THE PARAMAGNETIC FORCE IN PLANT GROWTH AND INSECT CONTROL

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It is a mystery how someone who was born in Menlo, Iowa in 1909 and in 1941 completed all of his undergraduate and graduate education at George Washington University in Washington, D.C. decided to pursue a career in medical and veterinary entomology. At 17 years of age, Carroll Newton Smith worked as a Congressional Page. He liked to joke that he began only 6-7 steps from the U.S. Presidency and retired at least 20 steps away, having attained the rank of GS-15 in the interim. In 1935, after finishing his M.S. degree, he was employed by the USDA as a Junior Entomologist in Washington D.C. and advanced from Associate Entomologist to Entomologist during 1937-41 while earning his Ph.D. degree (Weidhaas et al. 1993). He conducted fundamental research on the biology and control of the American dog tick on Martha's Vineyard during the latter period. He worked for the USDA in Savannah, Georgia in 1941-1946 conducting research on insecticides, insect repellents and the attraction of biting insects to humans. He continued this work after transferring to Orlando in 1946 and subsequently conducted pioneering research on radiation, chemosterilization and the genetics of insect candidates for the sterile insect technique. The wide range of arthropods used in his research included ticks, mites, mosquitoes, lice, fleas, cockroaches, ants and flies, notably the tsetse fly. Later in his career, he developed a passion for editing and collaboratively produced several excellent books: *Principles of Insect Chemosterilization, History of Entomology and Insect Colonization and Mass Production* (a personal, signed copy given to the senior author). He also served as an editor for the Annual Review of Entomology published by Annual Reviews in cooperation with the Entomological Society of America (Anonymous 1989). Incredibly, he read and edited every scientific paper written by his staff members over the years. He came by this proclivity naturally because his father was a newspaper editor. Dr. Smith also liked to travel around North America and to foreign countries in Europe, Africa, and Asia. Unlike many entomologists, he did not collect insects, rather he enjoyed other professional activities; socializing with colleagues; spending time with his wife, Charlotte, gardening and walking; and reading about a wide range of subjects.

Dr. Smith became an administrator in the USDA, Bureau of Entomology and Plant Quarantine at the beginning of an exciting new era. Post-World War II expansion of the sciences, including entomology, created a need for more Ph.D. scientists and an opportunity for administrators to acquire them and build new research programs around their expertise. At that time, the Bureau was organized by discipline into a system of "branches" led by experts who administered laboratories focused on specific pest problems and control technologies. Dr. Smith served as director of the Insects Affecting Man and Animals Research Laboratory (IAMAL) in Orlando beginning in 1954, having been a scientist in the laboratory since 1946. This laboratory in the Insects Affecting Man and Animals Branch was established in 1942 to develop technology for protecting military personnel from insect vectors of disease. The highly effective and widely used insect repellent, N,N-diethyl-*meta*-toluamide (DEET), was discovered and developed at the laboratory for a variety of applications. It was used first by the military in 1946 and became available to the public in 1957 (EPA 1998). Various formulations of DEET are used to provide protection against mosquitoes, biting midges, black flies, deer flies, horse flies, sand flies, stable flies, gnats, fleas, mites and ticks. As the only scientist in the laboratory with a Ph.D. degree in 1954, Dr. Smith immediately sought to increase the level of education of his staff members through both graduate training at universities and recruiting. The first scientist he hired graduated from Cornell University in 1955, Dr. Donald E. Weidhaas, who ultimately became his successor as director of the IAMAL. One of Dr. Smith's major assignments from the leader of the Bureau, E. F. Knipling (honored in Pioneer Lecture #2), was to move the laboratory in 1963 from Orlando to the campus of the University of Florida in Gainesville.

As the director of IAMAL from 1954 until 1968, Dr. Smith led a highly successful effort to build probably the world's premier medical and veterinary research laboratory. The Bureau of Entomology and Plant Quarantine was reorganized in the late 1960's, eliminating the branch system, creating the Agricultural Research Service (ARS) and several other federal agencies, and establishing a regional administrative structure. This resulted in less emphasis on the quality and application of scientific research and a more political orientation for the USDA. During this time, Dr. Smith intensified his efforts to strengthen the laboratory's research programs and fought the

*For Philip S. Callahan. Dr. Callahan has been unable to write a paper based on his Pioneer Lecture due to failing health.

USDA administration for causes that he thought were attainable. He left the laboratory in early 1969 well funded and still responsible for all testing of insecticides and insect repellents for the military. Dr. Don Weidhaas then became the director of IAMAL until his retirement in 1984 (Weidhaas & Corlew 2007).

After leaving the IAMAL, Dr. Smith literally moved next door to become director of the new Insect Attractants, Behavior and Basic Biology Research Laboratory (IABBBRL) (Fig. 1). This laboratory was established to develop non-chemical methods for controlling insect pests. Dr. Philip Callahan was one of the first scientists who transferred to the IABBBRL, focusing his studies on insect morphology and communication. He was formerly a member of the staff of the USDA, ARS Southern Grains Research Laboratory at Tifton, Georgia. Dr. Smith retired as director of the IABBBRL and from the USDA in late 1969, and was succeeded by Dr. D. L. Chambers who hired six new Ph.D.s: Drs. Milton Huettel (University of Texas, Genetics), Thomas Ashley (University of California, biological control), John McLaughlin (University of California, chemical communication), Patrick Greany (University of California, biological control), J. Sharp (University of Hawaii, flight behavior), and Norman Leppla (University of Arizona, rearing and reproductive behavior). The IABBBRL and IAMAL, renamed the Medical and Veterinary Entomology Research Laboratory in 1993, were combined to create the current Center for Medical, Agricultural and Veterinary Entomology, first under the directorship of Dr. Herbert Oberlander and then Dr. Kenneth Linthicum.

Dr. Smith developed progressively in his role as a scientific leader, not unlike others at the time, respected and followed because of his knowledge of entomology and willingness to share what he knew with scientists who earned his esteem. Although openly friendly and genuinely helpful to all members of his staff, he invested most of his attention in other senior scientists with whom he interacted frequently. He spent less time with junior scientists but it was a more formal time in history with greater separation between the generations. One staff member recalled that he an uncanny ability "to make me feel just as good leaving his office after he said no to my request as I felt when I entered!" In his earlier days as a scientist, as would be expected, Dr. Smith has been described by his cohorts as a 'cut up" who enjoyed socializing as well as long hours working on his research. This probably contributed to his reputation of later being a great host with lots of important visitors. He continued this practice of alternating hard work with relaxation throughout his career. This work ethic earned him the admiration of his staff members whom he also expected to work hard and be accurate and honest in their research. They have described him as a brilliant, methodical and analytical man who could be tough if necessary. He routinely corrected the misperceptions of others, above and below his position, without malice and tested their understanding by asking questions for which he already knew the answer. He was considered to be kind and gentle but determined and somewhat complex, a task master who kept his staff "in line." Political matters were not shared unnecessarily and he maintained confidentiality in conducting staff business. Dr. Smith was extremely protective of his staff members and did not allow them to be criticized, and his loyalty was reciprocated. He knew the "right" people and methods of negotiation to acquire resources for the laboratory. Dr. Smith was an unassuming yet exceptionally effective administrator.

Fig. 1. Center for Medical, Agricultural and Veterinary Entomology. The pictured building initially was the Insect Attractants, Behavior and Basic Biology Research Laboratory (photograph by Eric Daniels).

After retiring from the USDA, Dr. Smith immediately accepted a 1-year assignment with the World Health Organization (WHO) in India. He enticed Dr. Richard Patterson (the third author of this paper) from his former IAMAL staff to take a leave of absence from the USDA to help him build a laboratory and research program in New Delhi for developing methods to use the sterile insect technique for controlling mosquitoes. The Smith and Patterson families lived close to each other, shared meals and evening walks several times a week, and naturally developed a very friendly relationship. Happily, Dr. Patterson became accepted into Dr. Smith's inner circle of senior scientists. The overall objective of the work was to determine the most economically feasible method for inducing sterility, including irradiation, chemosterilization, and cytoplasmic incompatibility and other genetic mechanisms. Much of Dr. Patterson's research effort was focused on evaluating in the field the effectiveness of the various methods of sterilizing mosquitoes. After 11 months, Dr. Smith became 65 years old, the mandatory WHO retirement age. Consequently, Dr. Patterson became acting director of the laboratory until Dr. Germaine "Gerry" LaBrecque arrived in 1971. Although Dr. Patterson did not want to be the permanent direc-

tor, the transition could have created some friction if Dr. Smith had not anticipated this possibility and previously sent Drs. Patterson and LaBrecque on an assignment together in Puerto Rico. They became good friends and their cohesiveness carried over to assure their cooperation in India. After another two years, Dr. Patterson returned to Gainesville and became a Research Leader in the IAMAL. Dr. Smith also had returned to Gainesville but to enjoy his retirement and periodic international consulting. He and Charlotte also became active in serving the Gainesville community.

Dr. Smith had many important assignments and received considerable recognition for his service to humanity. He was an advisor to the Armed Forces Pest Management Board, a Courtesy Professor in the University of Florida, Entomology and Nematology Department, an associate member of the Rickettsial Disease Commission, and a member of the Malaria Commission of the Armed Forces Epidemiological Board, FAO Expert Panel on Tick Borne Diseases of Livestock, American Mosquito Control Association, Florida Anti-Mosquito Association, Society of Tropical Medicine and Hygiene, and Sigma Xi. He also was a consultant for the WHO Expert Panel on Insecticides. His awards included the American Mosquito Control Association Medal of Honor (1976), USDA Group Superior Service Award for developing DEET and other insect repellents (1958), and the Entomological Society of America Presidential Certificate signifying his election as the President (1964). In addition, he was an Honorary Member of the Entomological Society of America and the Florida Entomological Society (Weidhaas et al. 1993).

The lecture presented by Dr. Philip Serna Callahan emphasized the environmental hazards posed by the non-target effects of insecticides. This was not surprising since he spent much of his time in the IABBBRL studying alternatives to insecticides, some under Dr. Smith's leadership. One of these alternatives was trapping insects by developing devices that emit selected frequencies of attractive semiochemicals. Dr. Callahan graciously shared these kinds of ideas with those who attended the Pioneer Lecture. Many in attendance agreed with his views about insecticides and marveled at his ability to synthesize ideas and data from a broad range of sources. This ability probably stems from his varied background initially in radar and electronics, and later in zoology, more specifically ornithology and entomology. Dr. Callahan's background in radar and electronics came from his intensive training in the U.S. Army Air Force during World War II. He trained for a year and then received orders to man a radar station in Ireland. After the war, he was sent to Japan to help build radar stations. This accomplished "antenna expert" then returned to the States and enrolled in college. While observing insects under the microscope, he became absolutely delighted to discover antennal sensillae with shapes and relative sizes similar to the antennas made by humans. Understanding the ways in which these "miniature antennas" are involved in insect communication became a major emphasis of his career as a professional entomologist. His research was focused on studying relationships between insect morphology (form) and associated behavior (function). Much of this work has been published for readers of general science in books such as *Insects and How They Function, The Evolution of Insects and Tuning in to Nature*. Additionally, he is an avid naturalist, accomplished illustrator and enthusiastic lecturer.

Dr. Callahan was born at Fort Benning, Georgia and attended Fordham University (1949-51), the University of Arkansas (B.A. and M.S., 1951-54, zoology) and Kansas State University (Ph.D., 1954-56, Entomology). The title of his dissertation was "Reproductive Behavior and Oviposition of a Nocturnal Lepidopteran, *Heliothis zea* (Boddie) as Affected by Various Environmental Factors Such as Light, Color, Surface Texture and Nutrition." During 1956-62, he was a faculty member at Louisiana State University and later served as a Research Entomologist for the USDA, ARS from 1962 until 1986. He also was a very active member of the courtesy faculty of the University of Florida Entomology and Nematology Department from 1969 until his retirement in 1986. During his career he received many awards for his work, including a Superior Service Medal from the USDA, a Sigma Xi Distinguished Research Award from the University of Georgia Chapter, and election as a Fellow of the New York Explorer's Club. The Florida Entomological Society honored him as their sixth Pioneer Lecturer.

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