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## Feature

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# William Gorgas, Soldier of Public Health<sup>1</sup>

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**B**y any account, William Crawford Gorgas led a full life. The son of a distinguished Civil War general, he was at various times a barefoot Southern rebel, a simple Army doctor, director of the first successful campaign against yellow fever in Cuba, health manager of the Panama Canal project, U.S. Army Surgeon-General in World War I, and for many years the most revered and respected public health leader in the world.

Unlike most medical luminaries, Gorgas did no research. He just administered. But he managed things so well that he raised the practice of public health administration to a high art and got spectacular results.

His upbringing had a lot to do with it. Gorgas was born near Mobile, Alabama, on 3 October 1854, six years before the outbreak of the U.S. Civil War. His mother, Amelia Gayle, came from a prominent Southern family—her father had been Governor of Alabama, a Congressman, and a U.S. District Judge. Josiah Gorgas, William's father, was a U.S. military officer from Pennsylvania

with a finely honed knowledge of ordnance; at the time of his son's birth he was commanding the federal arsenal at Mount Vernon a few miles from Mobile.

When the Civil War came, Josiah Gorgas joined the Southern cause. Jefferson Davis, President of the Confederacy, recognized his skills (Gorgas probably knew more about munitions than anyone else in the country at the time), commissioned him a Brigadier General, and made him Ordnance Chief of the Southern forces. Accordingly, in 1861 Gorgas and his family moved to the Confederate capital of Richmond, where he served as a key Confederate leader until the South's collapse in 1865.

Partly because of the military example set by his father, young William was combative. He once took on his whole school class using slates as weapons, and he got enough experience from frequent fights to be known later, despite his outward gentility, as a young man extremely handy with his fists.

Probably for the same reason, he was fascinated with things military and loved books about soldiers and battles. His mother, who was quite religious, took pleasure in his intense devotion to Bible-reading—until she found his interest was sparked not by piety but by the Wars of

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<sup>1</sup>This is the third in a series of profiles on individuals who have made outstanding contributions to public health in the Americas.

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the Israelites. For one whole winter he insisted on going barefoot, in sympathy with the ragged Southern troops. And he developed an unswerving determination to become a military officer himself.

An acid test of this youthful military stance came in 1865, when the Confederates abandoned Richmond. At that time the city's stores were to be destroyed; the arsenal, dangerously near the Gorgas home, was to be burned; and General Gorgas was ordered to leave the city with Jefferson Davis and members of the Confederate Cabinet. Before departing, the elder Gorgas reviewed the family's situation with his eleven-year-old son.

Summoning William he solemnly informed him that the safety of his mother and sisters rested in his hands. . . . When a certain building caught fire the boy was directed to lead his mother and sisters to the house of Thomas Bayne, his uncle. He enjoined him especially not to forget the family cow. Soon a considerable part of the city was ablaze; and the sight of the exulting Federal troops coming over the hill added to the excitement. The Gorgas family abandoned their home and started up Cary Street to their appointed refuge; William led the procession, with his invaluable cow tied to a halter; his four little sisters followed, clinging to the skirts of the mother, who held the baby in her arms. The town was full of disorder. . . . Suddenly a terrific explosion took place; the air was full of bursting projectiles; the arsenal had caught fire. Every member of the Gorgas family, except one, bore the shock with coolness; the one that gave evidence of excitement was the cow, which frantically cavorted right and left, pulling its youthful custodian in all directions. Willie, however, persistently held the rope; amid crackling flame and exploding shells, at the corner of Cary and Fifth streets, a fragment of shell hit the excited animal; she gave one spring into the air, hurling William head first against a cobblestone, and so dazing him that, when he regained his composure, the cow had com-

pletely vanished from the history of the Gorgas family. Willie keenly felt his disgrace; he had not fulfilled his father's injunction and he refused to be comforted.

"It's not so bad, Willie," said his mother. "Just think, that shell might have hit your baby brother instead of the cow."

"I thought at the time," Gorgas said afterward, recalling the incident, "that women had a greatly exaggerated idea of the value of babies."<sup>3</sup>

General Gorgas was away for nearly a year, and during that time his family sought refuge in Baltimore, Maryland. As William later said, "I first came to Baltimore a ragged, barefoot little rebel, with empty pockets and an empty stomach. My father had gone south with the army. At the fall and destruction of Richmond my mother's house, with all that she had, was burned, leaving her stranded with six small children. She came to Baltimore and was cared for by friends."<sup>4</sup>

In 1870, following several hard years, General Gorgas was asked to head the newly established University of the South at Sewanee, Tennessee. He accepted and remained there for 10 years.

William entered this new university, where he became a brilliant athlete. At first a poor student, he applied himself to his books toward the end (reputedly after overhearing his father express regret about his careless studies) and finished with high marks. Thereafter he spent a year in New Orleans studying law, a course his father favored, before abandoning law to pursue the military career he himself desired.

At first his path to an officer's commission seemed blocked. In those days virtually all army officers graduated from West Point; admission to West Point re-

<sup>3</sup>M.D. Gorgas and B.J. Hendrick, *William Crawford Gorgas: His Life and Work* (New York: Doubleday, Page, 1924), 39-40.

<sup>4</sup>*Ibid.*, p. 41.

quired an established residence in some state; and by temporarily moving to New Orleans, Gorgas had given up his residence in Tennessee.

Thus denied entrance to West Point but determined to get a commission, he took a surprising step. Physicians had no trouble getting Army commissions in those days, partly because Army doctors were poorly paid and ill-regarded. So Gorgas decided to become a doctor for the specific purpose of procuring a commission.

To this end he began medical studies at Bellevue Medical College in New York City, where he soon became enthralled with medicine and totally absorbed in his studies. He graduated with an excellent record in 1879, served briefly as an intern at Bellevue Hospital, and entered the medical department of the U.S. Army in 1880.

From then until the outbreak of the Spanish-American War in 1898, Gorgas lived the life of an ordinary Army doctor, working at a series of military posts in Texas, North Dakota, and Florida. Physicians often being scarce in those parts, he typically served both post residents and civilians for miles around. He also applied himself to reading medical literature and keeping up with current medical advances. However, the military posts tended to be primitive, and the circumstances of life were limited.

At one of these posts, Fort Brown in Brownsville, Texas, Gorgas had his first major run-in with "Yellow Jack," as yellow fever was then known. In 1882 Fort Brown, neighboring areas of Texas, and portions of Mexico across the adjoining Rio Grande suffered a severe yellow fever outbreak. Gorgas, who had never had the disease and was therefore not immune, was sent there as an advance man for a large medical group that would ultimately treat some 2,300 yellow fever cases.

One of those afflicted was Marie Cook Doughty, sister-in-law of the post commander. She became desperately ill, had the black vomit associated with fatal cases, and was assigned an open grave. Gorgas, who commonly conducted token graveside formalities for the epidemic's victims, arranged to read her burial service. But then, somehow, she began to rally. Meanwhile, Gorgas himself caught yellow fever and was hospitalized. The two went through convalescence together, struck up an acquaintance, and became friends. Three years later they were married.

After his illness, because he was immune, Gorgas was often called when Yellow Jack appeared. Probably for this reason he spent the years from 1888 to 1898 at Fort Barrancas in Pensacola, Florida, a place notorious for yellow fever epidemics, where he developed a reputation in Army circles for skill in treating the disease.

## HAVANA

When the Battleship Maine blew up in Havana Harbor in 1898 and the United States declared war on Spain, Gorgas was ordered to Cuba. Hostilities were brief, and the Spaniards were soon routed. But typhoid fever, malaria, yellow fever, and other ailments attacked the expeditionary force and soon caused more casualties and deaths than all the battles. Yellow fever, well-known for its escalating epidemics and mass slaughter, aroused particular concern.

Gorgas had been assigned to the yellow fever section of a hospital at Siboney, Cuba. He soon assumed command of that hospital, which was one of several such facilities at Siboney. However, a few months later the U.S. command responded to the growing yellow fever danger by burning the whole group of Siboney hospitals and the village of

Siboney to the ground. This decision, which received Gorgas' assent, was based on imperfect knowledge and a conviction that yellow fever was spread by fomites—materials contaminated by yellow fever patients.

Around this time Gorgas caught typhoid fever and went to the United States to recover. He returned to Cuba soon, and early in 1899 became Chief Surgeon for the Department of Havana. Then, following General Leonard Wood's appointment as Military Governor of Cuba in December 1899, he became Chief Sanitary Officer for the City of Havana, a post that placed him at the forefront of the campaign against Yellow Jack.

From the standpoint of the expeditionary force and a growing stream of non-immune Spanish immigrants entering the port of Havana, Yellow Jack posed no idle threat. Cuba, most especially Havana, was yellow fever's main endemic heartland; and while local residents generally contracted mild cases in infancy that rendered them immune to subsequent attack, the same was not true of adults arriving in Cuba without immunity. Sooner or later, such adults could expect to catch yellow fever, and many (25% or more) could expect to die.

Gorgas and his medical colleagues knew that yellow fever epidemics tended to grow fast when they encountered large numbers of nonimmunes. Therefore, they took no particular joy from figures showing that fewer than 250 Havana residents had died from yellow fever in 1898 and 1899, for in those years few nonimmune immigrants had arrived. Rather, they were quite alarmed by 1900 figures showing a major surge of immigration that seemed capable of fueling an explosive epidemic—one that could conceivably devastate the expeditionary force and immigrants alike.

Concerned about this yellow fever

peril and wishing to control other health problems including a raging typhoid fever epidemic, Gorgas applied himself to cleaning up Havana. As already noted, yellow fever was generally considered a filth disease spread by fomites—clothes, bedding, furniture, and other materials associated with yellow fever patients; and so a logical way to prevent yellow fever was to clean the city.

But cleaning Havana was no small matter. The city had never been much on sanitation, and after five years of ruthless internal warfare capped by the Spanish-American conflict, it had become a running sore. "Unspeakable odors assailed one everywhere; streets were filled with decaying vegetables, dead animals, miscellaneous sewage, and refuse of all kinds. The hospitals were so overcrowded . . . that many sick could find no place of refuge and lay stricken in the streets. Children wandered homeless . . . , and everywhere beggars with livid sores pleaded pitifully for alms."<sup>5</sup>

Gorgas set to with a vengeance. Naturally, he took specific steps to contain Yellow Jack—by promptly isolating and quarantining all reported yellow fever cases, providing appropriate burial for victims, and disinfecting the quarantined area after a patient died or recovered.

More impressive, he directed a mammoth general cleanup unlike anything Havana had ever seen. His squads were thorough. They did not just pick up, clean, and scour well-known places. They went into back alleyways and impoverished settlements unknown to average residents and gave them minute attention. They entered yards, homes, offices, stores, factories, if necessary ordering alterations like new plumbing or new drainage, and everywhere enforcing Gorgas' ideas of absolute cleanliness.

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<sup>5</sup>Ibid., pp. 82-83.

About 300 men were employed at this work daily, and not a single building in the entire city of 300,000 souls was overlooked.

The reason that all this did not spark an insurrection seems related to the fact that Gorgas had outgrown his early combative youth. From college onward he had good control over his temper, being generally modest, amiable, and soft-spoken. It may also be supposed that the passage of time and his years ministering to those in need at army outposts had served to strengthen his sensitivity, gentility, and tact—all of which were applied in full measure and set the tone for this project.

One day while work was progressing, a large local woman “. . . her face a mirror of contentment, was seen emerging from the Chief Surgeon's (Gorgas') room; only a few minutes before she had entered, a spectacle of . . . animated fury.”

“What are you so happy about,” someone asked. “At last there's justice in Havana,” she replied, “and the King is in there.”

All that Gorgas had done was talk to her for a few minutes. Certain repairs were necessary to her premises: It was a crime to ask a poor woman to spend so much money! But Gorgas briefly explained why it was necessary, what the health implications of his measures were, and gave her a short and gentle discourse on good citizenship. It was probably the first time she had ever received such consideration from a public officer, and it transformed her into an enthusiastic crusader for Gorgas' work.<sup>6</sup>

The cleanup wrought striking changes. After several months of scrubbing, burning, and disinfection, Havana emerged a great deal cleaner than any other tropical city in the world—almost as spotless as

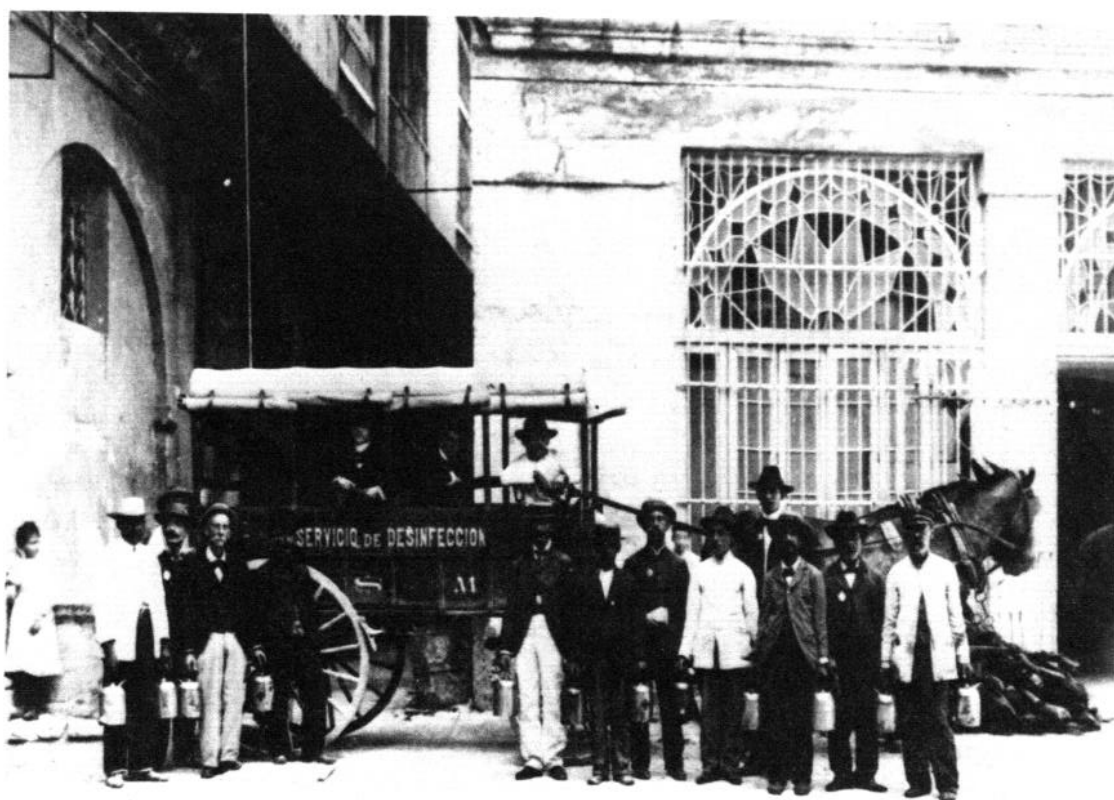
Geneva. In the process the typhoid fever epidemic ended, many other diseases subsided, and general mortality fell sharply—from 34 deaths per thousand Havana residents in 1899 to 24 in 1900.

Unfortunately, none of this affected Yellow Jack. Indeed, as Cubans bemused by the cleanup were fond of noting, the yellow fever death toll rose—from 103 in 1899 to 310 in 1900. In hindsight, the reason is plain enough. Yellow fever was not being transmitted by fomites but by the mosquito then named *Stegomyia fasciata*, now *Aedes aegypti*. That mosquito breeds abundantly in the fresh water held by containers such as rain barrels and flower vases; so although the general cleanup destroyed some of its breeding places, many others remained; and neither the stegomyia population nor Yellow Jack suffered greatly. Instead, the mounting toll of yellow fever deaths suggested that the swelling tide of nonimmune immigrants and foreign troops in and around Havana was close to providing fuel for an immense epidemic that could flare out of control at any time.

In 1900, however, the truth about the mosquito was starting to emerge. Carlos Finlay, an eminent Cuban physician, had correctly identified *Stegomyia fasciata* as yellow fever's transmitter in 1881; and while his theory was generally ignored, Finlay continued to espouse it. So when a four-man U.S. yellow fever commission headed by another Army doctor, Walter Reed, arrived in Havana and found its best research lead defunct, it decided to test Finlay's theory.

This work culminated in a series of classic tests. Reed had two small screened buildings erected in a zone kept as free as possible from yellow fever. In the first building he placed seven non-immune human volunteers and had them sleep for 20 nights in the disgustingly foul bedsheets, garments, and discharges of yellow fever patients. None

<sup>6</sup>Ibid., pp. 126–27.



A disinfection crew in Havana. (Courtesy of Otis Historical Archives, National Museum of Health and Medicine, U.S. Armed Forces Institute of Pathology.)

got yellow fever. In the second building he placed two volunteers separated from infected yellow fever mosquitoes by careful screening. Neither of them got yellow fever. Finally, he briefly exposed one volunteer to infected mosquitoes in the second building for three days in succession. On the fourth day, this volunteer developed an unmistakable case of yellow fever.

This dramatic demonstration did not immediately make Gorgas or many other respected medical officials believe in the mosquito theory. As Gorgas said two years later, referring to the Reed Commission's work,

This work was so brilliant in its execution and so positive in its results that, as I look back now, I am surprised that I was not at once convinced. But many years of contact with men engaged in the practical work of managing yellow fever and my own personal experience with this disease had so impressed me with the belief that fomites were the principal, and practically the only,

carrier of the disease that I had scant belief in the mosquito theory.<sup>7</sup>

Fortunately, one man who felt Reed's results could be important was General Leonard Wood, the Military Governor of Cuba. So Wood, himself a member of the Army Medical Corps, told Gorgas to "go to any reasonable expense in providing for the destruction of mosquitoes."<sup>8</sup> Though Gorgas doubted the mosquito's major role, and while many including Reed believed the task of eliminating the *stegomyia* to be impossible, Gorgas proceeded with his usual dispatch.

A new city ordinance required everyone to make water-bearing receptacles mosquito-proof. Squads of men, 50 to 150 depending on the season, crisscrossed the city looking for breeding places, emptying or removing con-

<sup>7</sup>W. C. Gorgas, "Results in Havana during the year 1901 of disinfection for yellow fever," *Lancet*, 2(1902), 669.

<sup>8</sup>*Ibid.*

tainers, screening rain barrels, draining all pools and low ground, and oiling puddles, cesspools, and places that could not be drained. Every home had a file card, every card listed the number and location of all water-bearing containers on the premises (this list was made before the campaign started on the assumption that some receptacles would be hidden from inspectors). Finally, after sufficient notice had been given, containers bearing mosquito larvae were destroyed, and people blatantly harboring such containers on their premises were fined.

Beyond that, to prevent the remaining adult mosquitoes from getting infected, workers screened every hospital receiving yellow fever cases and every home reporting a case—usually within two hours of the report. And once a household patient had died or recovered, workers sealed all rooms in the quarantined residence and neighboring residences, treated them with pyrethrum powder, and swept up all the mosquitoes intoxicated by the powder.

The real miracle wrought by Gorgas was not that he did all these things while still unsure of the mosquito theory, but that he got the Cuban people's help. After all, they were not dying of yellow fever. They were immune, their homes were being periodically entered and inspected, they were being made to keep their premises free of larvae, and most of them, along with a good many learned physicians, thought the mosquito theory plumb crazy.

What made the campaign work was that Gorgas and his people pursued it so as to enlist cooperation everywhere they went. Their basic measures were education and persuasion. Gorgas felt that his business was to make the people of Havana demand his sanitary measures, and his whole campaign was imbued with determination to create just that kind of public sentiment. Thus, while

Gorgas had plenty of enforcement power—the whole U.S. Government was behind him—he almost never used it. This approach contrasted sharply with that of Cuba's former Spanish colonial regime, which had become notoriously arbitrary and unresponsive, a contrast that worked strongly in Gorgas' favor.

Moreover, Gorgas seemed tireless. His office was never closed. He knew all his inspectors well, kept track of their movements, and personally checked their work. He became a familiar figure on the back streets of Havana—poking about tin cans and refuse, checking rain barrels, talking to housewives, delivering small spontaneous lectures, and making converts. Indeed, presumably with some poetic license, it has been claimed that "whenever he rang a front-door bell, a beaming señora would greet him almost invariably with the same words: 'No hay mosquitos aquí, señor.' ('We have no mosquitoes here, sir')."<sup>9</sup>

And so it happened that despite Gorgas' doubts and the bemused disbelief of the people, the mosquito campaign was effectively pursued.

That was a good thing, because the results were dramatic. *Stegomyia fasciata* turned out to be a human camp follower like the cockroach and Norway rat, living only around human dwellings and breeding only in artificial containers of clean fresh water. Hence, it was more vulnerable than anyone supposed, and it succumbed to Gorgas' methods.

The turnaround came quickly. Havana had seen 24 yellow fever cases and seven deaths in January 1901, eight cases and five deaths in February. As Gorgas wrote afterward,

The mosquito work was inaugurated on February 27th. We went through March

<sup>9</sup>M. D. Gorgas, *William Crawford Gorgas: His Life and Work*, 128.

with only two cases, which occurred on the 2nd and 8th. I was much pleased with this but not particularly impressed, knowing that it might be a coincidence. We then went to April 20th without another case. This was unexpected, particularly as the year had commenced so badly and as there was plenty of nonimmune material around . . . This condition . . . had never been approximated before in Havana. On April 21st and 22nd there were two more cases, but under our system of disinfection the disease did not spread. I began to feel pretty certain by this time that the results were due to our mosquito work. On May 6th and 7th we had four more cases, but this focus was promptly controlled. We then went through the whole month of June up to July 21st before we had another case.<sup>10</sup>

Beginning in June the disinfection of fomites was abandoned, and the yellow fever campaign focused solely on the mosquito.

In all, from March onward the year 1901 saw only five deaths from yellow fever, and after that the disease virtually disappeared. Another small outbreak flared in 1905, but this was snuffed out quickly. Furthermore, Havana had been a great endemic center, from whence yellow fever had spread outward to other parts of Cuba and the world; so, unexpectedly, its eradication there led to its quick demise throughout Cuba and marked reductions elsewhere—notably in periodically afflicted parts of the Caribbean and the United States.

Gorgas coupled this spectacular feat with an only slightly less stunning success against malaria. As Ronald Ross convincingly explained in 1897, malaria's transmitter is the *Anopheles* mosquito. *Anopheles* has fewer reservations about egg-laying than *Stegomyia fasciata*. (It requires no artificial receptacles, typically

depositing its eggs in clear fresh water containing abundant grass and algae.) But anophelines are weak flyers, that typically stay close to the place where they emerge; and this makes the malaria transmission process vulnerable to countermeasures.

Havana's zoning unconsciously encouraged *Anopheles* control—because it concentrated the population in the center of the city while placing all gardens and farm areas outside. When this zoning was coupled with the general cleanup and work against *Stegomyia*, anophelines found it hard to propagate inside the city center.

To help things along, Gorgas organized an *Anopheles* brigade employing up to 150 workers whose principal job was to restrict irrigation in mosquito breeding areas on the city's agricultural fringes and to install and clean ditches. This brigade had its own chief and was kept entirely separate from the groups working against *Stegomyia*. Its work, combined with side-effects of the *Stegomyia* campaign, reduced Havana's malaria mortality from 325 deaths in 1900 to 77 in 1902.

Clearly, the success of these anti-mosquito campaigns, the first large-scale systematic efforts of their kind anywhere in the world, was enormous. As Gorgas wrote to Ronald Ross, "For the first time since . . . 1762 we have an October free from yellow fever and malaria decreased more than one half."<sup>11</sup>

Understandably, these developments deeply affected their perpetrator. Gorgas came to believe, correctly, that what had been done in Cuba could be done in other tropical areas, and that yellow fever, malaria, and similar plagues could be conquered. From then on, their suppression became his goal.

<sup>10</sup>W. C. Gorgas, "Results in Havana during the year 1901 of disinfection for yellow fever," 669.

<sup>11</sup>L. J. Bruce-Chwatt, "Ronald Ross, William Gorgas, and malaria eradication," *Am J Trop Med Hyg*, 26(1977), 1074.



## PANAMA'S PROBLEMS

Around this time the United States was preparing to build a canal across the Central American Isthmus through either Nicaragua or Panama. Gorgas, knowing of potential malaria and yellow fever problems, urged Army Surgeon General George Sternberg to press for appropriate sanitary measures and asked to head the effort. As a result, he was made the project's chief sanitary officer. In 1902 he went to Washington to prepare for this task; in March 1903 Congress recognized his Havana work by raising his rank to colonel; and for two years he studied sanitary problems tied to canal-building and Central America, making visits to both the Suez Canal and Panama.

In those days, Panama was known as a pesthole. Malaria, yellow fever, and other ills waged war on all comers. Over the centuries of Spanish rule, multitudes of gold-hungry conquistadors following the Chagres River across the Isthmus had fallen ill and perished. During the California Gold Rush, workers building the Panama Railroad along this same route took immense losses—allegedly one life for every tie laid. And would-be French canal builders of the 1880s, following the Chagres route under Ferdinand de Lesseps of Suez Canal fame, did even worse, suffering roughly 20,000 deaths in nine years and losing their dream of an isthmian canal to human carnage.

Years later, the lingering recollection of all this was summed up in verse by James Stanley Gilbert, a long-time U.S. resident of the area:

Beyond the Chagres River  
'Tis said—the story's old—  
Are paths that lead to mountains  
Of purest virgin gold;  
But 'tis my firm conviction,  
Whatever tales they tell,  
That beyond the Chagres River  
All paths lead straight to hell!

None of this being any secret, Gorgas knew he would be facing severe malaria problems and a gigantic well-oiled yellow fever trap. Therefore, before leaving for Panama he made a strong plea for proper supplies and enough experienced people to carry on.

That request was denied. Great discoveries take time to penetrate, and people needed time to change their minds about mosquitoes. Gorgas himself had doubted the mosquito theory of yellow fever transmission until 1901. So it was ironic but not surprising that the head of the newly formed Canal Commission, Admiral John G. Walker, called Gorgas' mosquito ideas "balderdash," and that the other six commissioners deemed them a waste of time. The upshot was that Gorgas left Washington with an appropriation of \$50,000—far less than he requested—and a hand-picked team of seven people, reaching Panama in June 1904.

A few months later, following a bout of malaria, he was back. He had found so few of his requisitions approved and so few supplies arriving that his work was severely handicapped. But Walker and the others stood firm. "On the mosquito you are simply wild" said Commissioner George Davis. "All who agree with you are wild. Get the idea out of your head."<sup>12</sup>

Beyond that, Walker and this first Commission embraced thrift. In fact, they were so tight, so concerned with personally reviewing every step taken, every dollar spent, that they devised an insanely burdensome system of rules and regulations seemingly dedicated to bringing all Isthmian operations to a halt.

On the Isthmus, to hire a single handcart for an hour required six separate vouchers.

<sup>12</sup>D. McCullough, *The Path Between the Seas* (New York: Simon and Schuster, 1977), 423.

Carpenters were forbidden to saw boards over 10 feet in length without a signed permit. The clerical work required for each fortnightly payroll was amazing: By September, with 1,800 workers on the books, payment took six and a half hours and involved the filling out of 7,500 separate sheets of paper weighing in all 103 pounds.<sup>13</sup>

Though Gorgas got nowhere with the Commission, he was familiar with bureaucratic travails, and he neither lost his temper nor resigned. Instead he returned to Panama to stay, this time taking his wife with him. In the end, due partly to such calm persistence, he endured longer than any other leading canal officer and became the only key official to oversee construction of the "big ditch" from start to finish.

Meanwhile, the person who lost all patience with the commissioners was Teddy Roosevelt. Responding to growing public uproar about health problems and bureaucratic delays, the President fired all seven commissioners and appointed new ones effective 1 April 1905. This broke the bureaucratic logjam, and that June saw appointment of a new Chief Engineer, John Stevens, who valued Gorgas and gave him a free hand. A few months later Stevens defended Gorgas against a move to dismiss him—a move that backfired, because Roosevelt considered this step, consulted medical authorities and friends, and concluded that Gorgas should be retained and strongly backed.

All this came amid a mounting health crisis. Offered a growing supply of non-immunes, Yellow Jack was stirring. The first reported case occurred in November 1904, and by the end of January 1905 everyone knew the disease was on the prowl. The numbers of reported cases were very small—six cases in December,

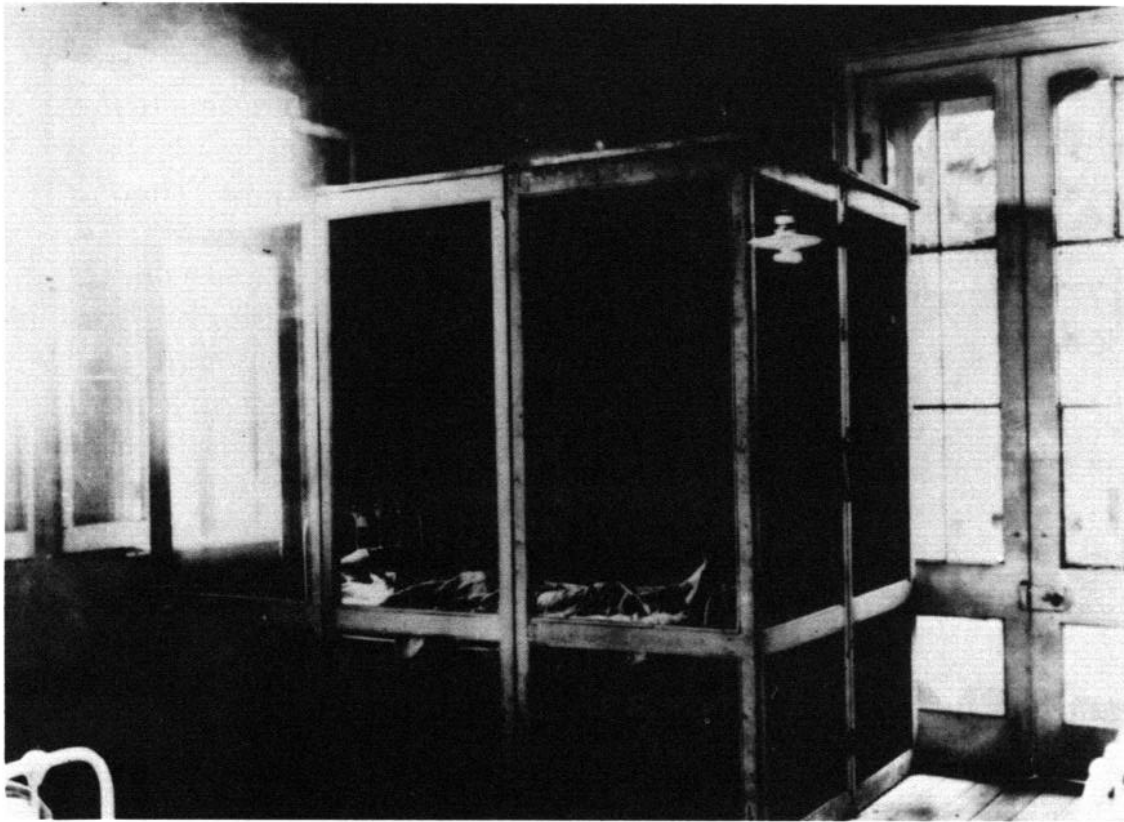
eight cases and two deaths in January—but they grew steadily as time passed and loomed larger than life in the imaginings of people only too aware of Panama's gruesome past. Then in April yellow fever slew two leading canal company officers. Uneasiness, fanned by the newspapers, gripped the canal-building community, and a growing stream of recent arrivals began to leave.

In June several startling things happened. The yellow fever case count doubled from the previous month—to 62 known cases and 19 deaths. A case of bubonic plague surfaced, raising widespread fear of a plague epidemic. And on 11 June 1905 Chief Engineer John Wallace, the top-ranking canal-builder in Panama and a man known to fear diseases, left the Isthmus never to return. At this point public uneasiness became a public rout; all other sentiments gave way to panic; and an unprecedented exodus—ultimately involving precipitous departure by three-quarters of the U.S. canal-building community—became limited only by the availability of boats to take people away. Collapse of the whole venture threatened.

Naturally, Gorgas had not been idle as things worsened, but he had needed a long time to gear up. Quite aside from the Commission's tightness and the public's skepticism about mosquitoes, Gorgas found that it took considerable time to select and train local inspectors. Many of these people, unaccustomed to disciplined behavior, at first tended to be careless, and so everything needed to be double-checked.

Nevertheless, by February 1905 he was ready to proceed with work like that which had succeeded in Havana, and he did. At first on a small scale his workers mosquito-proofed rain barrels, removed or treated other water-bearing containers, oiled areas of standing water, and fumigated the homes of yellow fever

<sup>13</sup>*Ibid.*, p. 439.



Above: As in the Havana campaign, Panama yellow fever patients like this one at Ancón Hospital were screened—not to protect the patient but to prevent infection of mosquitoes. Below: Fumigation brigade in Panama City. (Courtesy Otis Historical Archives.)

patients. They also pursued plans to provide Panama City, Colón, and other settlements with piped water, so that rain barrels and cisterns could be abolished.

By June, when panic struck, Gorgas' organization had been operating in this manner for some time. So when the first commission was replaced and Engineer Stevens gave him free rein, he was prepared for full-scale work, and at this point his progress became striking. As David McCullough explains in his excellent history, *The Path Between the Seas*,

He [Gorgas] now found himself leading the most costly, concentrated health campaign the world had yet seen. . . . His requisitions had priority over all others. . . . The city of Panama was fumigated house by house, some sections several times over. The same was done at Colón. Fumigation brigades—hundreds of men carrying ladders, paste pots, buckets, rolls of brown paper, old newspaper—trailed through the streets in the early morning like some strange ragtag army of occupation. . . . Cisterns and cesspools were oiled once a week. Most critically, Panama City, Colón, Cristóbal, Ancón, La Boca, Empire, Culebra were all provided with running water, thus dispensing—after centuries—with the need for domestic water containers.<sup>14</sup>

All this made quick work of Yellow Jack. In September, a month that saw only seven yellow fever cases and four deaths, the back of the epidemic broke. A few weeks later, Gorgas told staff members performing an autopsy to "take a good look at this man," because his was the last yellow fever cadaver they would see. By the end of December the disease had disappeared.

This feat of liberating the Isthmus from yellow fever for the first time in recorded history should not be understated. But in terms of its real danger to health, yellow

fever was merely a potent threat. The real villain was malaria.

Malaria was less dramatic than yellow fever, much as a steadily drinking alcoholic tends to be less dramatic than one who goes off on mighty toots. Nevertheless, the relatively fast-acting and deadly malaria prevailing on the Isthmus had probably killed more people than yellow fever; it was ever-present in human settlements, maintaining itself in people who were ill and in others who had become partly resistant through repeated exposures; and its anopheline mosquito vectors appeared eradication-proof.

Gorgas harbored no delusions. Around the end of 1904, when the yellow fever epidemic was just starting, he wrote,

So far as yellow fever is concerned, it seems to me that the problem is not so difficult as it was at Havana. . . . But malaria on the Isthmus and malaria at Havana are very different problems. . . . On the Isthmus . . . we have a long line of canal with twenty-odd villages and some twelve thousand people scattered over a length of nearly fifty miles. We find that most of these twelve thousand people are capable of conveying the contagion of malaria to any newcomer who comes to live among them, . . . that practically every female *Anopheles* mosquito that bites a human being along the line of the canal becomes infected, and . . . that there is no lack of *Anopheles* mosquitoes.<sup>15</sup>

To deal with all this, Gorgas planned a two-pronged attack combining destruction of *Anopheles* mosquitoes near human settlements with prophylactic treatment of endangered people. Atop his organizational pyramid he appointed a chief in-

<sup>14</sup>Ibid., p. 466.

<sup>15</sup>W. C. Gorgas, "Sanitary conditions as encountered in Cuba and Panama, and what is being done to render the canal zone healthy," *Med Rec*, 67(1905), 162.



William Gorgas at work in Panama. (Courtesy Otis Historical Archives.)

pector and provided him with the assistance of three experts—one specializing in mosquitoes, another in tiles and drainage, and the third in administration. He then divided the canal area's 500 square miles into 17 districts and assigned them to 17 district inspectors.

Each district inspector received regular instruction and guidance from the chief inspector's office, and each directed a team of 25 or 30 men who dug ditches and cut brush, a smaller group of carpenters who repaired and maintained screens, and one or two workers who dispensed the antimalarial drug quinine. Research on the anophelines' limited flying ability showed that they rarely strayed 100 yards from their birthplaces over open ground. So Gorgas ordered the draining or destruction of potential breeding places within 100 yards of any dwelling, regular killing of larvae in breeding places that could not be drained

or destroyed, removal of all brush within 100 yards that could shelter adult anophelines, screening of all habitations to keep mosquitoes out, and regular dispensing of quinine to all takers.

The results were then monitored. A physician assigned to each district sent daily reports to the central office. These showed the number of malaria cases occurring in the district, the number of malarious canal employees, and the percentage of all employees afflicted. The reports, consolidated weekly with copies to the district inspectors, provided a rough assessment of the situation in each district. If the malaria rate for a district was seen to rise, special inspectors from the central office would visit the district and work with the district inspector to find the cause and correct it.

At first the results were uncertain, and deaths from malaria rose fast—from nine in 1904 to 199 in 1906, outpacing the rate

of growth in the number of canal employees (6,700 in 1904, 26,700 in 1906). But then, as kinks got worked out of the system and the cumulative effects of drainage, brush-clearing, and screening gained momentum, the campaign took hold. In 1907 the number of employees rose to 39,300 while malaria deaths dropped to 138; and in 1908 things kept improving, the number of malaria deaths among 43,900 workers being 59. The case count was down too—from 831 reported cases per 1,000 employees in 1906 to 282 in 1908—and it kept falling.

Recognition of this work's quality came early. In 1904, while Gorgas was in Washington, Ronald Ross briefly visited the Isthmus. After a week in Panama he declared Gorgas' projected plans sound in every particular and said they could be made an example for the entire world.

Toward the end of 1906 President Roosevelt toured the canal works. Shortly thereafter he made Gorgas a member of the Panama Canal Commission and devoted large sections of a Congressional speech about his visit to describing health advances and praising Gorgas—probably the first time any U.S. medical officer had received such recognition in a Presidential message. The American Medical Association elected Gorgas its president in 1908.

Dr. Malcolm Watson, later noted for eradicating malaria from the Federated Malay States, also visited Panama in this period. He described Gorgas' work as "the greatest sanitary achievement the world has seen," adding that "I doubt if we shall ever see as great again. . . . It is perfect work and its organization is the only kind that would have succeeded under the circumstances."<sup>16</sup>

Gorgas did face interference from George Goethals, who succeeded John

Stevens as Chief Engineer and became Chairman of the Panama Canal Commission in 1908. Goethals, who appears to have been obsessed with asserting his own authority, took a dim view of both Gorgas' efforts and his status. But although he removed certain key activities—most notably brush-clearing and ditching—from the sanitary department's immediate control, his interference did not overcome the sanitary program's accumulated momentum, and Gorgas continued to make progress.

At the end, in 1913, there were only 76 known malaria cases per 1,000 employees. Obviously, this number of cases was still significant; but even so, in the light of Panama's past history and malaria's worldwide ravages, Gorgas' campaign was a remarkable success.

Nor was that all. The greatest killer of black canal employees, who constituted the bulk of the work force, was pneumonia. To combat it, Gorgas took a number of measures—including development of better dwellings, wider spacing of living quarters to reduce contagion, and immediate isolation of the sick—that cut pneumonia deaths from 466 in fiscal year 1907-08 to 50 in 1913-14. Gorgas' workers also cleaned up Panama City and Colón, suppressed incipient outbreaks of bubonic plague, dealt with dysentery and other ailments, oversaw the modernizing and building of hospitals and treatment centers, and provided free medical care for the entire community.

Thus reformed, the whole area in and around the canal settlements turned from a pestilential morass into the healthiest tropical region in the world. In 1908 the death rate among all U.S. Government employees (most of them black laborers from the Caribbean) was 13 per thousand—probably no higher than that of a comparable body of men then doing similar work in New York State. For U.S. citizens on the payroll—who were typically

<sup>16</sup>M. D. Gorgas, *William Crawford Gorgas: His Life and Work*, 231.

clerical workers or administrators with less hazardous duties and less exposure to disease—the rate was only 8 deaths per thousand. By 1914, the year the canal opened, these rates had fallen to a phenomenal 6 per thousand for all government employees and 2 per thousand for U.S. citizens, rates that compared favorably with the overall rate of 14 per thousand then prevailing in the United States, and also with rates of 9.5, 9.4, and 9.2 deaths per thousand prevailing in Washington, Minnesota, and Nebraska—the states with the lowest mortality. While it is true that the canal employee population contained fewer of the infants and elderly who typically have the highest mortality, it is also true that William Gorgas had taken the world's most infamous pesthole and transformed it into a veritable health spa. In hindsight, the feat was unexpected, striking, and singular. Over the entire course of human history, nothing like this had ever happened.

## TRAVELS AND THE GREAT WAR

Gorgas left Panama in November 1913, shortly before the canal opened. He did so at the request of British authorities in South Africa, where black mine workers faced a devastating pneumonia epidemic worse than anything in Panama that was killing roughly 35% of the workers yearly. Gorgas spent over a month visiting the mines, workers' quarters, and associated hospitals. When a strike closed the mines in January, he accepted an invitation from the Government of Rhodesia to visit the capital, Salisbury, and provide advice about malaria control. While doing this, he learned that President Woodrow Wilson had raised his rank to Brigadier General and appointed him Surgeon-General of the U.S. Army.

Before sailing from Cape Town in Feb-

ruary 1914, Gorgas presented the Transvaal Chamber of Mines (the mineowners' association) with his recommendations. Many were put into effect, and while none were revolutionary, they produced results. Within four years, pneumonia mortality had dropped to about 0.3% per year (three deaths per thousand) and mortality from other diseases to about 0.6% per year—by any account a strong gain.

On his way home, Gorgas visited Great Britain, whose still-flourishing empire had long suffered from the health problems he had overcome in Havana and Panama. On this occasion he was not merely welcomed. The press, leading medical scientists, and the universities went out of their way to do him honor. The British Society of Medicine arranged a banquet, and Oxford University held a special convocation to award him the honorary degree of Doctor of Science. According to the noted Oxford professor Sir William Osler, it was the greatest ovation ever given a medical man in England.

Gorgas, whose rank at home was soon raised to Major General, spent the next two years in the U.S. During this time, as Surgeon-General, he became involved with the Rockefeller Foundation's International Health Board, then seeking to eradicate yellow fever from its lingering haunts in the Americas, and in 1916 he assisted that work by making a four-month tour of Central and South America.

The ostensible purpose was to visit yellow fever's remaining strongholds and gather information needed for a comprehensive eradication program. But Gorgas' reputation turned the tour into a succession of high official celebrations, presentations of honorary university degrees, and endorsements of his health plans by key public bodies. That was a fine thing, because at heart the interna-





William Gorgas as Surgeon-General of the U.S. Army during World War I. (Courtesy Otis Historical Archives.)

tional campaign against Yellow Jack was diplomatically delicate; good initial rapport was needed; and Gorgas was so genial, approachable, and sensitive to prevailing problems that he made an ideal good-will ambassador and encouraged cooperation everywhere he went. In this spirit he prepared the way for international public health work in Ecuador, Peru, Colombia, Venezuela, Brazil, Mexico, and several Central American countries before returning home that fall.

Upon his return he presented the board with a plan for eradicating yellow fever from the Americas as well as from existing foci in Africa, and it was arranged that he would step down as Surgeon-General to direct the effort. But in April 1917 rupture of diplomatic relations with Germany and pending U.S. engagement in World War I intervened. So instead of stepping down, Gorgas retained

his post and took charge of expanding the U.S. Army Medical Corps.

This was no small matter, because existing manpower and facilities were limited. In April 1917 the Army Medical Corps had less than a thousand trained commissioned officers and nine hospitals to examine and care for an expected influx of millions of servicemen. So ideally, the corps' medical manpower and hospital beds should have grown magically, by a factor of 20 or so within a year, though the exact magic to be applied was uncertain.

Gorgas started by getting the American Medical Association and other medical organizations to back his cause. He had already laid important groundwork by conducting a campaign among physicians to break down widespread prejudice against his own career—that of army doctor—and encouraging doctors to join



the Medical Reserve Corps. He also supported a medical committee of leading physicians—created by the National Defense Act of 1916—that was in a fine position to garner support from the medical profession and spur interest in Medical Reserve Corps commissions.

As the war loomed nearer, Gorgas used his personal prestige, position as a former AMA president, and popular support for the war to maximum effect. The *AMA Journal* regularly carried his appeals for more medical officers, detailed the medical phases of the war effort, opened a new section called "Medical Mobilization and the War," and published lists of physicians who had accepted Medical Reserve Corps commissions. Warm relations between Gorgas and the AMA encouraged the organization to mail a personal appeal to every physician under age 55 asking him to offer his professional skills to his country—and a second appeal to those not answering the first. In concert with this well-orchestrated national campaign, state, county, and other medical societies followed suit—until nearly every physician's group became an active recruiting agency for the fast-growing Medical Reserve Corps.

So powerful was Gorgas' magic that without ever resorting to a draft he brought the Medical Reserve Corps to a strength of 23,274 physicians by 30 July 1918. When the Armistice was signed, on 11 November 1918, his all-volunteer army medical department included 30,591 physicians, 4,620 dentists, 21,480 nurses, and 281,341 enlisted men—a force larger than the entire army at the war's start and probably larger than any U.S. group ever before commanded by a Major General.

As the medical corps grew, Gorgas took care to recognize medical specialties, appoint leaders in those specialties to top positions, give them both freedom and responsibility to do their

work, and generally ensure that incoming physicians were assigned to respected colleagues within their fields of competence.

Gorgas also oversaw a massive hospital construction program that raised the Army's domestic hospital facilities from nine hospitals and 4,150 beds to 92 large hospitals and 120,916 beds by the war's end. In the process, he issued instructions that there must be 15 hospital beds in France for every hundred U.S. soldiers serving in that country, a ratio that was generally maintained.

Beyond that, he issued detailed instructions designed to end the lax sanitary practices that had allowed disease to run rampant in previous wars. Among other things, troop concentration centers were to maintain high standards of cleanliness: All drinking water was to be sterilized; all sources of water used for other purposes were to be analyzed and pronounced safe; kitchens and mess halls were to be properly screened; iceboxes were to be elevated, their drip pans emptied and cleaned daily; sanitary inspectors were to inspect all food before it was served; food peddlers were to be banned from the centers; if natural water drainage was not present at campsites, artificial drainage was to be provided; land used for keeping horses was to be burned over with oil once a week to keep flies from breeding; and inspectors were to make their rounds regularly to see that these and other sanitary regulations were observed.

Not everything went smoothly. In the initial phases, serious overcrowding of certain camps in the U.S. and other problems led to major pneumonia and measles epidemics and many deaths—over 150 from pneumonia alone in December 1917. But Gorgas personally inspected the four camps where things seemed worst, described the causes in a report to the Chief of Staff that made national

headlines, provided calm testimony to Congress that helped clear the air, and oversaw changes ending the epidemics.

More generally, the Medical Department had to compete continually with other army departments that tended to get top priority. But Gorgas was at the peak of his form, and the results were good.

In the American Expeditionary Forces some 23,853 officers and men succumbed to disease, as compared to 50,554 who were killed in action or died of wounds.<sup>17</sup> This contrasts sharply to tolls from other wars: 50,000 disease deaths versus 20,000 battle fatalities in the Crimean War, three times as many disease deaths as battle fatalities in the U.S. Civil War, 10 times as many in the English army fighting the Boer War, and 14 times as many among U.S. soldiers in the Spanish-American War.

This was not simply a development whose time had come, for the European armies fighting World War I were suffering massive casualties and deaths at the hands of diseases like malaria from which the U.S. camps were almost free. Rather, it appears that Gorgas' experience, determination, and skill had encouraged military public health of a sort never before seen in wartime—something unique that would probably not have taken hold without his guidance.

One day, while attention was still focused on the war, a friend remarked to Gorgas about the turn of fate that had raised him, an apostle of lifesaving, to a position of great responsibility in history's greatest mass killing. The irony impressed them both.

Gorgas made it clear that despite his great love of the Army he had no stomach for wholesale slaughter and wished the war were over. So his friend asked what he would do if he received a phone call telling him the war had ended.

"Do you know what I would do?" he asked. "I would ring off, call New York City, and order a passage for South America. I would go to Guayaquil, Ecuador, the only place in which yellow fever is prevalent, exterminate the pestilence, and then—and then return to Panama, the garden spot of the world, and end my days writing an elegy on yellow fever."<sup>18</sup>

## RETIREMENT AND RECOGNITION

This was not mere daydreaming. On 3 October 1918, a month before the Armistice, he reached the mandatory retirement age of 64 and stepped down as Surgeon-General. Within a matter of weeks the Rockefeller Foundation had asked him to take up its campaign against yellow fever where he left off, and soon he was bound for Guayaquil to do just that.

He spent time in Guayaquil and also in Quito planning a yellow fever eradication campaign with Ecuadorian authorities and supervising initial work. The Ecuadorian Government gave its enthusiastic support and asked him to head the entire effort. His commitment to the Rockefeller Foundation prevented this, but he agreed to become the honorary director and some time later expressed confidence that measures begun under his supervision would soon free Guayaquil of Yellow Jack. He was correct. By May 1919, four months after work began,

<sup>17</sup>If troops training in the United States in this period are included, the total number of deaths from disease was around 62,618—a figure swelled by pandemic influenza and associated pneumonia that is believed to have slain over half a million people in the United States alone.

<sup>18</sup>F. Martin, *Major General William Crawford Gorgas, M.D., U.S.A.*, Chicago, Board of Directors of the Gorgas Memorial Institute (no date), as quoted in M. D. Gorgas, *William Crawford Gorgas: His Life and Work*, p. 323.

the scourge that had devastated Guayaquil's immigrants and trade for centuries was gone.

By then Gorgas had visited Peru, where he planned another campaign and agreed to accept another honorary directorship. He then spent the better part of a year traveling around the hemisphere—returning at one point to Panama and making a return visit to Peru—before proceeding with plans to assess the yellow fever situation in West Africa.

He had been named winner of the prestigious Harbin Gold Medal for his services to mankind. So in late May 1920 he, Mrs. Gorgas, and the rest of his Africa-bound party stopped off at Brussels, site of the International Hygiene Congress, to receive it. He also received the Star of Belgium from King Albert, attended ceremonies and social affairs in his honor, and conferred with officials about yellow fever in the Belgian Congo. From there he went to London and began a series of discussions with British officials whose help was needed for the proposed African trip, and it was there, around two in the morning of 30 May, that he awoke his wife to tell her he felt faint and feared he had suffered a slight paralytic stroke.

Quickly transferred to the Queen Alexandra Military Hospital, he remained mentally alert and under no delusions about the seriousness of his condition. He was to have been knighted by King George, and this was done by the King at the hospital when Gorgas' chances for recovery seemed slim. He died peacefully on 3 July 1920. An initial funeral ceremony was held at St. Paul's Cathedral—the first time this honor was ever accorded a non-British subject. Following a second funeral service in the United States, on 16 August his remains were interred at Arlington National Cemetery.

An unknown journalist, reporting on

the solemn funeral procession through the streets of London, wrote:

What was happening that day up Ludgate Hill was a rare and stirring thing. I looked down from the windows of the little House with Green Shutters in the very shadow of the dome, and I thought that here indeed was a public opinion of which our London, and our country, and all the entire world might well be proud. For here was no great Englishman, no great Briton, going to his rest; here was a ragged, bare-foot boy of Baltimore being carried to St. Paul's after his life's work was done.

He had done for the world one of the greatest things that an American brain has ever done: He made the Panama Canal possible after thousands of people had died in the attempt. . . .

It seemed good that death should find him here, for so there came our opportunity to do a great man honor. He passed through the great door through which the sun streams into the nave of St. Paul's, and there he lay with Nelson and Wellington, and all that mighty host who came this way and passed into the universe.

They will take him to his own land, but in truth he belongs to us all. He was one of life's great helpers, for he cleaned up foul places and made them sweet, and now, as they said of Lincoln, "he belongs to the ages."<sup>19</sup>

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<sup>19</sup>Ibid., pp. 277-278.

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## *International Travel and Health*

The 1991 edition of WHO's *International Travel and Health* has recently been published in English and French. This 94-page booklet is addressed to national health administrators and to practicing physicians, tourist agencies, shipping companies, airline operators, and others who may be called upon to give health advice to travelers.

In addition to summarizing the vaccination requirements of individual countries, the 1991 edition provides updated information on the malaria situation and details on areas where malaria can be contracted. The occurrence of drug-resistant *Plasmodium falciparum* is indicated. Other health hazards to which the traveler to certain areas may be exposed are also covered, and the booklet recommends precautions that the wise traveler should take when visiting unfamiliar places.

Order information: ISBN 92 4 158016 X; Sw.fr. 14.—/US\$12.60 (in developing countries Sw.fr. 9.80); order no. 1189100; see bottom of p. 195 in this issue for address.

Source: WHO, *Wkly Epidemiol Rec* 66(12):87, 1991.