



BIOGRAPHICAL MEMOIRS

LUIS SEQUEIRA

September 1, 1927–July 25, 2021

Elected to the NAS, 1980

*A Biographical Memoir by Caitilyn Allen,
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LUIS SEQUEIRA HAD an extraordinary career in plant pathology and was recognized internationally for his seminal contributions to plant disease physiology and phytopathology. He and his colleagues focused on elucidating the host-parasite interactions involving infections by the wilt-inducing bacterium *Pseudomonas* (now *Ralstonia*) *solanacearum*). He was also a gifted and beloved teacher, whom generations of students consistently rated as superlative and gracious. Sequeira served in numerous influential positions, including on several editorial boards, the National Science Board, and as president of the American Phytopathological Society. Among his honors were membership in the Linnean Society of London; a named professorship at the University of Wisconsin-Madison (the J. C. Walker Professor of Plant Pathology and Bacteriology); and the E. C. Stakman Award from the University of Minnesota. He was elected to the National Academy of Sciences in 1980 and subsequently chaired its Section of Agricultural Sciences.

THE EARLY YEARS

Luis Sequeira was born on September 1, 1927, in San José, Costa Rica, to Raúl and Dora (Jenkins) Sequeira. His mother, through her gentle yet firm disposition, influenced him greatly, but she died prematurely when Sequeira was only fourteen, leaving her husband to raise four young boys. His father, whom Luis came to admire and emulate, was a talented and ambitious businessman. The family was brought

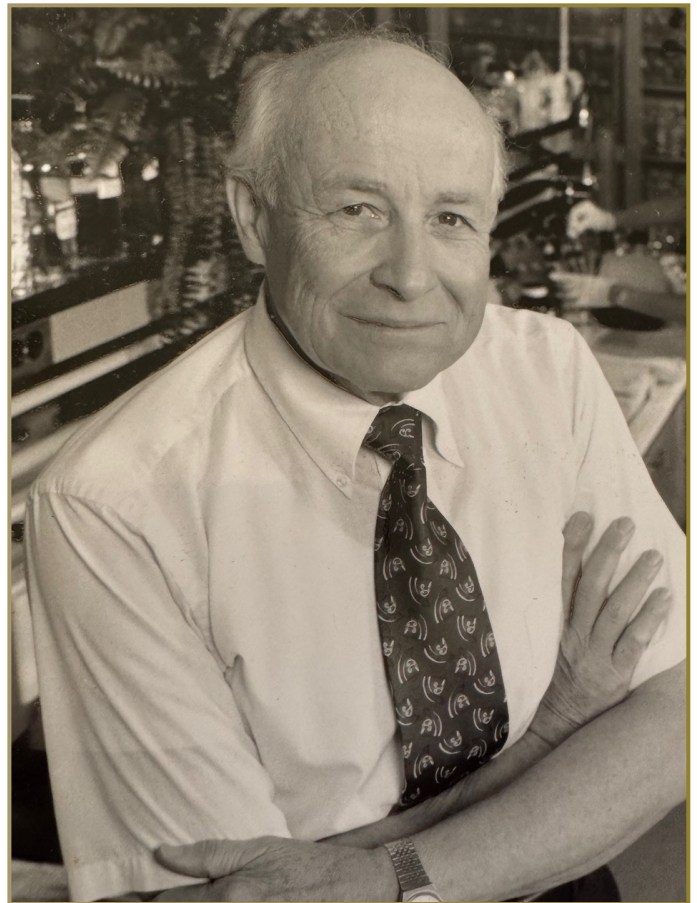


Figure 1 Luis Sequeira. Photo by Jeff Miller / University of Wisconsin–Madison.

up in an environment where respect for your elders, reliability, integrity, and hard work were the guiding principles. Sequeira attributed his lifelong interest in biology and natural resources to many summer vacations spent happily observing and helping his several uncles, who operated farms or cattle ranches in the countryside, as well as to the gifted teachers that he had in high school.

Sequeira entered Harvard University in the summer of 1945 and went on to receive his bachelor of arts (cum laude),



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master of arts, and PhD degrees there, the latter in 1952 at age twenty-five. His initial interests were in invertebrate zoology, the subject of his undergraduate thesis. He recalled these years as happy, perhaps largely so because he again fell under the spell of remarkable mentors, none more so than William “Cap” Weston, a kindly teacher and eminent mycologist. Weston had done research in the Philippines and encouraged Sequeira to take a course in tropical plant pathology in Cuba. As a result, Sequeira realized the devastating nature of disease epidemics in such crops as coffee, cacao, and sugar cane. He also chanced to meet, during a visit to a tropical research institute in Costa Rica, Frederick Wellman, a researcher from the U.S. Department of Agriculture who was exploring coffee diseases. This man captivated Sequeira with his vivid descriptions of coffee-spot disease, at the time a serious problem. More importantly, Wellman suggested that Sequeira study mycology under the direction of Weston instead of pursuing zoology. Sequeira would later characterize these two fortuitous events as his “backdoor route to plant pathology.”¹

Weston agreed that Sequeira should focus his research on a fungal pathogen of a commodity of economic importance in Costa Rica. His thesis was the first of many studies in plant disease physiology that would become the hallmark of Sequeira’s career. Fortunately, the Harvard biology faculty included renowned plant physiologist Kenneth V. Thimann, an expert on auxin plant-growth regulators. He became a second mentor to Sequeira, overseeing his research on *Omphalia flavida*, the agent of the American leaf spot disease of coffee (the same disease he had witnessed destroying Wellman’s experimental plots). Under Thimann’s oversight and in collaboration with fellow graduate student Taylor Steeves, Sequeira showed that infected coffee trees lost their leaves because the pathogen makes an enzyme that degrades auxins.² This was the first demonstration that an auxin-inactivating enzyme produced by a fungus could induce a specific disease symptom and the first report that a plant hormone imbalance can be caused by increased auxin degradation rather than increased auxin synthesis.

Clearly, both Weston and Thimann were an indelible influence on Sequeira, not only through their brilliance, but also because of their extraordinary kindness, graciousness, and generosity. Sequeira shared these qualities, and they became the standard for how he treated colleagues, especially his many graduate students, throughout his career.

PLANT PATHOLOGY IN THE JUNGLE

Following brief postdoctoral work in São Paulo, Brazil, Sequeira returned to Costa Rica set on a career in fungal physiology. No such opportunities presented themselves. In due course, however, a friend introduced him to the head

of plant pathology for the United Fruit Company, which promptly hired and dispatched him for what would become an eight-year research assignment managing a remote jungle outpost in Coto, Costa Rica. The facility was rudimentary, lacking even a functional laboratory, and supplies could only be shipped by slow and unpredictable rail. Improvisation was necessary, and Sequeira used sharpened, flame-sterilized pencils instead of inoculating needles and a kitchen pressure cooker instead of an autoclave. Each day brought new challenges—how to use spray equipment, how to diagnose and treat multifaceted plant problems—but also the beauty and mystery of the jungle habitat and interesting puzzles to solve. He described the experience as “plant pathology at the front lines.” Among his other investigations, Sequeira diagnosed a bacterial wilt (Moko disease) of the banana caused by the pathogen *Pseudomonas* (now *Ralstonia*) *solanacearum*, which began his lifelong exploration of this organism. It is telling that, notwithstanding the handicaps of a remote location, Sequeira made several important scientific discoveries in Coto. He was the first to show that using oil sprays to control Sigatoka leafspot disease of bananas reduced crop yields, paving the way for development of effective alternative controls that did not reduce yield. This discovery saved millions of dollars for the banana industry across the tropics. Most notably, he argued that the Moko disease bacterium originated in native *Heliconia* plants and jumped from the jungle to a new host when bananas were introduced to Central America from their origin in southeast Asia. Decades later, genomic data proved him right.

The Coto research outpost increased in staff and included the occasional visiting consultant sent by United Fruit. One of these experts was Arthur Kelman, at the time associated with North Carolina State University (Raleigh). This encounter in the wilds of Costa Rica was the plant pathology counterpart to the prescient meeting of Henry Stanley and David Livingstone in Africa. Sequeira and Kelman became lifelong collaborators and close friends. In 1960, Sequeira left the jungle for a sabbatical leave from United Fruit in Raleigh, and in 1961 he was offered a faculty position (on Kelman’s recommendation) in the Department of Plant Pathology at the University of Wisconsin-Madison. Kelman would join him there in 1965 as a faculty member and chair of the department.

WISCONSIN (1961–92)

Relishing the novelty of academic freedom at a campus that allowed faculty to pursue their own interests and in a department with a broad view of its mission, Sequeira launched a career centered on the physiology of host-parasite interactions and his global interests in plant pathology. His early studies combined his experience with *P. solanacearum*

in Costa Rica and the work at Harvard on plant growth hormones. Following up on the observation that the bacterium elicits growth abnormalities in host plants, Sequeira used a tobacco-*P. solanacearum* model system to investigate synthesis and degradation of the auxin indoleacetic acid (IAA) in bacterial wilt. He then devised a radiochemical method that determined the relative contributions of host and parasite to the synthesis of IAA in infected tissues, a discrimination that had stymied previous researchers. He and collaborators went on to explore the accumulation of defensive secondary metabolites such as phenolic compounds, which he expertly purified from large volumes of infected plant tissue. He showed that the synthesis of aromatic amino acids in plants is controlled by cross-pathway regulation, implying that precursor availability is a major factor regulating the synthesis of secondary metabolites. Both findings underpinned important concepts in plant intermediary metabolism.

In parallel with these fundamental studies of disease physiology, Sequeira continued to research bacterial wilt in a translational framework. His students isolated *P. solanacearum* from Asia, Latin America, and Africa, working to understand pathogen dissemination and survival, as well as seeking ways to manage the disease. Much of his practical research was in an exceptionally productive collaboration with the International Potato Center (CIP) in Peru, especially in efforts to select potatoes with resistance to bacterial wilt. He never stopped advocating for the research and training needed to ensure sustainable production of key tropical crops.^{3–5}

Beginning in the 1980s, Sequeira and colleagues developed molecular tools to explore the genetics of *P. solanacearum* virulence and phylogeny, thereby making bacterial wilt one of his discipline's most powerful model pathosystems. This pioneering work allowed the Sequeira lab and others to identify key virulence factors, including extracellular polysaccharides (EPS), type III-secreted effectors, plant cell-wall-degrading enzymes, and a network of global regulators. His lab conducted the first molecular analyses of evolutionary relationships in what is now known as the *Ralstonia solanacearum* Species Complex. Sequeira would not have been surprised by the tremendous diversity revealed in *Ralstonia* genomes (including those of hundreds from his own large strain collection); he had himself described the group as “a mutable and treacherous tribe.”⁴

Sequeira was renowned for his creativity and high standards of excellence in research. This is attested to, in part, by his decades of continuous competitive extramural funding from numerous federal agencies, including the National Science Foundation (NSF), the Department of Energy, and the U.S. Department of Agriculture (USDA), as well as from non-profit organizations such as the International Potato Center and the Rockefeller Foundation.

TEACHER AND MENTOR

Sequeira's experience as a teaching assistant at Harvard convinced him that he enjoyed teaching. When he took up the appointment at Madison, teaching became an important part of his academic life. By his own estimation, he taught graduate or undergraduate courses nearly every semester until he retired after thirty-two years. They ranged from seminars, introductory classes for plant pathology majors or non-majors, and advanced courses in disease physiology. He was consistently rated by students as a superlative teacher. Sequeira's lectures were memorable and profoundly scholarly, weaving key biological concepts into rich narratives that included relevant history, economics, politics, and human interest. His graduate courses explained both a current model and the hypotheses and experiments that built and supported it. Students did not merely memorize terminology and facts in Sequeira's courses; rather, they learned how the process of scientific research creates knowledge.

Sequeira was a generous and deeply engaged mentor to dozens of graduate students and postdocs, many of whom went on to lead research groups of their own. From him they acquired high standards in research and professional communication (he was a stickler for clear scientific writing). He also offered a shining example of kindness, loyalty, and patience. Sloppy science irritated him, to be sure, but his critiques were laced with compassion. As he remarked about an erring colleague, “I'm sure what he *actually* meant was....” Sequeira's remarkable memory, which shaped both the originality and the quality of his research, regularly impressed his mentees. He seemed to have details of every relevant publication at his fingertips, from the broader finding to the authors, journal, year, and sometimes even the volume number.

SERVICE AND ACCOLADES

Sequeira was active for his entire academic career in the American Phytopathological Society (APS). He served multi-year terms as senior editor and then editor-in-chief of its two major journals, *Phytopathology* and *Molecular Plant-Microbe Interactions*, and he was vice-president, president-elect, and then president of APS between 1983–86. Among other things, his leadership led to the creation of two enduring and important offices for the society: the APS Foundation and the Office for International Programs. He was elected a fellow of APS in 1971 and subsequently received the society's most prestigious accolade, the rarely bestowed Award of Distinction in 1994, accorded to recipients for “exceptional productivity in research, inspiring leadership, and effective application of plant pathology for the benefit of humanity.” In 1991, he was elected honorary president of the Phytopathological Society of Costa Rica.

Sequeira was elected to the National Academy of Sciences in 1980 and later served for several years as chair of its Section of Agricultural Sciences. In 1978, he was honored with the privilege of holding a cross appointment with the Department of Bacteriology. In 1982, he was invited to be a resident scholar at the Rockefeller Foundation's think tank, the Bellagio Conference and Study Center, in Bellagio, Italy. Also in 1982, Sequeira was appointed the J. C. Walker Professor of Plant Pathology by the University of Wisconsin, an honor he held until he retired in 1993. In 1987–88, Sequeira took a faculty leave of absence to serve as chief scientist of the USDA's Competitive Grants Office. He was elected a fellow of the Linnean Society of London in 1990. In 1992, the Department of Plant Pathology at the University of Minnesota awarded him its coveted E.C. Stakman Award for superlative performance, citing his international preeminence in phyto bacteriology and plant disease physiology.

By virtue of Sequeira's brilliance, engaging personality, and the preeminence of his research, he was routinely selected for service on various panels of the NSF and other federal agencies as reviewer of research proposals and programs. He served as editor, associate editor, or an editorial board member for multiple scientific journals and as an advisor in various capacities to societies and publishers. For example, for many years he was on the editorial committee of *Annual Review of Phytopathology*. Likewise, he was sought out by universities as a guest lecturer and as an invited speaker at national and international conferences.

LATER YEARS

Retirement provided the opportunity for Sequeira to extend his professional society and consulting activities. He was associated with multiple organizations, including the World Bank, the NSF, the International Late Blight Research Program in Toluca, Mexico, the USDA, the Smithsonian Institution, and the University of Queensland, all of which required frequent national and international travel. He was a consultant from 1994 until 2001 with the Australian Cooperative Research Centre for Tropical Plant Pathology established at the University of Queensland (Brisbane). His role was to assess the quality of the research outputs, confer with the graduate students, and advise the board on cutting-edge research.

From 1998 to 2004, he served on the National Science Board (NSB), the presidentially appointed committee that governs the NSF and provides independent science policy advice to the president and the U.S. Congress. In 2003, as a member of the NSB, he joined a team that reviewed scientific programs at McMurdo Station in Antarctica and the South Pole, delighting in this opportunity to meet young scientists

doing field research on the microbiomes of glaciers and subterranean lakes.

Sequeira died in 2021 at age ninety-three. He was preceded in death by his wife, Elisabeth, who was his devoted partner and astute adviser from the early days in the Costa Rican jungle to the later days as an eminent scholar. Together they raised four children: Anabel, Marta, Robert, and Patricia.

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