Epilogue

The Secret of the Yellow Death: A True Story of Medical Sleuthing

- 1. After December 31, 1900, the battle against yellow fever continued.
- 2. As soon as the results of the Reed team's work were known, public health officials launched an all-out campaign against the mosquitoes that carried the disease. In the United States and Cuba a virtual army of sanitation workers used poison fumes to kill mosquitoes that lurked in buildings and wiped out eggs by spraying oil on the pools, ponds, puddles, and containers of

still water where the insects liked to breed. Killing the mosquitoes killed the yellow fever germs the insects carried, and by the end of 1901 there were no cases of the illness in Havana, Cuba. By 1905 the United States was free of the disease. And between 1902 and 1914 thanks to an effective battle against germ-bearing mosquitoes in Central America—U.S. workers were able to safely build the Panama Canal.

- 3. As the threat of yellow fever gradually receded, people showered Dr. Finlay and the Reed team scientists with honors, thanks, and praise. Statues of Carlos Finlay were set up in Cuba. A medical society and an American elementary school were named after him; and—though he never won—Dr. Finlay was nominated for one of science's greatest awards, the Nobel Prize in medicine, three times before his death in 1915.
- 4. Although Walter Reed died of appendicitis in 1902, soon after his return from Cuba, he, too, became a hero. Researchers adopted Reed's belief that all volunteers in scientific experiments should be fully informed of all the risks. In 1909 the American government named the Walter Reed Army Hospital in Washington, D.C., after the team's chief investigator. And in 1929, Congress awarded all the American volunteer scientists (including Dr. Jesse Lazear) one of the nation's highest honors, the Congressional Gold Medal, for their work on yellow fever.





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5. But while people and governments were honoring past work on the illness, twentieth-century scientists were looking for new ways to fight the terrible disease. Until his death in 1907, Dr. James Carroll continued to search for the yellow fever germ. Although his efforts were unsuccessful, Carroll ultimately came to believe that the disease is caused by a microbe that is much smaller than bacteria. Dr. Aristides Agramonte, who taught bacteriology in both the United States and Cuba before his death in 1931, tended to agree. And by 1927 scientists knew that the disease was produced by a virus—an extremely tiny, extremely simple microorganism that is so much smaller than bacteria, it cannot be seen with an ordinary microscope.



Scientists infecting while mice with yellow fever. Studying the disease became easier after researchers learned that white mice could get yellow fever if the virus was injected directly into their became

- 6. Once scientists had identified the virus, the next step was to make a vaccine that would prevent people from getting the disease. That, however, proved difficult. Although researchers worked on the problem, progress was slow until scientists discovered two facts that the Reed team had not known. In the late 1920s and early 1930s researchers learned that some types of monkeys could actually get yellow fever and that, under special conditions, the virus could sometimes be grown inside the bodies of ordinary white laboratory mice. Using animals made experimental work much easier; and, finally, in 1936, Dr. Max Theiler developed a vaccine that safely kept humans from getting the disease.
- 7. Research also continued on other fronts; and, during the twentieth century, scientists answered many of the questions about the cause and spread of yellow fever that had puzzled earlier investigators. Researchers learned that an infected female mosquito can pass the virus on to all her offspring through her eggs. They found that the yellow fever virus actually enters every cell of an infected mosquito's body. And they discovered that a female mosquito transmits the disease by dripping infected saliva into the wound while she is sucking blood.
- Additional investigation uncovered more facts, and scientists soon realized that a mosquito must bite a yellow fever patient in the first three days of the illness in order to pick up the infection. They also learned that the virus may have to remain in the



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insect's body for as much as seventeen days before the bug can infect a person with the disease. To scientists, this information was particularly interesting because it explained why some of the Reed team's volunteers did not come down with yellow fever after being bitten. In some cases, it was clear that the team's mosquitoes weren't carrying the germ because they hadn't bitten yellow fever victims during the crucial three-day infectious period at the beginning of the illness. In other instances, volunteers did not get sick because the germ was not allowed to stay inside the host mosquito long enough.

- 9. Today, researchers believe that the yellow fever virus originated in West Africa and was brought to the Americas by slave ships carrying infected insects. They also know that the germ still lurks in the dense jungles of Africa and South America, where it infects monkeys and is carried by mosquitoes who transmit it to endless generations of offspring through their eggs.
- 10. Vaccination programs and mosquito extermination programs have slowed the spread of yellow fever, but it is impossible to completely eliminate the virus. Many poor countries cannot afford to pay for the lifesaving vaccine, and some people now believe that insecticides should not be used to kill mosquitoes because these poisons may damage the environment.
- 11. At this moment there is still no cure for yellow fever, and deadly outbreaks of the disease can still occur. In the early 1960s, 30,000 people died during a yellow fever epidemic in Ethiopia. The illness continues to plague people in parts of Africa and South America. Only three companies—in France, Brazil, and Senegal—now rank as approved yellow fever vaccine producers and demand is sometimes high. When the government of Paraguay failed to provide enough vaccine during a 2008 outbreak of the fever, desperate people mobbed clinics, yelling, "Vaccinations! Vaccinations!"





Protograph of the yellow fever vinas (the small protes) taken with an electron microacope. Verses a so much smaller than beclerie that they can be seen only with an electron microscope capable of magnifying chiects at least 190/000 times.

12. In the twenty-first century yellow fever is still one of the many diseases that threaten humans, and doctors are still trying to develop new ways to combat the illness. Some, but not all, modern research can be done with laboratory animals. For that reason, in countries around the world, many scientists and many ordinary people—like those who worked with Reed—are now knowingly risking possible illness, injury, or even death in order to voluntarily participate in experiments that test new vaccines, new treatments, new medical techniques, and new drugs that may one day benefit humanity.