

Medicine in Stamps

Carlos Juan Finlay (1833-1915): of mosquitoes and yellow fever

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Years before the emergence of infamous Cuban revolutionaries like Castro and Guevara, a Cuban physician by the name Carlos Juan Finlay was stirring up a revolution of his own. The son of a Scottish physician, Finlay was born and raised in Havana, and educated in France, England and the United States. Described as courteous and energetic with boundless capacity for work, Finlay was first and foremost a clinician-scientist. His stunning hypothesis that a mosquito bite could transmit yellow fever, formed the foundation for the eventual eradication of the disease in the Western hemisphere.

It was in his homeland of Cuba where Finlay challenged the entrenched medical doctrines regarding the transmission of yellow fever. First reported over 400 years ago, yellow fever is believed to have spread to the New World when slave-trading ships arrived from Africa or the West Indies. The condition is aptly named, given the rapidly progressing jaundice, haemorrhagic fever, and “black vomit,” the latter a harbinger of death.

EDUCATING FINLAY

Carlos Juan Finlay was born on December 3, 1833, in the city of Puerto Principe, now Camaguey, in Cuba. An aunt provided home-education until the age of 11 years, when young Finlay crossed the Atlantic to study at Le Havre in France. Unfortunately, after two short years, he was stricken with cholera and was forced to return home. His recovery left him with a residual speech impairment that persisted into adulthood, giving the casual observer the impression of absent-mindedness, even “mental slowness.” However, this did not deter Finlay from continuing his studies in Europe, London, and eventually the US, where he enrolled as a medical student at Jefferson Medical College in Philadelphia. While at Jefferson, he met the influential Dr John Kearsly Mitchell, an early proponent of the germ theory of disease, and his son, Silas Mitchel, a neurologist and acclaimed writer. Finlay graduated in 1855 at the age of 22 years, and then spent several years in Peru and Paris before retracing his steps to Cuba in 1864, setting up medical practice a short distance from Havana, in the city of Matanzas. In

addition to his medical skills, he was also accomplished in Latin, chess, philosophy and higher mathematics.

MIASMA Finlay’s early work focused on the transmission of cholera. At the time, the dominant theory held that disease was spread through “miasma” or foulness in the air associated with malodorous decomposing matter. During a cholera outbreak that ravaged Havana in 1867, he stunned the medical community by proposing that contaminated water was in fact the source of infection. His theory met with vigorous opposition, and although eventually vindicated, he again faced an uphill fight when he later hypothesised that the mode of transmission of yellow fever was the lowly mosquito.

Cuba was not the only region affected by yellow fever, and several epidemics swept across the Americas, causing much death and suffering.

It has been estimated that a total of over 100,000 Americans died from the disease, hence the name, the American plague. In 1890, the first of three deadly epidemics swept across Philadelphia, wiping out almost 10% of the population. One of the most illustrious of the colonial American physicians,

Dr Benjamin Rush, was at the centre of the struggle to contain its spread. In addition to common remedies that included bloodletting and purging with near lethal doses of mercury, Rush used buckets of water to cool patients, often wrapping them in blankets soaked in vinegar. Unfortunately, most patients died, although Rush himself survived the disease, which he naturally attributed to his own unorthodox treatment methods.

NEW THEORY For all of the iatrogenic harm that he may have caused with his remedies, Rush should be credited for recognising the seasonality of the epidemics, which peaked during the hot and wet summer months, and for proposing that “miasma” was strongest as evidenced by the increased stench from the swamps and wastelands during those months. He also observed that any patient who recovered appeared immune to further infection. What Rush missed, however, was the mosquito connection. Finlay, on the other hand, correctly surmised



that it was not the worsened “miasma”, but rather the peak in the population of the female mosquito, *Stegomyia fasciata* or *Aedes aegypti* (Finlay referred to it as the *Culex* mosquito), during the hot, wet summer months that sparked the epidemics. In 1881, Finlay presented his results in *The Annals of the Academy of Medical, Physical, and Natural Sciences of Havana*. The medical community scoffed at the notion of human-to-human transmission via mosquito inoculation, incredulous that such a tiny insect could be responsible for so many deaths. History records that his early supporters included only his loyal and gifted Trinidadian wife, Adela Shine, and his Cuban physician disciple, Claudio Delgado.

Over the next twenty years, Finlay extended his clinical observations and conducted human studies to prove his hypothesis. He bred thousands of mosquitoes and recruited 102 human volunteers upon whom he carried out daring, if controversial, experiments. He allowed the mosquitoes to first feed on patients with yellow fever, and then turned them loose on his healthy volunteers. Some, though not all, of the volunteers came down with the disease. On the basis of these experiments, Finlay concluded that the mosquito was the agent responsible for transmitting the condition. We now know that the aetiologic agent for yellow fever is an arbovirus, which is transmitted to humans by one of several species of biting mosquitoes.

Predictably, critics raised objections to Finlay’s conclusion. The most prominent came from Dr George Miller Sternberg, later to become the Surgeon General of the United States. Sternberg argued that during the inoculation stage, volunteer subjects had not been sufficiently isolated from the general population, and so one could not completely exclude direct transmission between humans. He also pointed out that not all experimental subjects became ill or feverish after inoculation. At the time, Finlay could not fully explain this inconsistency, as it was not known that patients remained infectious only during the first three to five days of the disease.

VINDICATION In 1900, Dr Walter Reed, a major in the US army, was asked to assemble the Yellow Fever Commission to look into the large number of American troops that perished in Cuba during the Spanish-American War. Over 2,000 American soldiers had died of yellow fever compared to the 400 killed in actual combat. One young Commission member, an army surgeon by the name of Dr Jesse Lazear, was intrigued by Finlay’s theory, and although Reed was himself sceptical, he allowed Lazear to conduct experiments to replicate Finlay’s findings. Unfortunately, Lazear himself was bitten by one of his infected insects, and died 13 days later. A determined Reed then set out to test once and for all Finlay’s theory.

Using mosquitoes and ova supplied by Finlay, coupled with newer controlled methods of experimentation, Reed and his team of experts conducted studies in a network of isolation tents, which they named Camp Lazear. Reed was able to confirm the vector role of the mosquito, and his experiments led to newer insights into its life-cycle, and the development of effective insect eradication and quarantine practices. Unfortunately, Finlay did not receive full credit for his original observations; litigation followed, and a biography by his son in 1940 sought to correct the “undervaluation and the nonrecognition of the experimental phase of his work.”

Finlay later became the Chief Health and Sanitation Officer of Cuba, a post he held for eight years until his retirement in 1909. By then he had successfully tackled another lethal condition - infantile tetanus. In 1902, tetanus infections caused over 1,300 infant deaths. After recognising the filthy conditions during deliveries, Finlay isolated the wick used for ligating the umbilical cord at birth as the likely infectious source. He implemented an aseptic technique that soon gained widespread use in Cuba, and reduced the death rate three-fold.

August 15, 1914, a year before Finlay’s death, saw the completion of the Panama Canal, a marvel of engineering and human ingenuity. The project however came at the huge expense of human lives lost to yellow fever. Originally undertaken by the French in 1881, the project was abandoned after eight years and 30,000 deaths. In 1904, the United States resurrected the massive undertaking. By that time, the fields of medicine and immunology had progressed to the point where vaccinations for yellow fever were readily available. Knowledge of the mosquito life-cycle also allowed for its reduction through improved sanitation and door-to-door efforts to eliminate standing-water where mosquitoes bred. Some of this success is rightfully traceable to Carlos Finlay, without whose bold and original studies, the timely completion of the Panama Canal in the sweltering mosquito-infested swamps of Central America would surely have been in doubt.

BIBLIOGRAPHY

- Carter HR. Yellow Fever: An Epidemiological and Historical Study of Its Place of Origin. Baltimore, MD: The Williams & Wilkins Company, 1931.
- Finlay CE. Carlos Finlay and Yellow Fever. New York: Oxford University Press, 1940.
- Guiteras J. Who was Dr. Finlay? The official website of the Finlay Medical Society. Available at: www.finlay-online.com/welcome/whowasdrfinlay.html. Accessed March 2008.
- Kelly HA. Walter Reed and Yellow Fever. Baltimore: The Medical Standard Book Company, 1906.
- Philip SH. Walter Reed Yellow Fever Collection. Carlos Juan Finlay (1833-1915). Available at: etext.virginia.edu/healthsci/reed/finlay.html. Accessed March 2008.
- Yellow Fever. Available at: en.wikipedia.org/wiki/Yellow_fever. Accessed March 2008.