



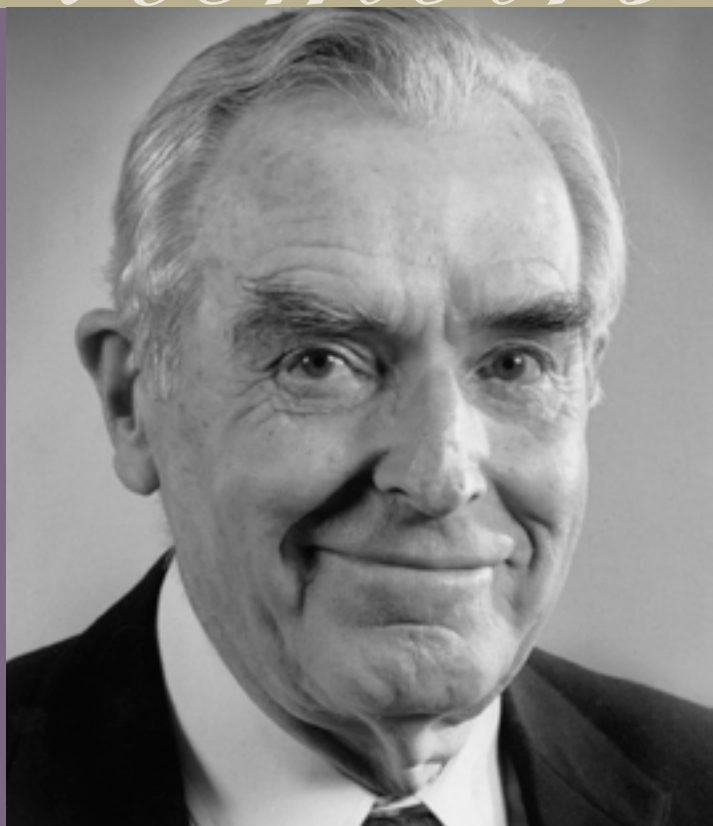
**George A. Zentmyer**  
1913–2003

BIOGRAPHICAL

*Memoirs*

*A Biographical Memoir by*  
*Donald A. Cooksey*

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# GEORGE AUBREY ZENTMYER

August 9, 1913 – February 8, 2003

Elected to the NAS, 1979

Any appreciation of the life and work of George A. Zentmyer must begin with a brief primer on an infamous ravisher of valuable vegetation around the world, the genus *Phytophthora*. Indeed, the name *Phytophthora* comes from Ancient Greek words meaning “plant destroyer.” *Phytophthora* is an oomycete, a funguslike organism that causes economically important diseases in a wide range of crops and natural plant systems. Control of diseases caused by *Phytophthora* is difficult, and the development of resistant plant varieties is often the best longterm solution.



By Donald A. Cooksey

When George Zentmyer started work at the University of California Citrus Experiment Station in Riverside in 1944, a growing California avocado industry was facing an epidemic tree-decline disease, which he would confirm was caused by *Phytophthora cinnamomi*. With research support from the California Avocado Society, George began a career-long investigation into the biology of this disease and how to control it. During extensive travels over several decades to Mexico, as well as Central and South America, he searched through the native habitat of the avocado, *Persea americana*, and relatives in the genus *Persea*, to collect thousands of specimens that were tested for resistance to *P. cinnamomi*. Significant resistance was found, and the first resistant clonal rootstock in California, Duke 7, is still in wide use today. Other varieties were subsequently developed with greater resistance to *Phytophthora*, and George’s selections are the basis of continuing avocado breeding efforts at the University of California, Riverside.

George also contributed strongly to our fundamental understanding of the biology of *Phytophthora*. He studied chemotactic attraction of *Phytophthora* zoospores to the zone of elongation of roots, as well as chemotropism of zoospore germ tubes that were oriented

to grow toward the root zone. Researching further, he identified particular amino acids in root exudates as signals for these responses. He found that other soil microorganisms stimulated production of sporangia by *P. cinnamomi*, described both heterothallic and homothallic sexual recombination in the species, and identified specific components of root exudates that stimulated oospore production.

George's work on the saprophytic capabilities of *P. cinnamomi* helped explain its invasiveness when it spread to new areas. He was a pioneer in research on biological control of *Phytophthora* root rot, showing that the addition of alfalfa meal to soil

reduced the severity of root disease on avocado. On further investigation he was able to attribute this biological control effect to increases in general microbial populations, to saponins in the alfalfa meal, and to ammonia produced during decomposition of the alfalfa meal. He also showed the value of starch and acrylamide gel electrophoresis of proteins as an approach to the taxonomy of several species of *Phytophthora*.

The prime mover behind these vital advances in plant pathology was born on August 9, 1913, in North Platte, Nebraska. George Zentmyer's interest in plant pathology grew out of his experiences during a summer vacation at age 15, when he was invited to work with his uncle Arthur Strahorn—a U.S. Department of Agriculture soil scientist studying smelter damage to coniferous forests in northern Washington. A young forest pathologist working with his uncle showed George tree diseases he was studying and explained many aspects of fungi, diseases, and how they are spread and controlled. Many of their discussions took place while they were trout fishing in the mountains on weekends and evenings, which helped establish a strong connection for young George between his love for the outdoors and the scientific discipline of plant pathology. He decided then to pursue forest pathology as a career.



Avocado root rot symptoms caused by *Phytophthora cinnamomi* in California.

(Photo courtesy George E. Goodall, [Avocadosource.com](http://Avocadosource.com).)

After completing a B.A. with honors in botany in 1935 and an M.S. in 1936 from the University of California, Los Angeles, he enrolled in the UC Berkeley graduate program in plant pathology, earning his Ph.D. in 1938. He accepted his first full-time position in 1937 at the USDA Division of Forest Pathology in San Francisco to work on forest disease problems in the Pacific Northwest. As part of a forest pathology research team, he helped monitor the spread of white pine blister rust from Oregon into northern California, spending considerable time scouting for the disease in the northern Sierra Nevada range. George was particularly impressed by how fast and far the spores of this fungal pathogen could travel through the air.

In 1940 George moved to the Connecticut Agricultural Experiment Station in New Haven to work with the great plant pathologist James G. Horsfall. There he focused on another destructive forest and shade tree problem, Dutch elm disease. His early work in chemotherapy for this disease led to the identification of several classes of chemicals that were effective in treating young trees with the disease. Unfortunately, these early fungicides were unable to achieve true systemic penetration, thus producing less definitive results with larger trees.

George's approach to this project took on a whimsical aspect when he began using inexpensive ale cans from a local brewery to hold the fungicide solutions as they were dripped into holes bored into the tree trunks, rather than the expensive flasks from scientific supply houses that were used in earlier trials. In his 1994 retrospective published in the *Annual Review of Phytopathology*, George noted that "the ale was only of modest quality but the containers were superb." He also noted how local citizens' curiosity was aroused when they saw trees along New Haven streets with ale cans hanging from their trunks.

One of George's most important contributions during his work in Connecticut occurred when he hypothesized that one of his more effective fungicides against Dutch elm disease, 8-hydroxyquinoline sulfate, a chelating agent, might hinder the growth of fungi by inhibition of metal catalysis, due to its chelating ability. This idea led to experiments confirming that chelating chemicals could reduce growth and reproduction of several fungal pathogens, and that fungicide activity could be reversed by adding important metal cations back to the system. His "chelation theory" was published in *Science* in 1944.

After four years in Connecticut, George accepted a position at the University of California Citrus Experiment Station in Riverside in 1944. This was where he turned his attention for the remainder of his career to the oomycete genus *Phytophthora*, with emphasis on the avocado decline disease that was causing serious losses in southern



Zentmyer at UC Riverside greenhouse screening avocado varieties for resistance to root rot.

California when he arrived. He soon confirmed that the disease was caused by *Phytophthora cinnamomi* and began his life-long research on the biology and control of this important pathogen and other species of *Phytophthora*. This work earned him a worldwide reputation in the field and election to the National Academy of Sciences in 1979.

George was an international scientist. His search for avocado varieties with resistance to Phytophthora took him to nearly every country in Central and South America and in the Caribbean. He noted in his 1994 retrospective that his travels involved many forms of transportation, from “dugout canoes to Boeing 747s.” He credited much of the inspiration for his avocado explorations to Wilson Popenoe, a horticulturalist who had been an avid collector of avocado varieties since 1913. George met Popenoe in the early 1950s in Honduras, where Popenoe was the director of the institution he founded, the Panamerican Agricultural School, Zamorano. They hiked up Mt. Uyuca together and collected fruit of a new species of avocado, *Persea nubigena*.

George and Popenoe continued a collaboration and friendship for over 20 years, including many visits to Popenoe’s final home in the city of Antigua, Guatemala. Later, George gained valuable assistance from a plant pathologist from Guatemala, Eugenio Schieber, who helped him collect many additional specimens, including several new species of *Persea*, from locations throughout Guatemala and other Central American countries.

In addition to travels related to the avocado root rot problem, George was also called upon to work on other important diseases caused by *Phytophthora* in various countries. In 1965 he was awarded a Guggenheim fellowship to collaborate with scientists in Western Australia, where they established that *Phytophthora cinnamomi* was the cause of a destructive dieback epidemic in the native Jarrah eucalyptus forests. In the 1960s he began a 25-year project, funded by the American Cocoa Research Institute, on the black pod disease of cacao, which took him many times to countries where cacao is grown as a commercial crop for chocolate, including Brazil, Costa Rica, and parts of west Africa. While it had been thought for years that one species of *Phytophthora*, *P. palmivora*, was responsible for this severe disease, George and collaborators in several countries showed that four different species of *Phytophthora* could cause it. He also served as a consultant in many countries on other plant diseases caused by *Phytophthora*, including Spain, Australia, Ghana, Nigeria, South Africa, and Malaysia.



Zentmyer examining *Phytophthora* spores at UC Riverside.

George officially retired in 1981, but he continued active research and professional activities for many years afterward. He served as associate editor of the *Annual Review of Phytopathology* from 1972 to 1994 and was a leader in the American Phytopathological Society (APS) as secretary (1959-63), vice president (1964), president-elect (1965), and president (1966). In 1981 he received the highest honor the APS bestows, the Award of Distinction, which has been granted to only 13 scientists in the last 45 years for truly exceptional contributions to plant pathology.

During his career at Riverside, George saw the University of California Citrus Experiment Station establish a College of Letters and Science and offer its first classes in 1954, then become a general campus in 1959. At UC Riverside, he made many valuable contributions to instruction and to campus leadership. He taught advanced plant pathology, supervised 15 students in the plant pathology Ph.D. program, and trained many post-doctoral and visiting scientists. He served on many academic senate committees and as chairman of the Department of Plant Pathology from 1968 to 1973. He was selected as the UC Riverside Faculty Lecturer in 1964.





Zentmyer evaluating avocado rootstock varieties at one of many field sites in California.

(Photo courtesy George E. Goodall. Avocadosource.com.)

George was active in many community activities, including leadership on the board of directors of the UC Riverside Botanical Gardens and support for the Riverside Hospice, YMCA, UCR Museum of Photography, and Riverside County Philharmonic. He had an excellent voice and sang in both community and campus chorale groups. He was a tall and impressive-looking man but soft-spoken, modest, and almost always with a smile on his face. He was a sports enthusiast, almost deciding to become a sportswriter after serving as sports editor for his high school newspaper and yearbook and sportswriter for the UCLA newspaper as an undergraduate. He remained active in sports such as handball, racquetball, and tennis until late in life. I had the pleasure of playing tennis with George one last time not many years before his death, shortly after he had knee replacement surgery. He was a little unsteady and not as fast as in his younger years, but his competitive spirit, and accurate shots, were still there. George Zentmyer passed away on February 8, 2003, at the age of 89.

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