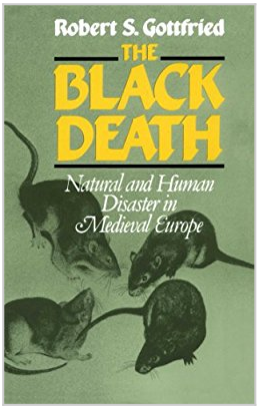

The Black Death: Natural and Human Disaster in Medieval Europe

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Editorial Review

Review
New York Times Book Review An engrossing study...Gottfried leaves us with a better understanding of how humans turned out to be at the mercy of changes in insect and rodent ecology.

The Atlantic Monthly Intriguing [description of] the social and economic effects of the plague, particularly its impact on the medical profession...Professor Gottfried describes the process in brisk and stimulating style.

William H. McNeill *New York Review of Books* Marks a distinct intellectual advance...a powerful reminder of how drastically ecological balances can be upset...

New England Journal of Medicine The epidemiology of plague and its introduction into Europe, the details of its devastation of various regions, and the economic consequences of the pandemic...represents the scholarly consensus and is well told.

The Boston Globe Book Review Gottfried's own historical expertise serves him well in describing the broad tears, temporary patches, and eventual retailoring of the fabric of medieval life...Gottfried's examination of the Black Death can help us to understand ourselves as well as our darkest past.

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CHAPTER 1

A Natural History of Plague

Like all infectious diseases, the Black Death has a natural history and can be properly understood only in that context. First, there is environment. Anyone traveling through Europe today would find it hard to imagine what the continent looked like a thousand years ago. There were no sprawling urban and industrial complexes, the outstanding characteristic of the last century, and surprisingly few towns of any size. Towns were usually far apart, located next to the sea or astride great rivers. By the middle of the twelfth century, a few urban centers in Italy and the Netherlands, and perhaps Paris, had fifty thousand or more people, but most claimed a thousand or so inhabitants. Nine out of ten Europeans lived in still smaller settlements, nucleated villages or hamlets of a few hundred people, fifteen to twenty miles apart. Both town and village were small and cramped, with woefully inadequate sanitation and transportation facilities. Ironically, in the confines of their small but isolated settlements, most people lived close together and had little privacy.

Surrounding the villages were the fields, pastures, and woodlands from which most people squeezed their subsistence. By 1250 or so, field and pasture had come to dominate Europe's landscape, but, until at least the mid-twelfth century, the extent and density of the woodlands characterized the European environment. In the far north -- most of Scandinavia and Russia -- the forests were coniferous, consisting primarily of fir trees, with a smattering of birch and, where the land was poorly drained and the elevation low, moors, marshes, and tundra. The rest of Europe had deciduous forests. The generally cold, wet, acidic-soil areas around the

Baltic and North Seas and throughout much of eastern Europe had beech trees surrounded by holly and other aquifoliacs. Central Europe was mostly oak forest. Where the soil was alkaline, especially on both sides of the Alps and the Carpathians, the oaks were mixed with alders. Where the climate was wetter and the soil was more acidic, as in most of central and northern France and central Germany, the oaks were surrounded by birch and aspen. South of the Alps, in most of the Mediterranean Basin, the sunlight was brighter, the temperatures were higher, the rainfall was less frequent and less well-distributed throughout the year, and the soil was sandy and acidic. The Mediterranean Basin had also been settled longer than northern Europe and had a higher population density. Hence, it was less densely forested than the North; but, even in the twelfth century, much woodland remained, particularly stands of conifers, such as pines and junipers, which can tolerate sandy soils.

A second consideration in studying disease is causation. All epidemics, plague included, are caused by parasites that have relations with other, usually larger organisms. This process is a natural part of human and animal ecology. A third factor, and one of paramount concern to man, is toxicity. Epidemiologists generally distinguish between lethal and nonlethal diseases. Nonlethal infections are usually "old" and well-established. Often, they are only mildly deleterious to their hosts, thus ensuring a steady supply of victims. By contrast, those spectacular diseases that periodically burst onto the historical stage, killing large numbers of people, are caused by newer parasites that have yet to establish an equilibrium with their hosts. An example of an older disease is malaria; the plasmodium that causes it is debilitating, but generally not fatal. An example of a newer disease is pneumonic plague, which is 95% to 100% fatal. Both diseases have been significant in the past, but because of the plague's enormous mortality, it has had far greater impact.

A fourth concern regarding infectious diseases -- and, indeed, an important way of distinguishing one from another -- is their means of transmission. One such mechanism is direct contact between people, usually via the respiratory system. Diseases so disseminated include influenza, diphtheria, measles, and pneumonic plague. Respiratory diseases are highly communicable, virtually impossible to prevent, and closely related to human population density. Consequently, they were common in the cities and towns of medieval Europe. A second mechanism of dissemination comprises enteric diseases, those spread through the digestive system; among them are dysentery, diarrhea, typhoid, and cholera. Like respiratory afflictions, enteric ailments were very common throughout the Middle Ages. They often reflected social conditions, especially poor sanitation. Because of this, and in contrast to respiratory diseases, enteric diseases can be eliminated rather easily through basic improvements in public health.

Diseases are spread in at least two other fashions. One is through venereal contact, the prime example being the treponema infections, especially syphilis, and gonorrhea. The causative organisms of venereal ailments are highly vulnerable when exposed, even in temperate environments, and were less frequent in the Middle Ages than were either respiratory or enteric diseases. A fourth group, however, was very common -- diseases transferred to humans from animal hosts, with animals acting either as intermediaries, as with malaria or typhus, or as primary or secondary epizoötic victims, as with bubonic plague. The role of animals in the spread of diseases can be crucial: humans share 65 different diseases with dogs; 50 with cattle; 46 with sheep and goats; 42 with pigs; 35 with horses; 32 with rats and mice; and 26 with poultry. While not as common as respiratory or enteric diseases, those transmitted by animals are usually more lethal, since most viruses and bacteria, the organisms that actually cause infection, gain in virulence as they pass through the chain of hosts.

In addition to their virulence, diseases facilitated by animal intermediaries are important for other reasons. They represent still another disease classification and interpretation in that their dissemination and frequency are based primarily on the animal hosts rather than on humans. Bubonic plague provides a good example. When a rodent population in which plague is enzoötic, that is, indigenous, begins to multiply and reaches a

certain population density, there is a concentrated transfer among the rodents of parasites -- fleas, in this case -- and bacteria. The result is usually an epizoötic among the rodents, which sometimes leads to an epidemic of bubonic plague. Some scholars have suggested that communicable diseases are a basic part of the human environment and a function of the population density, and that civilization and disease travel hand in hand. Accordingly, the incidence of a given epidemic would hinge on patterns of human settlement. This is indeed the case with respiratory, enteric, and venereal diseases, but it is not so with those diseases spread by animal intermediaries. The latter are primarily dependent on factors exogenous to civilization, such as climate and rodent and insect population density and ecology. There is great danger when studying the history of infectious diseases in being too anthropocentric and overemphasizing the human element. In many epidemic diseases, humans are most effective as carriers when entering new ecospheres, such as the Americas in the sixteenth century, where they brought smallpox and measles, rather than in areas of older inhabitation, such as Europe in the Middle Ages.

Another key characteristic in the development of infectious diseases is immunity. Humans have complex mechanisms for defending themselves against pathogens, the microorganisms that cause disease. Individual resistance varies with many factors, such as number of protective antibodies -- the proteins generated in reaction to the disease toxins introduced into the bloodstream. Immunity is either innate or acquired; if acquired, it is either active or passive. Active immunity comes when the host generates his own defenses, passive when generated defenses are introduced. Passive immunity is often only temporary. In the Middle Ages, active immunity was particularly important in determining the extent and intensity of an epidemic. Some infections, especially respiratory types such as smallpox and measles, do not change a great deal in their etiology. Hence, survival from an initial attack confers a degree of immunity, limiting recurrence to those members of society born after the last epidemic. Diseases for which there was immunity had less of an impact on medieval Europe than did more complex, multiple infections such as dysentery, influenza, and plague, for which immunity is quite limited, if it exists at all.

Medieval infectious diseases were an inheritance from the classical world. Between about 500 B.C. and A.D. 550 there were extensive contacts between the animal populations and the civilizations of China, Central Asia, India, the Upper Nile, and the Mediterranean Basin. As a result, as William McNeill has argued, there was a general confluence of Eurasian and African disease pools which, by the sixth century A.D., brought to the Mediterranean Basin most of the important diseases that can survive in temperate climates. To be sure, this proliferation of diseases took a long time. With a few exceptions, such as the Athenian Plague of the fifth century B.C., the classical world was remarkably free from major, deadly epidemics. This was fundamental to its steady population growth, which continued almost unabated until the second century A.D. But this biological peace was deceptive; in fact, the peripatetic character of ancient empires acted as a conduit and incubator for future disease patterns. An example was the reticulum of commerce and communications established by the Romans late in the first century B.C. This included their famed road system and, even more important, network of commercial sea routes. The sea routes converged on the Levantine Coast, then branched east across the northern Arabian Peninsula to the Arabian Sea, the Indian Ocean, and South Asia; and west to Italy, southern Gaul, and Iberia, whence goods proceeded inland via major river valleys such as the Rhone. Sea travel was relatively quick and, with good weather, all Mediterranean ports were just a few days apart. Thus, a person who seemed well on embarkation could fall sick en route, infect fellow passengers, and then spread the disease hundreds of miles from its point of origin. Further, cargoes were often bulky enough to conceal potential insect and rodent intermediaries. This, coupled with the linking of south and central Asia, the Middle East, the Nile Delta, and the European coast along the Mediterranean, brought about the fruition of disease pools.

From the second through the sixth centuries A.D., three new and lethal infections emerged from this disease pool, bringing an end to the ecological stability of the ancient world. The first began in 165 and persisted

until 180, striking Italy and the western part of the Roman Empire. It seems to have been brought west by Roman legionnaires and probably marks the introduction into Mediterranean Europe of smallpox. Some authorities believe that smallpox was concomitantly present among the Germanic tribes beyond the Rhine-Danube frontier, but, even if this were so, the barbarians apparently did not transmit it to the peoples within the Empire, at least not before the third century. Smallpox is one of man's most communicable diseases and can be very deadly to a population with no innate immunity. This was the case in the Roman Empire. The physician Galen estimated that between a quarter and a third of Italy's population died during the 15 years after it appeared. But because the smallpox virus changes little and survival of an attack generally confers immunity, its role in the Middle Ages was limited to areas it had yet to visit and to those who never had had it -- primarily children. Thus, it was as a killer of children that smallpox made its biggest mark in the medieval world.

Smallpox was joined in 251 by the second of the great epidemic diseases, marking the classical/medieval disease watershed. This disease was the "Antonine Plague," probably measles. It was described by St. Cyprian, bishop of the North African town of Carthage:

Now that the bowels loosened into a flux exhaust the strength of the body, that a fever contracted in the very marrow of the bones breaks out into ulcers of the throat, that the intestines are shaken by the continual vomiting, that the blood-shot eyes burn, that the feet of some or certain parts of their members are cut away by the infection of diseased putrefaction that, by a weakness developing through the losses and injuries of the body, either the gait is enfeebled, or the hearing impaired, or the sight blinded.

At its height, measles allegedly killed 5000 people a day in Rome, and it remained a major menace until about 260. Measles is like smallpox in many ways and the two diseases were not distinguished by European doctors until the sixteenth century. It is caused by a virus, transmitted via the respiratory system, and highly lethal to a population with little or no immunity. As is the case with smallpox, however, survival of a measles attack confers immunity from future visitations. Thus, it, too, was primarily a childhood affliction in the Middle Ages. Nevertheless, it is important not to diminish the effects of either disease, especially in their initial appearances. Measles depleted the population, hastened the desertion of many rural areas (particularly in the grain-producing regions of Sicily and North Africa), and cut the rolls of the Roman army and taxpayers. It caused at least a temporary reduction in East-West trade and, with smallpox, has formed the cornerstone of a major theory of the decline of the Roman Empire.

Important as smallpox and measles were in the natural history of infectious disease, their combined role was dwarfed by the arrival in 541 of a third disease. This was plague, caused by a complex series of bacterial strains called *Yersinia pestis.* Plague's etiology helps to explain its historical importance; *Y. pestis's* toxicity varies, but the disease is always highly lethal. Under normal circumstances, it lives in the digestive tract of fleas, particularly the rat fleas *Xenopsylla cheopis* and *Cortophylus fasciatus,* but it can also live in the human flea, *Pulex irritans.* Periodically and for reasons that epidemiologists still do not fully understand, the bacilli multiply in the flea's stomach in numbers large enough to cause a blockage, thus threatening the flea with starvation. The "blocked flea," while feeding, regurgitates into its victims large numbers of *Y. pestis* bacilli. This process is crucial to plague's progress; furthermore, *Y. pestis* cannot pass through healthy skin, but only through a break in the surface.

Dozens of rodents carry plague. Among them are tarbagons, marmots, and susliks in Asia, prairie dogs and ground squirrels in America, and gerbels and mice in Africa. Generally living in networks of tunnels just beneath the earth's surface, these rodents can be very numerous. In the Volga steppe in south Russia, an average of 325,000 susliks per four square miles has been estimated. In Europe, rats, especially the black rat, *Rattus rattus,* have been most important carriers. Black rats are quite sedentary and rarely move more than

200 meters from their nests. Because they live so close to humans, they are most dangerous to them. An excellent climber, *R. rattus* was well-suited to both the thatched roofs of peasant dwellings and the high roof beams and dark corners of urban houses. But, important as black rats were in the dissemination of plague, it is essential to emphasize that they were not the only secondary carriers. Along with the other rodents already mentioned, additional secondary vector hosts included virtually all household and barnyard animals save the horse, whose odor apparently repels even starving blocked fleas.

When *Y. pestis* is enzoötic, that is, endemic to a rodent population, it is called silvatic plague. Silvatic plague is crucial to human epidemics because its presence in a rodent population provides a reservoir, or focus, in which the disease can survive for extended periods of time. Reservoirs may help explain the cyclic occurrence of plague, which ultimately made it so important in the Middle Ages. *Y. pestis* is able to live in the dark, moist environment of rodent burrows even after the rodents have been killed by an epizoötic, or epidemic. Thus, if a new rodent community replaces the old one, the plague chain can be revived.

The fleas carrying *Y. pestis* turn to humans only after their supply of secondary hosts has diminished. Most secondary hosts can tolerate a modest proportion of *Y. pestis* in their bloodstreams, but when the bacilli multiply and invade the pulmonary or nervous systems, the secondary hosts succumb. The fleas then seek a new host -- and sometimes that host is a human being. Humans, then, are not a preferred host for *Y. pestis,* but rather, the victims of an animal epizoötic. In effect, humans are victims of changes in insect and rodent ecology.

There are three principal varieties of plague -- bubonic, pneumonic, and septicaemic. Bubonic is by far the most common and therefore the most important of the three. Its incubation period from the time of infection to the appearance of the first symptoms is generally about six days. The initial symptom, a blackish, often gangrenous pustule at the point of the bite, is followed by an enlargement of the lymph nodes in the armpits, groin, or neck, depending on the place of the flea bite. Next, subcutaneous hemorrhaging occurs, causing purplish blotches and swelling in the lymphatic glands, from which bubonic plague takes its name. The hemorrhaging produces cell necrosis and intoxication of the nervous system, ultimately leading to neurological and psychological disorders, which may explain the *danse* macabre rituals that accompanied the Black Death. Bubonic plague is the least toxic of all plague types, but it is still highly lethal, killing 50% to 60% of its victims.

Pneumonic plague is unique in that it can be transmitted directly from person to person. This is in part the result of pneumonic plague's peculiar etiology, for it seems to occur only when there is a sharp temperature drop and the infection moves into the lungs. After the two-to-three-day incubation period, there is a rapid fall in body temperature, followed by a severe cough and consolidation in the lungs, rapid cyanosis, and the discharge of bloody sputum. The sputum contains *Y. pestis,* making transmission airborne and thus direct from human to human. Neurological difficulties and coma follow infection, with death coming in 95% to 100% of the cases. Therefore, while pneumonic plague is less frequent than bubonic, it is far more virulent.

Like bubonic plague, septicaemic plague is insect-borne, but its precise etiology and occasional appearance in selected epidemics have not been adequately explained. It is known that in septicaemic plague *Y. pestis* bacilli enter the bloodstream of victims in massive numbers. A rash forms within hours and death occurs within a day, before the buboes even have time to form. This type of plague is always fatal, but it is very rare and, because it is present in the bloodstream in such large quantities, it can be transmitted by the human flea, *P. irritans,* and even by the human body louse.

There are peculiar environmental conditions that determine the presence and virulence of plague epidemics. First, there are factors of insect and rodent ecology. The appropriate fleas and rodents must live near people.

The flea must be blocked or *Y. pestis* will remain in the digestive system; and the secondary host must die before the flea moves on to a tertiary host. An epizootic rather than an enzootic condition must prevail among the secondary host population, and the tertiary host must be man rather than other large mammals. Climate also plays an important role. The rat flea *X. cheopis* is quite hardy; it can survive for between six months and a year without a rodent host in dung, an abandoned rat's nest, or even textile bales. But it is active only at temperatures of 15°C-20°C, with 90%-95% humidity. Cold limits the flea's activity, while heat retards its productivity, and humidity of less than 70% kills it. These climatic factors limit most plague outbreaks to particular seasons in different parts of the Western world. In western Europe, for example, it generally comes in late summer and early autumn. It is important to stress that an outbreak of plague occurs only in confluence with a variety of environmental conditions.

Plague may be the most virulent of the human infectious diseases. But, historically, its frequency is even more important than its virulence. Plague comes not in isolated epidemics, but rather, in pandemics. A pandemic is a linked series of epidemics that strike in cyclic fashion. It occurs when *Y. pestis* has been established in the local rodent population, as discussed above, and is itself determined by climatic and ecological conditions. Once a pandemic is present, plague epidemics will recur in intervals of between 2 and 20 years. Hence, epidemics will strike at least once in every generation and act as a regular population check. Plague is unique among epidemic diseases in its deadly combination of virulence and frequency.

Y. pestis is native to particular parts of the world. These permanent reservoirs, called "inveterate foci," include central Asia, Siberia, the Yunan region of China, parts of Iran and Libya, the Arabian Peninsula, and east Africa. Europe probably has never had an inveterate focus. But because of its commercial connections and the geographical configuration of the Eurasian land mass and the Mediterranean Basin, it was always proximate to such reservoirs. Plague has taken two forms in Europe. The first was what epidemiologists call "temporary foci," reservoirs of prolonged plague persistence, like the pandemics already mentioned. When ecological and etiological conditions among the rodent and bacterial populations changed, the temporary plague foci disappeared. The second form was that of a locus of brief duration. Such loci were simply incidents of epidemics which did not become established among the local insect and rodent populations. These included epidemics of septicaemic plague -- attacks so virulent that they killed off virtually everyone and thus provided no reservoir for the future -- and epidemics brought to ports by ships and limited in their dissemination.

Medieval Europe was struck by two plague pandemics. It is likely that the first came down the Nile from east Africa to lower Egypt, and thence into the relatively populous eastern Mediterranean Basin. The first epidemic of this pandemic has been called "Justinian's Plague" after the Byzantine emperor reigning at the time of its outbreak. In 541, Justinian was trying to reconquer the western parts of the old Roman Empire from its new Germanic overlords. The Byzantine court historian, Procopius, wrote:

During this time there was a pestilence, by which the whole human race came near to being annihilated. Now in the case of all other scourges sent from Heaven some explanation of a cause might be given by daring men, such as the many theories propounded by those who are clever in these matters; for they love to conjure up causes which are absolutely incomprehensible to man, and to fabricate outlandish theories of natural philosophy, knowing well that they are saying nothing sound, but considering it sufficient for them, if they completely deceive by their argument some of those whom they meet and persuade them to their view. But for this calamity it is quite impossible now to express in words or conceive in thought any explanation, except indeed to refer it to God....

It started from the Egyptians who dwell in Pelusium. Then it divided and moved in one direction towards Alexandria and the rest of Egypt and in other directions; it came to Palestine on the borders of Egypt and

from here it spread over the whole world, always moving forward and traveling at times favorable to it. For it seemed to move by fixed arrangement, and to tarry for a specified time in each country, casting its blight slightingly upon none, but spreading in either direction right out to the ends of the world, as if fearing lest some corner of the earth might escape it. For it left neither island nor mountain ridge which had human inhabitants; and if it passed by any land, either not affecting the men there or touching them in indifferent fashion, still at a later time it came back....

With the majority it came about that they were seized by the disease without becoming aware of what was coming either through a waking vision or a dream. And they were taken in the following manner. They had a sudden fever, some when just roused from sleep, others while otherwise engaged, without any regard to what they were doing. And the body showed no change from its previous color, nor was it hot as it might be expected when attacked by fever, nor indeed did any inflammation set in, but the fever was of such a languid sort from its commencement and until evening that neither to the sick themselves nor to a physician who touched them would it afford any suspicion of danger. It was natural, therefore, that not one of those who contracted the disease expected to die from it. But on the same day in some cases, in others on the following day, and in the rest not only in the particular part of the body which is called the groin, that is, below the abdomen, but also inside the armpits, and in some cases besides the ears, and at different points on the thighs came a large swelling or bubo.

In a sixth century context, Justinian's Plague was very nearly "worldwide," striking central and south Asia, North Africa and Arabia, and Europe as far north as Denmark and as far west as Ireland, where mortality proved especially severe. Only eastern Asia seems to have escaped. In Constantinople, the center of the Byzantine Empire, the plague was at its most virulent from autumn 541 until spring 542. During a four-month span it allegedly killed 200,000 of the city's people, perhaps 40% of the total population. It had a devastating effect in Italy, southern France, the Rhine Valley, and Iberia, where it lingered until autumn 544. When Justinian's Plague had finally spent itself, between a fifth and a quarter of Europe's population south of the Alps had perished. In political terms, it dealt a crippling blow to Byzantine plans to conquer the western Mediterranean, and perhaps so weakened Byzantium as to set up its defeat by the Arabs a few generations later. From the perspective of the history of infectious disease, it marked the arrival in Europe of a third pandemic disease in a 400-year period, and the last one to come to the West from the lands abutting the Indian Ocean for almost a millenium.

Justinian's Plague established a temporary focus of *Y. pestis* among European fleas and rodents, ensuring that subsequent epidemics of the pandemic would recur in 10-to-24-year cycles for the next 200 years. Plague returned from 558 to 561, again beginning in Egypt, spreading throughout the eastern Mediterranean Basin to Constantinople, and then traveling west through the Italian ports of Ravenna and Genoa into southern France. It came again from 580 to 582, and from 588 to 591, the latter spreading from Spain to southern France and Italy, the reverse of the usual pattern of dissemination. There is some evidence that these third, fourth, and fifth plague epidemics were exacerbated by accompanying sieges of smallpox. The sixth plague epidemic occurred from 599 through 600. In Italy and southern France, it was the most lethal epidemic after Justinian's Plague, killing perhaps 15% of the population.

After 599-600, successive epidemics of the first plague pandemic were less virulent, but about as frequent. Large parts of Mediterranean Europe were afflicted in 608, 618, 628, 640, 654, 684-86, 694-700, 718, and 740-50. More localized plague epidemics struck Sicily and Calabria in 746, and Naples and southern Italy in 762. In both instances, the epidemics remained restricted, suggesting that they were introduced by foreign ships and that *Y. pestis* was no longer enzoötic among the indigenous rodent populations -- the latter perhaps the result of a mutation in the bacillus or a change in rodent and insect ecology. By the late eighth century, the first plague pandemic had come to its end in Europe.

The first pandemic, although restricted mainly to the Mediterranean Basin and consisting primarily of bubonic plague, left an indelible mark on early medieval Europe. Because it was recurrent, it helped to keep population levels below those of 541 before the plague. The demographic historian J. C. Russell has estimated total population loss from 541 to 700 at 50% to 600%. Contemporaries were baffled by the new disease, as would be their counterparts in the fourteenth and fifteenth centuries. Explanations of its causation were usually taken from Biblical exegesis, and high mortality was attributed to divine judgment. Pilgrimages and visible demonstrations of piety increased, and the Christian Church seems to have gained in influence during the pandemic. There is little statistical evidence that can be used to measure the pandemic's impact on economy and society, but it must have disrupted trade routes and patterns, at least during plague flare-ups, and changed patterns of food production and distribution. It was a major retardant during Europe's Dark Ages.

From the late eighth through the mid-fourteenth century, Europe was remarkably free from most epidemic diseases. There were isolated, often severe, infections, such as the unidentifiable epidemic of 870, which swept through western Europe killing perhaps 100% of the populations of England and France. Most infectious diseases in this period were endemic, or linked closely to famine, malnutrition, or plant diseases, such as recurring epidemics of ergotism, also called St. Anthony's disease, which struck from the mid-tenth through the mid-eleventh centuries. With the exception of a few isolated coastal epidemics, plague would not strike again en masse until 1347, and smallpox and measles were restricted to younger members of society. Since, in medieval demographic terms, childhood diseases were relatively unimportant, their effect on overall population levels was limited. At the same time, influenza and typhus, scourges of the late fifteenth and sixteenth centuries, had not yet made a significant impact. In part because these major constraints on population were curbed, the period between the ninth and fourteenth centuries corresponded with medieval Europe's most extended era of demographic and economic expansion.

The most important infectious disease in Europe from the tenth through the thirteenth centuries was leprosy, or Hansen's Disease. It is a chronic infection that develops slowly over a number of years and, by itself, rarely kills its victims. It does, however, produce for the afflicted decades of pain and suffering, and renders them vulnerable to respiratory and enteric ailments. Leprosy is not especially contagious, but because it so horribly mutilates and scars its victims, it always has been dreaded. Extremities and facial features slowly rot away, with the face becoming an almost formless mass. Compounding this horrible visage is a foul odor coming from gangrenous parts, all combining to make the disease and its victims quite horrifying.

Medieval society was unable to provide preventive or curative treatment for the leper; its best alternative was isolation. Upon diagnosis, the leper was counted among the dead, and a quasi-requiem mass was sung for his soul. Earth was shoveled on his feet, symbolizing departure from the mainstream of society, and the patient was removed to a leper hospital where, isolated from the rest of society, including friends and family, he lived out his days. Most medical authorities considered that the disease was caused by divine judgment and felt that mortal men could therefore never develop an effective cure. One of the few dissenters to this opinion was the thirteenth century English physician Gilbertus Anglicus. Having observed a number of lepers over several years, he concluded that the ailment was not easily communicable and was primarily a nervous affliction that might be treated in the same fashion as other nerve-related diseases. But even Gilbert was generally bereft of concrete ideas, suggesting only a few ways to balance the "body humors," that being a favorite medieval medical cure inherited from the Greeks. Isolation was the most practical -- and, in many ways, the most humane -- treatment.

Leprosy was not a great killer. Its demographic impact was rather limited and did not compare with that of plague or smallpox. Instead, it was an important cultural phenomenon, entering the psyche, art, and religion of Europe. The Christian Church regarded lepers as unclean, and it became known as the "disease of the

soul." Because of their forced isolation from society, lepers' legal identities became muddled. In many northern Italian cities, canon lawyers were called upon to discuss the alienation of lepers' property, and in several Rhineland towns, including Trier and Mainz, elaborate sets of rules were drawn up to guide lepers through their everyday routines. They were barred from all churches, markets, shops, and other public places. They could not wash or drink from any civic water source, and had to wear distinctive clothing. The leper was made to touch everything with a rod and could not enter inns or taverns. Sexual intercourse, even with spouses, was strictly forbidden. No public building could be touched without gloves, and shoes had to be worn at all times. Lepers were even required to stand downwind of those ordinary folk who chose to address them.

The incidence of leprosy seems to have increased from the eighth through the thirteenth centuries, reaching a peak early in the fourteenth century, and then disappearing almost entirely by 1400. Several theories have been offered to explain its rise and fall. The rise is usually connected with concomitant movements among the general population; increases in the latter yielded more potential and actual leprosy victims. The decline of leprosy is much harder to explain and has elicited several theories. One explains the disappearance by the Black Death; as the great plague swept away a third to a half of Europe's population, it took an even higher proportion of the already weakened lepers. Subsequent plague epidemics of the second pandemic had a similar effect until, by 1400, most of Europe's lepers had died. A second theory credits advancing medical analysis. Leprosy, with its characteristic skin eruptions, manifests itself in a fashion similar to that of many common skin diseases. Some modern authorities believe that high medieval chroniclers and physicians simply called all or at least most people with any skin diseases lepers without regard to whether they had the real thing, smallpox, measles, or just a severe rash or case of acne. By the late fourteenth century, physicians and even surgeons and apothecaries had become more sophisticated and discriminating in their diagnoses. Leechbooks and pharmaceuticals identified and typed a wide variety of skin conditions, and were more accurate when identifying Hansen's Disease *per se.*

A third theory explaining the decline of leprosy emphasizes the rise in incidence of pulmonary tuberculosis. In some circumstances, immunity reactions to tuberculosis provide a measure of resistance to Hansen's Disease. McNeill has offered that pulmonary tuberculosis, with its rapid means of transmission, afflicted more people than leprosy, which is not very contagious. Hence, survivors of tuberculosis gained a degree of immunity from leprosy. A fourth theory credits improved hygiene, especially in urban areas, while a fifth theory emphasizes the increased consumption of vitamin C. Whatever the precise cause, with the exception of a few isolated regions in Norway and Poland, the incidence of leprosy declined markedly, and many of Europe's leper houses closed down, changed their focus toward other ailments, especially plague, or became retirement homes or almshouses.

Europe's relatively disease-free era ended abruptly in the mid-fourteenth century. Population had increased about 300% from the tenth to the mid-thirteenth century to 75-80 million, higher than it had been for close to a thousand years. Militant imperialism had extended the boundaries of the Christian West into Russia, Iberia, and Palestine. Internal European trade and travel had improved considerably with the opening of new Alpine passes, the establishment of a direct sea-link between the Italian and Netherlandish cities, and the integration of the Baltic and North Sea hinterlands with the rest of the continent. Most important in epidemiological terms, closer connections were being forged between Europe, Asia, and Africa. To ease a bullion shortage, Italian merchants turned to Arab middlemen for access to sub-Saharan gold supplies. As demand for luxury goods and spices rose, more ships and caravans journeyed to south and central Asia. Much of this trade was carried on through Middle Eastern intermediaries, but, from the twelfth century onward, Europeans played a large and ever-growing role. In all, contacts between East and West flourished as never before. These contacts, so positive for commerce, changed the balance and pattern of infectious diseases. By the end of the twelfth century, Europe's disease pool was stable. Smallpox, measles, malaria, leprosy, and a few other

diseases had established a tentative equilibrium within Europe's population. Plague, the greatest epidemic killer, had disappeared. But, in the thirteenth century, climatic changes began to alter the insect and rodent ecology of Eurasia, and Mongol tribesmen began their conquest of central Asia. These factors would combine with the new political, social, and economic forms which were developing in Europe -- in part, at least, because of the absence of plague -- to forever change the course of Western history.

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