Gorgas Develops Effective Methods for Controlling Mosquitoes

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GORGAS DEVELOPS EFFECTIVE METHODS FOR CONTROLLING MOSQUITOES

Category of event: Medicine
Time: 1904-1905
Locale: Panama Canal Zone

Employing recent discoveries on the role of mosquitoes in the transmission of malaria and yellow fever, Gorgas applied strict sanitary controls within the Panama region, thereby enabling construction of the canal

Principal personages:
WILLIAM CRAWFORD GORGAS (1854-1920), an American army surgeon and sanitarian who was appointed, in 1904, the Panama Canal Commission's chief sanitary officer and eliminated yellow fever within two years
SIR RONALD ROSS (1857-1932), an English physician who proved conclusively that mosquitoes transmit malaria; awarded the 1902 Nobel Prize in Physiology or Medicine for investigations of the parasite and its various stages in mosquito's salivary glands
WALTER REED (1851-1902), a bacteriologist who was largely responsible for the eradication of yellow fever in Havana by screening patients and by waging a war on the mosquitoes that transmitted the disease
JOHN FRANK STEVENS (1853-1943), the chief engineer of the Isthmanian Canal Commission who played a crucial role in the design of the canal

Summary of Event
With the discovery of gold in California in 1848, considerable interest quickly developed in the United States concerning the construction of a transoceanic canal through Central America that would shorten the time and distance then necessary to travel from the East to West coast. Flushed with his success in building the Suez Canal during the 1860's, Ferdinand de Lesseps of France initiated efforts in the 1870's to construct such a canal by organizing the necessary financial backing and arranging for preliminary surveys. After evaluating a number of potential routes, de Lesseps and the leaders of his Panama Canal Company decided upon a sea-level canal cutting through the narrow Panamanian isthmus between Colón and Panama City. It was initially envisioned that the proposed canal would be 9 meters deep, 30 meters wide, and that it would cost a total of 658 million francs to build.

The challenges facing the highly skilled French engineers arriving in Panama at the start of the project, in 1881, were formidable. They included the taming of the unpredictable Chagres River and excavation difficulties at Culebra, where geological formations resulted in a continual problem with slides. Yet, the most difficult and,
indeed, insurmountable obstacle confronting French engineers and workers during the 1880's was the high incidence of various diseases, especially malaria and yellow fever. In 1889, a virtual epidemic on several occasions decimated the work force and ultimately ended de Lesseps' venture. After eight years in Panama, the French had lost an estimated two thousand workers to yellow fever and more than fifty-five hundred to other illnesses. A second brief attempt at continuing excavations ensued during the 1890's; but, in the end, de Lesseps and the French had failed. The episode was a tragic testimony to a misguided, optimistic faith in science and technology that was incommensurate with the realities of the project.

Despite these failures, American interest in the canal intensified after the Spanish-American War. Beginning in 1904, the United States embarked on a canal construction program that succeeded where the French had not; the reason for this achievement can be traced to advances in tropical medicine related to the eradication of malaria and yellow fever.

Throughout the nineteenth century, most physicians thought that diseases were spread by odors; Panama, with its abundance of decomposing vegetation, filth, and decomposing animal carcasses, possessed conditions that supported this idea. This so-called miasma theory of disease was gradually refuted. In the case of malaria, it was disproved by the English physician, Sir Ronald Ross, working in isolated Secunderabad, India. During the late 1890's, Ross showed that the Anopheles mosquito spread the disease after it had fed on an infected patient, and he carefully investigated the malaria parasite, Plasmodium falciparum, in the mosquito's stomach and salivary glands. It became obvious to Ross that in order to stamp out malaria, one had to isolate the mosquito from those infected; his sanitary ideas were systematically outlined in his Mosquito Brigades and How to Organise Them, published in 1901.

Concurrent with the publication of Mosquito Brigades, a team of United States Army doctors, which included Walter Reed and William Crawford Gorgas, were eliminating yellow fever in Havana, Cuba, using similar public health techniques. Reed, borrowing from the work of Cuban physician Carlos Finley, had concluded that only one type of mosquito, Stegomyia fasciata, was responsible for the dreaded "yellow jack." Once the particular pattern of incubation was determined, it was clear that to eliminate yellow fever, one had to prevent the propagation of the insect by keeping the female Stegomyia fasciata from laying its eggs.

Gorgas would employ this theoretical understanding of yellow fever in his practical public health efforts in Havana. Fresh water that had been left standing typically had been present inside the sick rooms of French engineers and workers at the Panama Canal Company hospital at Ancón during the 1880's. Tragically, the water had served as a mosquito-breeding ground. It was immediately disposed of or sealed off with wooden lids or screens. Further, following a suggestion by entomologist Leland O. Howard, water left standing was covered with a thin film of kerosene or oil whenever this method was feasible. In addition, adult mosquitoes were killed by the fumigation of every house in Havana where a case of yellow fever had appeared.
After doors and windows were tightly sealed, sulfur or powdered pyrethrum was burned in pots designed specifically for this purpose.

Reed's discoveries and Gorgas' yellow fever campaign in Cuba were great achievements of the day, and the results of the sanitary program were dramatic. Since the insect had only a ten-day life cycle, the Stegomyia population diminished rapidly. With this significant accomplishment, the stage was set for Gorgas' work in Panama, beginning in 1904. As a deeply religious man, Gorgas had long thought of his life experiences as ordered and ordained by God with the purpose of readying him for this one great task.

Somewhat ironically, Gorgas' success in Cuba was derived from Reed's scientific work; yet, Gorgas had been extremely resistant to the idea that a mosquito transmitted yellow fever. Born in Mobile, Alabama, in 1854, he received his undergraduate education at the University of the South, located in Sewanee, Tennessee, and his medical degree at New York City's Bellevue Hospital Medical College. Interested in medicine more as a means to enter the army than as a profession, Gorgas joined the United States Army Medical Corps in 1880, and he initially served on a number of outposts in the West. With the onset of the Spanish-American War, Gorgas was sent to Cuba on the Santiago expedition, and later to Havana, where he was first placed in charge of yellow fever patients before his appointment as chief sanitation officer.

In 1904, Gorgas was sent to Panama as the Isthmian Canal Commission's chief sanitary officer, charged with the elimination of two major obstacles to the completion of the American project there: malaria and yellow fever. Yet, despite the work of Ross and efforts in Cuba, most of the political leadership in Washington and key members of the commission, including Admiral John G. Walker and Governor George W. Davis, did not believe in the mosquito theory. Gorgas' arguments fell on deaf ears until a deadly epidemic hit the Canal Zone in the spring and early summer of 1905 and the subsequent appointment of John Frank Stevens as chief engineer.

Stevens, a railroad engineer with considerable experience, recognized that if the canal project were to succeed it had to be designed using locks and gates rather than constructed at sea level. Most significant, excavating the Culebra cut hinged upon the removal of dirt using an extensive rail network. Above all, Stevens clearly perceived that before construction could begin effectively, diseases such as yellow fever and malaria had to be eliminated and that Gorgas had to receive unequivocal support. Thus, in 1905, Stevens' engineering department stood behind Gorgas, who now had first priority in terms of men and materials. By the fall of 1905, Gorgas had more than four thousand men engaged in sanitation work, and his budget was increased dramatically. Supplies necessary for the eradication of mosquitoes were ordered and received in unprecedented quantities, including the requisition of 120 tons of pyrethrum powder, 300 tons of sulfur, and 50,000 gallons of kerosene per month. Fumigation pots, screens, buckets, garbage cans, and brushes were soon in abundance; this equipment was used in the subsequent house-by-house campaign. As a result of these efforts, cases of yellow fever in the Canal Zone fell from sixty-two in June, 1905, to twenty-seven in August and one in December, with no further out-
breaks in 1906. By using similar techniques to combat the *Anopheles* mosquito, malaria was reduced, although not totally eradicated, since the species had a much broader range of flight and bred in a more widespread area.

**Impact of Event**

Gorgas’ measures to control the spread of mosquito-transmitted diseases in Panama had both short- and long-term significance. Although malaria proved to be much more difficult to contain than yellow fever, construction on the Panama Canal progressed steadily to its completion and the opening of the waterway to commercial traffic on January 1, 1915. For his pioneering efforts, Gorgas received numerous honors, including honorary degrees from the University of the South, the University of Alabama, Harvard University, and The Johns Hopkins University. In 1907, he was appointed by President Theodore Roosevelt as a member of the Isthmian Canal Commission and the following year was elected president of the American Medical Association. Promoted to the rank of brigadier general and named surgeon general of the United States Army in 1914, Gorgas played an influential role in sanitation work during World War I, retiring in 1918. He then became the director of the yellow fever program for the International Health Board of the Rockefeller Foundation and traveled to Central America and Peru during the last two years of his life. He implemented procedures in other areas that were often subject to periodic outbreaks of yellow fever.

Gorgas’ methods were quickly implemented throughout South America and Africa. Considering the deadly nature of yellow fever, or *vomito negro*, an illness that typically claimed the lives of more than 50 percent of those afflicted, it was remarkable that, between 1910 and 1925, no major epidemic occurred in temperate regions or in the traditional endemic regions located in Ecuador, Mexico, and Brazil. Furthermore, Gorgas’ practical sanitation techniques were subsequently complemented by scientific advances related to yellow fever. In 1918, researchers identified the microbe, *Leptospira ecteroides*, that caused the disease, a minute spiral organism that was studied extensively during the 1920’s.

Perhaps the most enduring legacy to Gorgas’ work is the Panama Canal itself, an undertaking that could not have been completed without his sanitation measures. During the first ten years of operation, between 1915 and 1925, commercial transits increased from 1,072 to 4,673 and tolls from $4.3 million to $21.6 million. Because of the canal, shippers saved almost 12,900 kilometers sailing from New York to San Francisco, and almost 11,300 kilometers from New York to Honolulu. While these figures increased steadily before 1939, it was in the post-World War II era that traffic and tolls escalated dramatically as global trade and a dynamic international economy took on enhanced significance during the last quarter of the twentieth century.

**Bibliography**

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this authoritative and comprehensive work covers the history of the region and canal construction efforts from the Spanish colonial era to the completion of construction. Chapters describing Gorgas' sanitation efforts and the technology employed in the canal's design are extremely detailed. The author often relies on an abundance of tabulated factual data, including expenditures.

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**Cross-References**

Reed Establishes That Yellow Fever Is Transmitted by Mosquitoes (1900), p. 73; Theiler Introduces a Vaccine Against Yellow Fever (1937), p. 1091.