

PEOPLE, Chapter 1: Carlos Finlay (1833-1915)



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In response to his groundbreaking theory on the cause of yellow fever, Carlos Finlay was called a "crank" and a "crazy old man." The derision hurt the doctor whose homeland was devastated by the disease, but he would live to see his work vindicated.

### **Becoming a Doctor**

Finlay was born in Cuba on December 3, 1833. His father, Edward, a Scottish-born physician, and his mother, Eliza, a native of France, educated him at home and later enrolled him in school in France. Bouts of childhood illness interrupted his schooling, but he was able to enroll in the Jefferson Medical College in Philadelphia, where he earned his medical degree on March 10, 1855. Eschewing the chance for a lucrative practice in the States, he returned home to Cuba to begin his career.

### **Scientific Inquiry**

Establishing a general medical and ophthalmology practice in Havana, Finlay spent much of his free time on scientific investigation, including the study of yellow fever. He was appointed to work with the U.S. National Health Board Yellow Fever Commission when it traveled to Cuba in 1879. The commission found that "the agent capable of transmitting the disease must be in the air." That conclusion and microscopic slides of tissue from yellow fever victims led Finlay to focus on the blood vessels and the biting insect that accesses them.

### **A Hypothesis Scored**

On August 14, 1881, Finlay presented a paper to Havana's Academy of Sciences called "The Mosquito Hypothetically Considered as the Transmitting Agent of Yellow Fever," concluding: "I understand but too well that nothing less than an absolutely incontrovertible demonstration will be required before the generality of my colleagues accept a theory so entirely at variance with the ideas which have until now prevailed about yellow fever." He was correct about that, as evidenced by the stony silence that followed his presentation and the "universal ridicule" he received thereafter, as his son would recall. Finlay spent the next 20 years trying to prove his hypothesis, conducting 102 experimental inoculations on human volunteers. But his mosquito theory would not gain acceptance until the dawn of the new century.

### **Conclusive Results**

Arriving in Cuba in 1900, members of the U.S. Army Yellow Fever Board visited Finlay at his home in Old Havana. They used mosquitoes hatched from his eggs to test the hypothesis that the insects transmitted the disease and after [a series of experiments](#), showed that Finlay had been correct. The head of the board, [Walter Reed](#), noted that "it was Finlay's theory, and he deserves much for having suggested it." William Crawford Gorgas, who later spearheaded a public health campaign that protected the Panama Canal project from the disease, said of Finlay: "His reasoning for selecting the *Stegomyia* [mosquito] as the bearer of yellow fever is the best piece of logical reasoning that can be found in medicine anywhere."

### **Celebrated in Cuba**

Finlay was subsequently appointed chief sanitary officer of Cuba, a position he held into his 70s until his retirement in 1909. During that period, his work contributed to a reduction in the country's mortality rate of infantile tetanus. After his death on August 20, 1915, his achievements lived on in Cuba, which produced a flattering biography in 1985, requested by Cuban president [Fidel Castro](#), and with the Finlay Medical Society, an organization of medical professionals.

### **PEOPLE, Chapter 2: Walter Reed (1851-1902)**

Walter Reed is known today for the Army medical center that bears his name. But a century ago he was known as the Army officer who helped defeat one of the great enemies of the time: yellow fever.

#### **Precocious Student**



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The youngest of five children, Reed was born on September 13, 1851, in Gloucester County, Virginia. His father, a pastor, moved frequently to minister to different parishes, later settling his family in Charlottesville, near the University of Virginia. Under the tutelage of an older brother at the university, Reed enrolled there and graduated at age 17 with a medical degree on July 1, 1869. He remains the youngest graduate in the history of the university's medical school.

#### **City Doctor**

Reed earned a second M.D. a year later at the Bellevue Hospital Medical College in [New York City](#). In 1873 he gained a position as assistant sanitary officer for the Brooklyn Board of Health, sparking his interest in the public health field. Yet he grew to dislike urban living, as he wrote to his future wife, Emilie Blackwell Lawrence of North Carolina: "I have been unable to discover the great advantages of living in Metropolitan Cities, except it be in the 'wear and tear.'" The Army would give him the chance to go far away.

#### **Frontier Medicine**

On February 8, 1875, Reed began a grueling 30-hour exam for entry into the Medical Corps of the U.S. Army. One of the essay questions dealt with a pressing medical issue of the day, yellow fever. He noted the disease's prevalence in Havana and wrote that it could be spread "[e]ither by germs clinging to clothing or in cargo of ship -- or by a person who is ... sick of the disease being transported to a non-infected [location]." Reed passed the exam and accepted a commission on July 2, 1875. He was later assigned to several remote outposts, including in Arizona and Nebraska, where he was the only doctor for as much as a 200-mile area. At these postings, his wife gave birth to two children, Walter Lawrence and Emilie, most likely delivered by their father. After practicing frontier medicine for 15 years, Reed chose a different path, which would take him to Havana to fight the disease he was tested on as a young Army hopeful.

### **Back to School**

Returning to the East Coast in 1893 from his last Western appointment, Reed joined the faculty of the Army Medical School in Washington, D.C. Promoted to major, he served as professor of clinical and sanitary microscopy. He researched diseases such as cholera, typhoid, malaria, and yellow fever, taking him on a trip to Key West to study a smallpox outbreak in 1896 and throughout the southeastern United States studying typhoid in 1898-99. His work inspired Army Surgeon General George Sternberg to tap Reed to lead a board charged with the study of infectious disease in [Cuba](#).

### **Breakthrough**

After arriving in Havana in late June 1900, Reed and fellow members of the U.S. Army Yellow Fever Board conducted [experiments](#) on human subjects to find the cause of yellow fever. Reed lamented the loss of his colleague [Jesse Lazear](#) to the disease but celebrated the discovery that the mosquito was the transmitting agent. On New Year's Eve at the turn of the century, he wrote to his wife: "[I]t has been permitted to me and my assistants to lift the impenetrable veil that has surrounded the causation of this most dreadful pest of humanity and to put it on a rational and scientific basis. ... The prayer that has been mine for twenty or more years, that I might be permitted in some way or sometime to do something to alleviate human suffering has been answered!"

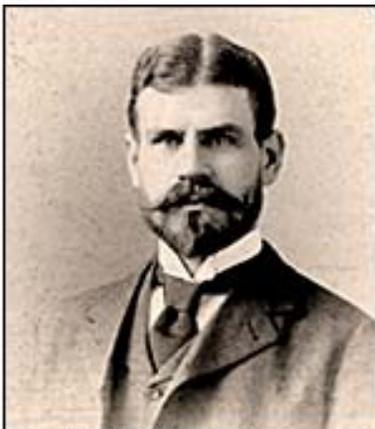
### **Honors and Tragedy**

In recognition of his work on yellow fever, Reed received honorary degrees from the University of Michigan and Harvard University. The secretary of war noted in his annual report that he would ask the president to appoint the Army major an assistant surgeon general with the rank of colonel. But in November 1902, Reed fell ill. Admitted to an Army hospital, he died on November 23 from peritonitis that developed after his appendix ruptured. The inscription on his burial marker at Arlington National Cemetery quotes his honorary degree from Harvard: "He gave to man control of that dreadful scourge yellow fever." His name would in 1909 adorn a new Army hospital that later grew to the Walter Reed Army Medical Center.

## **PEOPLE, Chapter 3: Jesse Lazear (1866-1900)**

When Jesse Lazear died from yellow fever, he left a wife, a newborn child, and an infant. He also left a lasting contribution to the scientific understanding of the disease.

### **Path to Cuba**



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Born in Baltimore County in 1866, Lazear graduated from the city's Johns Hopkins University in 1889. Three years later, he earned his M.D. from Columbia University in New York. Aristides Agramonte, a classmate with whom he would serve on the U.S. Army Yellow Fever Board, called him "the type of the old southern gentleman, kind, affectionate, dignified, with a high sense of honor,

a staunch friend and a faithful soldier." After studying abroad, Lazear married his wife Mabel in 1896. He joined the medical staff of Johns Hopkins Hospital, teaching and researching in the laboratory of clinical pathology. The work spurred him to further his study of malaria and yellow fever. He found the opportunity with the U.S. Army.

### **On Track of the "Real Germ"**

With the title of acting assistant surgeon with the U.S. Army Medical Corps, Lazear reported for duty to Camp Columbia, Cuba, in February 1900. He proceeded to study the bacteriology of tropical diseases, particularly malaria and yellow fever. In May, a new board was created to study such diseases on the island. Lazear became one of its four members -- the only one with experience in mosquito research. He began growing mosquito larvae from the laboratory of [Dr. Carlos Finlay](#), who had long argued that mosquitoes transmitted yellow fever. In Lazear's breakthrough discovery, mosquitoes that had fed on an active case of yellow fever 12 days before did indeed transmit the disease to two volunteers during [experiments](#) in late August. "I rather think I am on the track of the real germ," Lazear wrote on September 8, 1900.

### **Final Sacrifice**



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About a week later, Lazear fell ill. He had not told his colleagues that he experimented on himself but notes he took at the time gave evidence that he did. Lazear died of yellow fever on September 25, 1900, at age 34. "He was a splendid, brave fellow," wrote [Walter Reed](#), the head of the Yellow Fever Board, "and I lament his loss more than words can tell; but his death was not in vain. His name will live in the history of those who have benefited humanity." In tribute to their fallen comrade, members of the Yellow Fever Board in November opened "Camp Lazear," where follow-up experiments cemented the link between mosquitoes and yellow fever. Today Lazear is remembered in the place he began his career, with a brass plaque at Johns Hopkins Hospital commemorating his sacrifice: "With more than the courage and devotion of the soldier, he risked and lost his life to show how a fearful pestilence is communicated and how its ravages may be prevented."

## **EVENTS, Chapter 1: Epidemic in Philadelphia, 1793**

In 1793 [Philadelphia](#) was the nation's largest city and its capital, home to prominent citizens like [Thomas Jefferson](#), [George Washington](#), and [Alexander Hamilton](#). It was also the site of the most fearsome epidemic to strike the young nation.

### **The First Cases**

Dr. Benjamin Rush, one of the city's most prominent physicians and a signer of the [Declaration of Independence](#), was called to the home of Dr. Hugh Hodge on August 5. Hodge's young daughter was jaundiced, suffering from a high fever, and vomiting blood. She died that day. Over the next two weeks, Rush saw many more patients with the same [symptoms](#), several of whom also died. On August 21, he told Mayor Matthew Clarkson that unsanitary conditions in the bustling city were causing a yellow fever epidemic.

### **Conflicting Theories**

Not everyone agreed on [the cause](#). While Rush determined that the illness originated locally, the governor blamed foreigners from the West Indies. Other doctors argued that the disease had arrived on boats from the Caribbean and supported a quarantine of the vessels and passengers. Doctors also disagreed about treatment, with some advocating bleeding and purging while others proposed milder remedies such as teas and cold baths. Regardless, nothing was working to stem the crisis.

### **"Quit the City"**

The mayor convened the College of Physicians, which on August 27 advised people to avoid infected cases if possible and keep the streets clean, among other measures. Rush beseeched all "that can move, to quit the city." About 20,000 people fled, including George Washington, who explained that "as Mrs. Washington was unwilling to leave me surrounded by the malignant fever which prevailed, I could not think of hazarding her and the Children any longer by my continuance in the city, the house in which we lived being, in a manner, blockaded, by the disorder." Thomas Jefferson observed: "Everybody who can, is fleeing from the city, and the panic of the country people is likely to add famine to the disease." Treasury Secretary Alexander Hamilton left also but not before contracting the disease. He recovered but as he fled to Albany was treated as an outcast, a treatment typically afforded sick refugees.

### **Fear Rushes In**

As the deadly disease spread, Irish American publisher Mathew Carey chronicled the reaction of city residents who remained: "The consternation of the people of Philadelphia, at this period, was carried beyond all bounds. Dismay and affright were visible in almost every person's countenance." Acquaintances and friends avoided each other in the street, he noted. In some households, family members were banished into the street when they complained of a headache, a common precursor to yellow fever. "Parents desert their children as soon as they are infected," lamented Rush, "and in every room you enter you see no person but a solitary black man or woman near the sick."

### **Serving the Afflicted**

Indeed, most of the black residents of Philadelphia remained in the city and helped the stricken white residents. Members of Philadelphia's African Society, who held the common belief that black people were immune to the disease, offered their services to the mayor, fulfilling many responsibilities abandoned by white residents. The mayor would later write of the volunteer effort among black residents: "Their diligence, attention and decency of deportment, afforded me, at the time, much satisfaction." The belief in immunity turned out to be unfounded; 240 black residents died of yellow fever.

### **A Welcome Frost**

On September 12, Mayor Clarkson warned a group of citizens that the city was approaching anarchy. At the time, the epidemic was worsening, with deaths ranging from 67 on September 16 to 96 on September 24. The city's burial grounds were nearly filled. Meanwhile, cities in surrounding states established quarantine houses or roadblocks to stop Philadelphians from entering. October brought higher death tolls but also relief. At the end of the month, a welcomed frost, which had been known to end previous epidemics, arrived. On October 31, a white flag flew over the city hospital, signifying that no yellow fever patients remained. The disease caused an estimated 5,000 deaths that year in Philadelphia, about a tenth of the residents of the city and its suburbs.

## **EVENTS, Chapter 2: 1878 Epidemic**

There were comparatively few cases of yellow fever during the Civil War. Peacetime brought a boom of trade as improved rail service and shipping allowed people and goods -- as well as disease -- to travel easily in the united nation. By 1878, conditions were ripe for a powerful epidemic of yellow fever in the Mississippi Valley.

### **Seeds of an Epidemic**

The beginning of the year presaged trouble. In the spring, yellow fever cases were high in the Caribbean, in particular in Cuba. There, thousands of refugees fled the island after the end of a war of independence from Spain. Many came to New Orleans. On April 26, President [Rutherford B. Hayes](#) signed the Quarantine Act of 1878 into law, giving the Marine Hospital Service responsibility to stop disease from coming ashore via sailors from ships.

### **The Beginning**

In an attempt to stop the disease from entering New Orleans, a quarantine station on the Mississippi River south of the city inspected incoming ships. The *Emily B. Souder* arrived there in late May. One ill sailor, diagnosed with malaria, was removed from the ship. The ship was fumigated and cleared to dock in New Orleans. The night the ship docked, a crew member fell sick and died; another died four days later. When the *Souder* left to return to Havana, another ship, the *Charles B. Woods* arrived. Within six weeks every member of the families of the *Woods'* captain and engineer had contracted fever. They recovered, but a 4-year-old girl living in the same neighborhood died in July -- the first official fatality from yellow fever recorded that year in New Orleans.

### **Spread of the Disease**

The news that yellow fever had again hit New Orleans drove one-fifth of the city's population to leave, leaving streets and businesses barren. "Only our mosquitoes keep up the hum of industry," reported the *New Orleans Picayune*. Physicians who cared for victims watched helplessly as their patients died; attempted treatments with bloodlettings, carbolic acid, and doses of quinine proved useless. The state board of health declared an epidemic on August 10, after 431 reported cases and 118 deaths. But the epidemic was not contained to New Orleans. On July 27, a towboat dropped two crew members with yellow fever in Vicksburg, Mississippi. Another infected crew member died on the boat that night. In August, 100 cases of yellow fever were reported in Grenada, Mississippi, about 100 miles south of Memphis.

### **Trauma in Memphis**

In response to the spreading epidemic, the mayor of Memphis on July 28 imposed a quarantine, which blocked railroad lines. Local businessmen threatened a lawsuit unless the city released a train of goods from New Orleans. City leaders allowed the shipments to enter. In early August, a steamboat crew member who had avoided the quarantine died in a Memphis hospital. On August 13, a local resident who operated a food stand near the riverfront died from yellow fever. As in New Orleans, Memphis residents fled when they heard the news, an estimated 25,000 to 27,000 out of 47,000, traveling to rural areas or north and east away from the river. While some places accommodated them, others established "shotgun barricades," with armed men insuring that no one would enter their towns. The disease would travel with fleeing refugees as far away as Kentucky, Indiana, Illinois, and Ohio.

### **The Toll**

Those who remained in Memphis relied on volunteers from religious organizations to tend to the sick. The madam of a local brothel, Annie Cook, helped out by converting her place of business to a hospital, where she nursed the stricken. She died from the disease in September. By the end of the year, more than 5,000 were confirmed dead in Memphis. The New Orleans health board listed "not less than 4,600" dead. The Mississippi Valley experienced 120,000 cases of yellow fever, with 20,000 deaths.

### **The Aftermath**

In New Orleans, the city's Medical and Surgical Association argued for improved drainage and sanitary measures to quell future yellow fever outbreaks. Such efforts, though they were undertaken to eliminate germs, helped to remove the breeding grounds for mosquitoes, and New Orleans never again experienced the scope of the 1878 epidemic. The \$15 million in losses caused by the epidemic bankrupted the city of Memphis. The federal government convened a commission to investigate the outbreak and established the National Board of Health in 1879. In a report to Congress shortly before the national agency was created, John Woodworth, the Marine Hospital Service surgeon general, emphasized the gravity of the situation: "Yellow fever should be dealt with as an enemy which imperils life and cripples commerce and industry. To no other great nation of the earth is yellow fever so calamitous as to the United States of America."

## **EVENTS, Chapter 3: Scourge of the Spanish American War**

On February 13, 1898, the USS *Maine* exploded in a Havana harbor, killing 268 U.S. seamen. Blaming the country that controlled Cuba, the United States on April 25 declared war against Spain. U.S. troops then prepared to descend on an island where tropical diseases would prove to be their greatest enemy.

### **Warning Signs**

[Yellow fever](#) was first reported in Cuba in 1649, when one-third of Havana residents died from the disease. From 1856 to 1879, the disease struck the city nearly every month. Foreign occupiers were particularly susceptible: an estimated 16,000 Spanish troops died from yellow fever between 1895 and 1898. At the onset of war with the United States, illness had decimated the Spanish fighting force, with 55,000 troops out of an army of 230,000 healthy enough to fight. U.S. officials were aware of the dangers from disease. Army Major [Walter Reed](#), a physician who would later head the U.S. Army Yellow Fever Board in Cuba, offered advice to a friend who expected to be deployed there. Surmising that the germ for yellow fever was inhaled, Reed wrote that a "plug of cotton in the nostrils would be advisable."

### **Invasion**

Despite knowing that yellow fever was most likely to strike in the summer rainy season, the U.S. invaded Cuba on June 22, when the Fifth Army Corps landed at Daiquiri. U.S. forces vanquished Spanish troops on the road to Santiago, but Lieutenant Colonel [Theodore Roosevelt](#) of the Rough Rider unit foresaw the dangerous conditions in a letter to Secretary of War Russell Alger: "If we are kept here it will in all human possibility mean an appalling disaster, for the surgeons here estimate that over half the army, if kept here during the sickly season, will die." But Alger ordered the troops to hold their ground in Santiago until Spanish forces surrendered. They did on July 17, but the damage had already been done.

### **Battle Against Disease**

Fewer than 400 American soldiers were killed in combat during the war. But more than 2,000 contracted yellow fever during the campaign. Disease, said General William Shafter, was a "thousand times harder to stand up against than the missiles of the enemy." On July 6 in the town of Siboney, the first case of yellow fever among U.S. troops occurred. For the next several weeks, more troops were struck by malaria and dysentery. Yellow fever began to spread, which officers and doctors blamed on infected buildings in Siboney. In response, General Nelson Miles ordered Siboney evacuated and burned on July 11. An infantry unit of black soldiers, thought to be immune from yellow fever, were brought in to tend to the afflicted. More than a third of their regiment died from yellow fever or malaria.

### **Infection in Camps**

Meanwhile, troops stationed away from the fighting also faced danger. When the Spanish-American War was declared, thousands of U.S. volunteers entered training camps in the southeastern United States. Though the surgeon general advised soldiers to maintain sanitary conditions, the camps were filthy, leading to a deadly typhoid outbreak. Of 171,000 personnel, 20,700 contracted the disease and more than 1,500 died. The U.S. Army Typhoid Board, lead by Major Walter Reed, was established to study the disaster in August 1898. The board subsequently visited the training camps and outlined sanitary measures for military commanders to follow to protect the troops.

### **The Occupation**

Approximately 50,000 U.S. troops were stationed in Cuba at the conclusion of the war. U.S. officials focused on preventing future outbreaks of yellow fever and other diseases, which were all caused, according to Major William Crawford Gorgas, the chief sanitary officer in Havana, "by filth, dirt, and general unsanitary conditions." Cleanup measures helped control diseases spread by unsanitary conditions such as typhoid and dysentery. But by July 1899, yellow fever returned to Cuba, though to a lesser degree than the previous year. Gorgas later wrote: "The health authorities were at their wit's end. We evidently could not get rid of Havana as focus of infection by any method." In 1900, the U.S. Army established a special board of scientists to investigate the problem. In the end this board would prove, to the surprise and disbelief of many, that a common domestic mosquito spread the disease.

## **EVENTS, Chapter 4: Yellow Fever and the Scientific Method**

Since its first documented case in the 17th century, a great mystery surrounded yellow fever. What was its cause? Theories included "fomites" -- contaminated objects like clothing and bedding from yellow fever patients -- and airborne particles. It took a group of scientists in Cuba at the turn of the 20th century to discover the real answer.

### **In the Air**

The genesis of the discovery took place in 1879. After a yellow fever epidemic had devastated the Mississippi Valley the year before, the U.S. National Health Board Yellow Fever Commission traveled to Cuba to investigate the disease. [Carlos Finlay](#), a physician and scientific investigator in Havana, worked with the commission, which also included George Sternberg. After several months studying the disease in Cuba and in South America, the commission concluded: "Yellow fever is an epidemic, transmissible disease and the agent capable of transmitting the disease must be in the air." Following his assignment on the commission, Finlay theorized from his study of microscopic slides of tissue from yellow fever victims that the disease must be spread through the blood vessels. By 1881 Finlay had fixed on mosquitoes as the cause, but his theory was largely dismissed.

### **More Deadly Than War**

After the [Spanish-American War](#) of 1898, during which far more U.S. troops died from yellow fever than in battle, another board came to Cuba in 1900 to study the disease. [Walter Reed](#), an Army major and physician, headed the United States Army Yellow Fever Board, whose members visited Finlay and heard his theory of mosquito transmission. The board could find no other solution, so members decided to test Finlay's theory. There was only one way to do it, Reed believed. "Personally, I feel that only can experimentation on human beings serve to clear the field for further effective work," Reed told Army Surgeon General George Sternberg.

### **Infection**

Board member [Jesse Lazear](#) hatched Finlay's mosquito eggs for the experiments. He took the insects to Las Animas Hospital in Havana to "load" them with the infected blood of yellow fever patients. The mosquitoes then fed on volunteers nine times from August 11 to August 25, with no infections resulting. On August 27, Lazear placed a mosquito on fellow board member James Carroll and four days later on a soldier volunteer. Both of them contracted yellow fever. The mosquito that had bitten the men differed from the mosquitoes in the earlier experiments in one important respect: The insect that transmitted the disease had fed on a yellow fever patient at least 12 days before and had been incubating her deadly cargo. Both men recovered. Lazear, who had probably exposed himself to an infected mosquito as well, did not. He died from yellow fever on September 25, 1900.

### **Camp Lazear**

Upon his return to Cuba on October 4 from a trip to Washington, Reed was determined to substantiate his late colleague's work. Skepticism remained. When Reed presented the transmission theory before the American Public Health Association on October 23, the *Washington Post* called it "silly and nonsensical." Based on information in Lazear's notebook about the incubation period of the mosquitoes that transmitted the disease, in November Reed sought further proof in an isolated spot outside Havana he called Camp Lazear. Paid volunteers were isolated in separate buildings. One contained "fomites" from yellow fever patients. Volunteers who stayed in this building remained free of the disease. The other building was sterilized, but contained infected mosquitoes that bit volunteers. Several of them contracted yellow fever (all recovered).

### **Final Proof**

Describing the experiments to his wife in a letter on December 9, Reed wrote: "[W]e have succeeded in demonstrating this mode of propagation of the disease, so that the most doubtful and skeptical must yield." Reed presented "The Etiology of Yellow Fever" to the Pan-American Medical Congress in Havana on February 6, 1901. Subsequent efforts to eliminate mosquitoes in Havana resulted in the near immediate

cessation of the disease that had long plagued the city. It was the final piece of evidence that the mosquito theory was indeed correct.

## **EVENTS, Chapter 5: Epidemic in New Orleans, 1905**

In 1905 the final yellow fever epidemic in the United States took place in New Orleans, the city that had seen some of the nation's worst outbreaks. Though the danger of mosquitoes transmitting the disease had been established in 1900, five years later the city was still unprepared.

### **A Deadly Breach**

At the time, New Orleans continued to operate a quarantine system, fumigating ships and sanitizing clothing and bedding on board. In the spring, a smuggler's ship loaded with bananas avoided the quarantine. In June cases of yellow fever began appearing near the Mississippi River in an Italian immigrant community, many of whom unloaded banana boats from Central America. The city declared an emergency on June 22, after 100 people had contracted the disease, including 20 who died.

### **Breeding Ground**

Despite the conclusions of the U.S. Army Yellow Fever Board in 1900, many people in New Orleans still did not take the threat of mosquitoes seriously. Residents got their water from wooden cisterns, a breeding ground for the insects. Dr. Quitman Kohnke, the head of the New Orleans health board, beseeched the city to address the mosquito issue. "Even if you are not positive that the mosquito is the only source of the transmission of yellow fever," he told physicians, "give your city the benefit of the doubt in this important and vital matter." After the outbreak began, New Orleans finally mobilized.

### **Attacking the Mosquito**

On August 4, local officials asked for federal assistance, and President [Theodore Roosevelt](#) assigned Walter Wyman, the surgeon general of the U.S. Public Health and Marine Hospital Service, to the public health campaign. Workers employed the techniques that had recently proved successful in [Havana](#), another frequent location of yellow fever. They fumigated the city, screened cisterns and destroyed breeding grounds for mosquitoes. Fines were instituted against residents who failed to comply with public health measures. After Archbishop Placide Louis Chappelle died from yellow fever, holy water in St. Louis Cathedral was found with mosquito larvae. The priests emptied the containers. Still, the epidemic was not immediately stopped.

### **The Last Throes**

On August 12, 100 people fell ill from the disease. Yet by September the numbers of victims diminished. Further evidence that mosquitoes transmitted the disease surfaced at Charity Hospital, which reported that no other patients or medical personnel became infected from the approximately 100 cases of yellow fever treated there. The public health campaign to address yellow fever was working in a city that fewer than 30 years before had lost thousands to the disease. October would mark the end of the epidemic, with 452 deaths recorded in New Orleans. The year would also mark the last time a yellow fever epidemic plagued the United States, though the disease [remains](#) a problem elsewhere in the world.

## **EVENTS, Chapter 6: Yellow Fever in the 20th Century and Today**

In the 20th century, a vaccine for yellow fever was developed to protect people in regions where the disease still flourishes. Epidemics continued, however, during every decade of the century, and cases still surface to the present time.

### **The Panama Canal**

Soon after the discovery that mosquitoes transmit yellow fever, Major William Crawford Gorgas put the information to work in Cuba and later in the Panama Canal Zone. A previous French attempt to build the canal ended in disaster when disease, particularly yellow fever and malaria, incapacitated thousands of project workers. Gorgas, the sanitation chief in Cuba during the U.S. occupation, fumigated against mosquitoes and rid the area of standing water, leading to a healthy workforce and successful project. But while the opening of the [Panama Canal](#) in 1914 eased travel throughout the world, it also increased the possibility of spreading disease.

### **Path to a Vaccine**

After he became surgeon general of the Army in 1914, Gorgas met with Dr. Wickliffe Rose of the [Rockefeller Foundation](#), which subsequently focused on eradicating yellow fever from the world. Rockefeller researchers traveled to yellow fever hotspots such as South America and Africa. Several of them died from the disease. One researcher, Dr. Alexander Mahaffy, discovered in 1927 that yellow fever could be transmitted and studied in animals. A Harvard scientist, Max Thieler, showed in 1930 that mice were susceptible to the yellow fever virus. Using mouse and chick embryos, Thieler later developed the most effective vaccine against yellow fever, called 17D, which immunized U.S. soldiers during [World War II](#) and became the world standard. The achievement won him the Nobel Prize in Medicine in 1951.

### **Outbreaks Continue**

For the last 50 years, yellow fever has centered around South America and Africa, the only two places where it occurs today. Jungle yellow fever struck Central America in the 1950s and 1960s, and South America has experienced scattered outbreaks since then. Africa has seen the worst outbreaks, including epidemics in Central and East Africa between 1958 and 1966 that killed thousands of people. Hundreds died in a Ghanaian epidemic in the 1970s while Nigeria suffered thousands of fatalities from the disease in the 1980s. Other cases occurred in the 1990s, and in 2003, the World Health Organization cited new cases in West Africa and southern Sudan which caused at least 60 deaths. Immunization efforts in some French-speaking African countries between 1933 and 1961 resulted in the gradual disappearance of the disease there.

### **Current Status**

Between 1996 and 2002, five people from the United States and Europe who traveled to South America or Africa contracted yellow fever and died. They were all unvaccinated. The Center for Disease Control and Prevention estimates that several hundred cases of yellow fever still occur each year, though because of underreporting the number could be much higher. Large populations remain unvaccinated and some health officials fear more instances of the disease. Vaccination, which is generally safe, and avoiding mosquito bites are the best preventive measures against yellow fever.

To date, there is no treatment or cure for yellow fever.