconsequential, have been blight occurred in 1916 to 1918? The Irish civilians: the old, the weak, and the young. The Civil War (1914 to 1918)—the combination of the Irish and the Civil War mixture was needed for the Irish. The blight-caused famine, potatoes rotted in the ground, and the remaining were commandeered for the military. The rail lines were left to rot. In autumn of 1916 the Irish were starving. Germany's High

begins to rot. Dry rot of tubers by potato due to other microbes in

late-blight fungus was how it could overwinter in the soil or in spores under freezing conditions and low temperatures, within it was able to survive very low temperatures through the winter, the blighted tubers for the next season's crop. Be- lievable to get many cycles of late blight disease with great pow- erful outbreak. As a result, an epidemic. Indeed, one infected tuber per acre, especially when the weather is dry.

How did it get from in the first place? Most of the tubers brought to Belgium from France in July 1845, and it soon spread, it became a menace. Al- though Bordeaux mixture (made from copper and lime from the 1890s) may be sprayed on the tubers, a systemic fungicide devel- oped in the 1950s, none of the fungicides erad- icated the blight so that tubers were lost. However, in 1845 to 1849, none

of the Great Hunger or the Irish Potato Blight led to mass immigration to the United States. Every 10 Americans is of Irish descent. There are 30 million Irish-Americans. These immigrants went to work the lazy beds of the potato and to occupy key positions in business, industry, and politics.

The United States consisted of immigrants from Ireland, The Netherlands, Germany,

and Scandinavia; a smaller number of Catholics from France, Spain, Switzerland, and Germany; and very few Irish Catholics. Although the total number of Irish Catholics who emigrated to the United States between 1810 and 1840 was less than 100,000, over the next 25 years the blight-caused famine created a flood of Irish Catholic immigrants, whose numbers exceeded 100,000 per year. These immigrants favored the cities, especially Boston and New York—the ports where they first disembarked. In these urban centers they could constitute as much as 30% of the population. These poor, unskilled laborers with few relatives or homes crowded themselves together in Irish Catholic ghettos, where the priest was their friend and counselor on Sunday and the local politician became their advisor and caregiver for the remainder of the week. The ghetto Irish constituted a voting bloc that could exercise great political influence in the cities in which they lived. Through their social activism and unionization, these immigrants, the poorest of the poor and despised by most in the United States, changed political party platforms, especially that of the Democratic Party—a legacy that persists today. Anti-imperialist policies in America (and isolationism) were fostered by the Irish immigrants largely because of their hatred of Britain. It is thought that it was the effective lobbying efforts by the Irish (which continued to denigrate British imperialism) that delayed U.S. entry into World Wars I and II. The virulent anti-English position of the Irish, the first politically and ethnically integrated group, affected Northern attitudes toward the American South. Indeed, during the Civil War and thereafter, the Irish voted for the hard-line Republicans, not because they were anti-slavery but because they hated the English and the white Anglo-Saxon Protestants (WASPs) who lived in the American South.

Could there be a repeat of the 1845 to 1849 disaster? Possibly. Potato famines, smaller in scale than that of the Great Hunger but certainly not inconsequential, have been recorded. The last major famine due to late blight occurred in 1916 to 1917 and resulted in the death of 700,000 German civilians: the old, the weak, the children. During World War I—the Great War (1914 to 1918)—the copper used in the preparation of Bordeaux mixture was needed for shell casings and electric wire, and without this fungicide, potatoes rotted in the fields. All the grain and the potatoes that remained were commandeered for the war effort, and so the civilians behind the lines were left to feed on turnips or any other foods they could find. In autumn of 1916 the people were hungry, and by winter they were starving. Germany's High Command assumed that the eastern campaign

against a weakened Russian army would be simply a mop-up affair, and, once complete, the plan was to direct the army's efforts against the Allies on the Western front. That did not happen because there was a saboteur, *P. infestans*. Many of the rank-and-file German soldiers, knowing of the plight of their hungry, starving, and dying families at home, lost their will to fight. It has been speculated that this weakening of morale was one of the reasons the German High Command was never able to launch a successful campaign on the Western front. Indeed, the German army was forced to retreat and maintain their position on the Hindenberg line. In 1917, British and French forces were joined by the Americans, and a great new military strength could be brought to bear on the German front. But that strength became unnecessary since late blight had already struck a devastating blow against the German Empire. With morale in decline, the military might of Germany began to crumble, and by 1918 it collapsed. The Great War ended when the armistice was declared on 11 November 1918.

Even today in countries such as Russia, where for many people there is little to eat except potatoes, an epidemic of late blight could be catastrophic. When the blight appeared in the 1990s, yields from some Russian plots were reduced by as much as 70%. In countries where fungicide is affordable and is applied, losses can still be as high as 15%. It has been estimated that in developing countries, where fungicides are out of reach because of cost and difficulties in distribution, the annual toll amounts to billions of dollars. What to do? At a minimum, it is necessary to continue to search for new potato varieties that are resistant to blight and develop more effective fungicides, but more importantly it must be recognized that preventing future famines will require both political will and global social responsibility.

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Cholera

Cholera is a horrible disease that causes a surprised look as the body changes to agony as severe dehydration sets in. The vomit is clear liquid, resembling rice water. The patient's knees are stiff, and the only small relief is to lie on their knees; the breath whistles through the nostrils. In this stage, the body cannot hold its weight and the patient falls into the fetal position. Those who survive the initial stage undergo a more gradual and painful decline. The patient's breathing becomes more shallow and slower, but still remains a constant. The patient's eyes stare vacantly without focus, and the skin becomes pale and clammy.

The historian William

"The speed with which cholera can kill perfectly healthy people could be called perfection was anywhere near perfection: radical dehydration, the emaciation of his former self, the yellowish color of the skin, turning the patient into a uniquely visible: pattern of death, a lapse motion picture, to utter invincibility."

For more than two centuries, cholera has defied health defenses, and even the most advanced people. The most recent cholera pandemic and has relentlessly moved