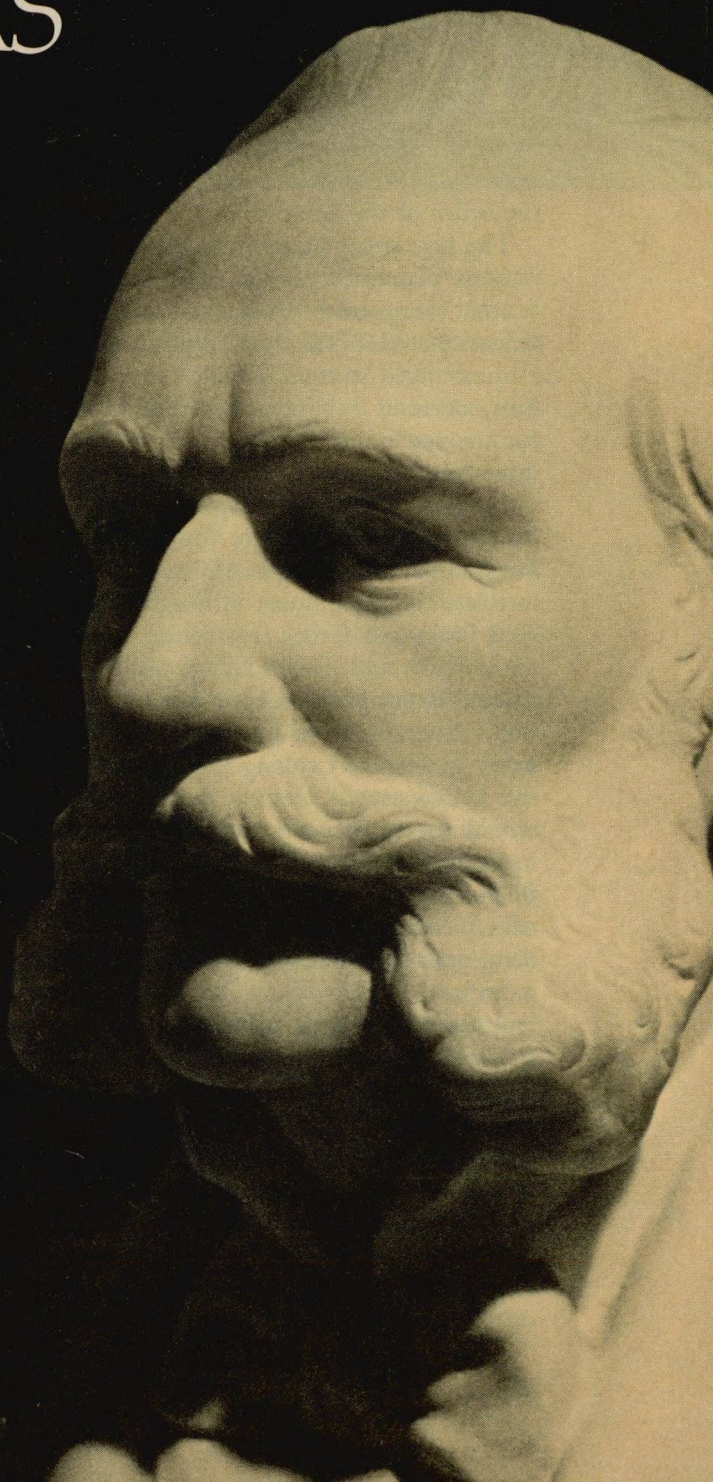
PASTEUR OF THE AMERICAS

MD PERSONALITY

▪ On August 14, 1881, Dr. Carlos Finlay stood before the members of the Royal Academy of Medical, Physical and Natural Sciences in Havana, Cuba, and in his somewhat halting manner read a paper titled "The Mosquito Hypothetically Considered as the Agent of Transmission of Yellow Fever." He named as the possible vector Culex, later known as *Stegomyia fasciatus*, and now called *Aëdes aegypti*.

When he finished reading his paper, his colleagues looked at one another incredulously. That Finlay could be serious in naming the mosquito as the vector in yellow fever was astounding. However, Finlay was highly respected by his colleagues, so the presiding officer of the Academy quickly had the paper tabled without discussion to prevent embarrassment to the author. But imperturbably, Finlay went his own way. He had been



Copy of the bust of Carlos Finlay in Havana given to his alma mater Jefferson Medical College by the Republic of Cuba on the occasion of the centenary of his graduation.

probing the mystery of yellow fever for 13 years and now, convinced that he had the answer, he continued his researches into the life cycle and ecology of the Culex. He had patience and he needed it, for it would take 19 years before his revolutionary theory would be accepted.

YOUTH. Carlos Finlay was the son of a Scottish-English physician, Edward Finlay, who had studied medicine at the University of Edinburgh and in Rouen* and who in 1821 sailed with a British contingent to aid Simón Bolivar in liberating Venezuela. The ship was wrecked in a hurricane and Dr. Finlay barely escaped with his life. He practiced medicine in Port-of-Spain, Trinidad, founded a hospital, and married a French girl named Eliza de Barres. The couple moved to Cuba in 1831, where he received an M.D. from the University of Havana and acquired a coffee plantation. In 1833 Eliza bore a son who was christened Juan Carlos, who later elected to reverse the order of the names.

The boy spent most of his early years on his father's plantation, and at 11 he and his older brother were sent to France for schooling. There he contracted severe chorea, which left him with a pronounced stutter. He tried to overcome this by a course of training directed by his father, but for the rest of his life he had a slight hesitancy in enunciation.

Carlos was sent abroad again at 15 to complete his education and prepare for a medical career. He studied in London, at Mainz, and at the lycée in Rouen, became fluent in English and German, read Latin and Greek. He came down with typhoid fever and had to return home, but he remained determined to enter the medical profession, although he had to abandon his plans to study in France. Lacking the credits to enroll at the University of Havana, because Spanish law would not allow acceptance of his French studies, he registered at the Jefferson Medical College in Philadelphia in 1853. Ironically, he arrived just as cold weather was ending the yellow fever epidemic that ravaged the city during the summer months.

Although a young institution, Jefferson had a remarkable faculty including Robley Dunglison, Charles Meigs, and T. D. Mutter. His preceptor was S. Weir Mitchell, whose father John, an early proponent of the germ theory of disease, constantly warned his students against blindly accepting traditional authority. In one of his lectures he expounded his belief that malarial and

* He interned under Professor Achille-Cléophas Flaubert, father of the famous novelist.

Dr. Finlay and his wife as a fashionable young couple in Cuba a few years after they were married in 1865, when he was first in practice.

epidemic fevers were caused by living organisms. He posed two questions: why was it that sailors who went ashore in infected areas frequently contracted a fever but those who remained aboard did not get it from their dying shipmates, and if the cause was miasmic gases, why was it that window screens seemed to offer protection? He ended: "We must conclude that yellow fever is portable, but not contagious." He had all but suggested a vector and his ideas seem to have impressed young Finlay.

THE MAN. Finlay was graduated in 1855 and practiced with his father in Lima, Peru, for a year. Returning to Havana after some time, he passed his incorporation examinations at the university and entered general practice for three years, then went to Paris for clinical work in general medicine and ophthalmology.

Returning to Cuba, he set up practice first in Mantanzas and then in Havana. In 1865 he married Adele Shine, of Irish descent born in Port-of-Spain, and they had three sons. Adele was a talented musician and singer, wrote short stories and poetry. She proved to be an excellent wife, helping him in his work and giving music lessons to supplement their income.

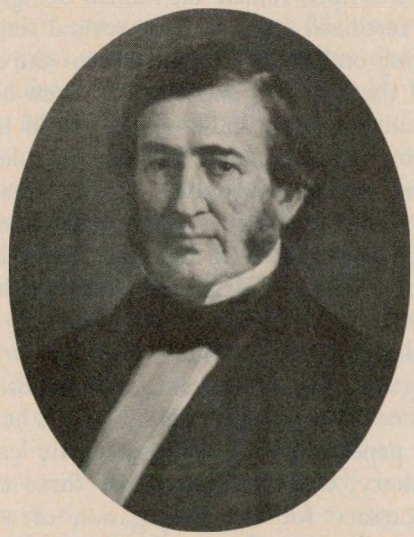
Like a true Cuban, Finlay enjoyed smoking. Short in stature, he was always elegantly dressed, usually in white; his manners were courteous and he had a genial wit, although he could be caustic

if occasion demanded it. He was an expert swimmer and enjoyed chess, cards, and baseball, a game which he encouraged his sons to play. With his children Finlay was authoritative, but this was tempered with affection and above all fairness.

Finlay was deeply religious and his beliefs pervaded every aspect of his life. In fact he firmly believed that the practice of medicine constituted a kind of priesthood. Fortunately, he had an enormous capacity for work and every minute not taken up with his family or patients was devoted to research.

THE WORK. Finlay's first important observation came in 1868 after a cholera epidemic had struck Havana. He worked tirelessly for months, tending the sick and studying the dead. He became convinced that the disease was transmitted by drinking water and boiled the water of his own household, which protected them from the disease. But it was in Cerro, a suburb of Havana, that he noted that cholera had appeared only on one side of a street populated by affluent families, although the disease was supposed to attack mainly in poverty-stricken areas. His search for an explanation led him to an open canal that supplied water to all the houses. Then he learned that a Chinese laundryman had died of cholera near the junction of the canal with the Almendares River. Finlay reported his suspicions in a letter to Havana's principal newspaper, but the government censor refused to permit its publication.

Four years later he presented his first paper on yellow fever before the Havana Academy of Sciences. One of the most baffling of diseases, it had



John Keasley Mitchell was one of the celebrated faculty members at Jefferson Medical College who taught Finlay as did his son S. Weir Mitchell.

Painting shows Finlay offering mosquito eggs to the American Commission on Yellow Fever. From left, Drs. Jesse Lazear, Carlos Finlay, Jr., James Carroll, Walter Reed, A. Diaz-Albertini.

for centuries been a widespread and wholesale killer, the principal scourge of the hot countries in the Western hemisphere. Mortality rates averaged 50 percent, and the disease ravaged most of the West Indies and tropical South America, almost all of Central America and Mexico and threatened cities as far north as Montreal and Quebec. The pestilence took more than 13,000 lives in the Mississippi Valley in the 19th century; by 1870 New York City had 23 epidemics, Philadelphia, 25.

For nearly 200 years Cuba had been a focus of chronic yellow fever, and Carlos Finlay became more than familiar with the characteristic symptoms. Many physicians tried the purging-plus-bleeding treatment advocated by the famous signer of the Declaration of Independence, Dr. Benjamin Rush; others prescribed burning gunpowder to purify the air, frequent changes of linen and bedclothes, carrying a handkerchief soaked in vinegar and camphor, the use of snakeroot and Peruvian bark.

Despite the lively controversy enveloping yellow fever, there were a few characteristics of the disease that were beyond dispute. It seemed to be a disease of the lowlands, rarely occurring in epidemic form above an altitude of 4000 feet; it was a "summer disease" of the temperate zones and was most frequently found in seaports; mortality

among whites seemed to be about 10 times that of blacks; and it was relatively rare among Chinese workers in the West Indies and Cuba.

THEORY. Finlay's attack on yellow fever was scientifically sound. First he searched ancient records, including those of the Mayas, that spoke of what seemed to be yellow fever. Then he began gathering his own data on the disease. In Havana he found that the epidemics occurred most seriously among white visitors to the island. While the natives had acquired some degree of immunity, nearly every foreigner came down with yellow fever within the first two years. He learned that boats loaded at Havana sailed with their holds sealed, but when the holds were opened on arrival at a distant port, yellow fever broke out. He ascertained that the incidence of disease decreased when the temperature dropped

City block in Santiago de Cuba is covered and sealed for fumigation in the countrywide effort to destroy the vectors of yellow fever in Cuba.

to 50 or 60 F. and entirely disappeared when the freezing point was reached.

Finlay was at first lured by climatic theories. Finding an excess of alkalinity in the Havana air, he tried to relate it to the changing incidence of yellow fever. He also theorized that filth was perhaps converted into some vegetable-animal germ.

The American Yellow Fever Commission that studied the disease in Cuba in 1879 issued a confusing report that included Finlay's theory on the alkalinity of the air. The value of the Commission to Finlay's work was that he met Rudolph Matas, Juan Guiteras, and bacteriologist George M. Sternberg. The Commission left numerous specimens with Finlay and on one slide he noticed that red blood globules were discharged unbroken into the hemorrhages of yellow fever, and noted in his journal: "it occurred to me that in order to inoculate yellow fever it would be necessary to pick out the inoculable material from within the blood vessels of a yellow fever patient and to carry it likewise into the interior of a blood vessel of the person who was to be inoculated."

About this same time Finlay was reading a book on botany by Philippe Van Tiegham in which was described the evolutionary cycle of a parasite of wheat. The spores of this fungus were thought to be able to germinate only on another plant. This triggered in Finlay the idea that there might be an equally indispensable intermediary between one case of yellow fever and the next. One night, while saying his Rosary, Finlay was distracted by a persistent mosquito, and it came into his mind that this insect might be the vector.

Insects as vectors had been considered as far back as ancient Egypt and Babylon. The American physician John Crawford about 1800 was the first to write that insects caused yellow fever, and Josiah C. Nott in 1848 argued that both yellow fever and malaria were caused by some insect or animalcule; the Venezuelan physician Louis D. Beauperthuy agreed with him, saying that mosquitoes carried the poison of infection derived from dirty marsh water.

With the aid of the Cuban naturalist Felipe Poëy, Finlay began to concentrate on the Culex. The silver-striped female bit human beings after she was fertilized and laid eggs several times after gorging on blood. He learned that the cooler hours of the morning and evening were her favorite hunting times and that she could be destroyed by high temperatures; that the Culex was not found on the plains, away from rivers; that she flew badly at altitudes above 1200 feet; that she could travel in closed baggage; and that her eggs could withstand dryness for months before hatching.

In February, 1881, Finlay was sent by the Spanish government to the International Sanitary Conference at Washington, D.C., where he presented a paper. With his characteristic caution and modesty, Finlay outlined the three conditions necessary for the propagation of yellow fever; the presence of a previous case of yellow fever within certain limits of time; the presence of a person in a condition to contract the disease;

and the presence of an independent agent to convey the disease from the yellow fever patient to a healthy individual.

Although convinced that the mosquito was the culprit, Finlay wanted to complete his laboratory research before making an official announcement. He had been making an intensive study of the mosquitoes' anatomy and physiology, and he concluded that the insect's proboscis acted in the same way that a hypodermic needle would to transfer the disease from one organism to another. He theorized that with captive mosquitoes he might succeed in producing mild, abortive cases of yellow fever that would immunize consenting subjects. To test this theory he found twenty Spanish soldiers who volunteered for the experiment. Finlay had a mosquito bite a patient who was in his fifth day of yellow fever, and 12 days later had the mosquito bite a volunteer; nine days later the volunteer was hospitalized with yellow fever. He inoculated four more patients, one of them without results, and also observed that the other 15 soldiers, living under the same conditions as those inoculated, did not develop the disease.

Thus encouraged, Finlay presented his previously mentioned paper to the Royal Academy in Havana, definitely naming the mosquito as vector. He admitted that there was no proof that his volunteers might not have acquired the disease independently of his inoculations and that a single bite of the infected mosquito had not produced a fatal case. His theory was too revolutionary for his colleagues and its immediate results only earned him the sobriquet of "mosquito doctor."

Later in the year Sir Patrick Manson, a pioneer in tropical medicine, published his discovery of the indirect transmission of filaria by the mosquito; he demonstrated that embryos of the minute worms were ingested from human blood, developed in the insect's body, and were transmitted when the mosquito again bit a human being. His finding, like that of Finlay's, was not generally accepted.

EXPERIMENTATION. Doggedly Finlay continued his studies, with the help of his loyal disciple Dr. Claudio Delgado and a group of Havana Jesuits who voluntereed for his experiments. In 1884, Finlay reported a comparative study of spontaneous and experimental yellow fever. At the same time, he tried to find a way to immunize against the disease. He identified a micrococcus that he thought might be the agent, and the cultures were studied by William Henry

A result of the confirmation of Finlay's theory was the widespread control of mosquitoes. These burly men are fumigators in New Orleans in 1914.

Welch and William Osler at Johns Hopkins University; the effort was a prestigious failure.

In 1893 Finlay inoculated 13 Spanish artillerymen with a blister serum from an active case of yellow fever; none of the men had contracted the disease as late as 1895, although yellow fever had swept through the garrison many times. In that year Finlay reported to the Eighth World Congress of Hygiene and Demography the preventive measures he considered valid: isolation of patients, fumigation of houses, extermination of mosquitoes. No action was taken in support of his theories.

When the United States declared war on Spain in 1898 Finlay went to Washington to persuade his old friend George Sternberg, now Surgeon General of the Army, to send another commission to Cuba. Sternberg refused, since Wyman, Surgeon General of the U.S. Public Health Service, had already assigned two physicians, Wasdin and Gedding, to study yellow fever in Cuba. Failing this, Finlay, who in spite of being 65 years old, volunteered to serve in the American army of occupation as surgeon, returning to civilian life in September, 1898, at the end of the war.

In 1899 Wasdin and Gedding reported that *Salmonella icteroides,* or Sanarelli's bacillus, was the cause of yellow fever and stated that infections were contracted through the respiratory tract. Sternberg doubted this, and when a few months later he became Surgeon General of the U.S. Public Health Service, he appointed a com-

mission to give full attention to the etiology and prophylaxis of yellow fever. The Commission consisted of Major Walter Reed, chairman and a bacteriologist, and surgeons Aristides Agramonte, James Carroll, and Jesse W. Lazear and they met for the first time in Havana in June, 1900.

This same year Finlay also received his first official support, which came from two distinguished British physicians, H. E. Durham and Walter Myers. They stopped off in Havana in 1899 on their way to study yellow fever in Brazil, met Finlay, and took careful note of his findings. In September 1900 they published an article in the *British Medical Journal* expressing confidence in his theory. Over the past 20 years Finlay himself had written 45 scientific papers, most of which dealt with yellow fever.

Panamanian stamps in honor of Finlay. Among other things his conquest of yellow fever made possible the completion of the Panama Canal.

VINDICATION. The commission spent the bulk of the summer of 1900 determining that the Sanarelli bacillus was merely a ubiquitous contaminant. At a loss as how to proceed, they turned to Dr. Finlay. He produced all the facts that he had accumulated over the years, gave them mosquito eggs and instructions on how to hatch them, aided them in every way he could. In August, 1900, Dr. Carroll, in a spirit of jest, allowed himself to be bitten by a mosquito that had gorged on a yellow fever patient 12 days earlier; three days later he became ill, and barely survived. Dr. Lazear was bitten by a mosquito that had been infected 10 days earlier; in 12 days he was dead.

Major Reed continued making controlled experiments, refining Finlay's techniques, and he found that the virus was transmissible to the female mosquito from an affected patient only during the first three to six days of the illness, and that the female mosquito must then incubate the virus for about 12 days before her bite could be infectious. Speaking before the American Public Health Organization, Major Reed stated that the mosquito "serves as the intermediate host for the parasite of yellow fever," and he gave Finlay complete credit for the discovery. General Leonard Wood, military governor of Cuba, paid tribute to Finlay: "The confirmation of Dr. Finlay's doctrine is the greatest step forward made by the medical sciences since Jenner's discovery of vaccination."

Early in 1901, Major Gorgas, the U.S. army physician in charge of measures against Culicidae, the family that includes mosquitoes, sent his brigades through Havana, destroying all water deposits where mosquitoes could lay eggs and providing covers for cisterns; six months later the last case of yellow fever was recorded in Havana.

Homage came from all over the world to Finlay, the modest physician who had clung to his brilliant hypothesis against widespread disbelief. Honorary degrees were awarded by his alma mater and other institutions, including the Liverpool School of Tropical Medicine; a bust of him was erected in the court of the Public Health Department building in Havana; he became an officer of France's Legion of Honor and Cuba created the Finlay Order of Merit. He was proposed for the Nobel Prize three times and in 1959 was nominated to the Hall of Fame for Great Americans at New York University.

LAST YEARS. Finlay became the first sanitary director of Cuba in 1902 and held the post for seven years, during which time he directed the battle against mosquito-borne diseases, tuberculosis, tetanus, infantile paralysis, and typhoid, and he instituted nationwide vaccination against smallpox.

Finlay also developed an antiseptic dressing for use in infantile tetanus, largely the result of the traditional use of cobwebs as a dressing for the newborn's navel. He published clinical observations on goiter, trichinosis, relapsing fever, wrote on filariasis, beriberi, leprosy; in general medicine he reported on hernia, anesthesia, electrotherapy, heart disease.

After he retired in 1909, Finlay's health began to fail. His speech impediment of earlier years became a pronounced stutter and he developed a facial palsy. On August 20, 1915, at the age of 82, he suffered hallucinations and fainted after a cold bath; he died in the arms of his physician son, Carlos Finlay, to become forever enshrined in the annals of medicine.

SUMMING UP. By Dr. Félix Martí-Ibáñez: "Finlay had simplicity coupled with aristocracy of the spirit."