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James E. Duffus: Pioneering Sugarbeet and Vegetable Virologist

USDA-ARS Sugarbeet and Vegetable Research Station, Salinas, California

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James (Jim) Edward Duffus, 96, passed away in Salinas, California, on May 29, 2025. His beloved wife of 72 years, Racheal (Anderson) Duffus, passed away the previous December of 2024. Jim was born to John and Dorothy (Pellow) Duffus in Detroit, Michigan, on February 11, 1929. He was an only child described as being rather precocious. During the Great Depression, he witnessed his hard-working parents striving to make ends meet and learned through their example: that one should set their sight on a goal and work hard to achieve it. His father, an immigrant from Scotland, was a steel worker who walked the narrow beams of many skyscrapers and bridges around Detroit. He recruited Jim one summer to work as an apprentice. Having to face his fear of heights, Jim quickly learned that he needed to find a safer way to make a living, and after a long, hard summer, he decided that education was the answer. Although he had been a decent student, he quickly saw new meaning in what school had to offer. He especially enjoyed biology. He enrolled at Michigan State University and received a B.S. in Botany. There, his love for biology, plants specifically, began to blossom. This interest led to his earning a Ph.D. in Plant Pathology at the University of Wisconsin, Madison.

During his graduate work, Jim worked at the University Research Station in Sturgeon Bay, Wisconsin, where he met a lovely, bright-eyed nurse named Racheal Anderson.

Jim and "Rae" married in Sturgeon Bay, on May 17, 1952. They remained in Wisconsin for the next three years while Rae continued her nursing and Jim continued his post-graduate studies. In May of 1954, they welcomed their first-born son, Mark, while living in Madison, WI. After receiving his Ph.D., Jim was offered a few job opportunities across the country and chose a position as a Research Plant Pathologist at the USDA Agricultural Research Station in Salinas, California. Rae was fortunate to find a position as a floor nurse at Salinas Valley Memorial Hospital (now Salinas Valley Health). Within a year of arriving in California, their second son, John, was born, and in 1958, a daughter, Lisa, arrived (above provided by John Duffus, personal communication).

The Salinas Valley was host to several crops of national importance from the 1920's to present. Prior to World War II, Guayule rubber production was important as a national source of rubber. After the war, synthetic rubber was improved to the point that the Guayule industry was no longer needed (Verardo & Verardo 1989). However, the Salinas Valley became vital to our national defense for another crop. In 1942 the Secretary of Agriculture announced that acreage restrictions were removed for sugarbeets. Spreckels Sugar Company in Salinas guaranteed a minimum payment and increased the price to growers for their product (Spreckels Sugar Beet Bulletin Vol VI, March 1942). Planting of sugarbeet at that time was still problematic, due to the multigerm seed that required thinning seedling clumps by hand (stoop labor). In the U.S., monogerm seed was not available.

Drs. Viacheslav and Helen Savitsky were sugarbeet scientists in Kiev, USSR and during the War fled to Poland, then Germany, to avoid a Siberian Camp. Together, they developed monogerm seed in the USSR. After the war, knowing that their fate would be grim if they were returned to their country of origin, the Savitskys managed to be transferred through a circuitous route to the USDA-ARS in Salinas, CA. This required secretive measures and the help of Dr. H.J. Muller, a Nobel Prize Winner, whom they had met in the USSR to help them get to the U.S. (McFarlane 1983). Since monogerm seed was essential to the increased production needed, the Savitskys and the technology they brought with them were a welcome addition to the sugarbeet research and development program.

As sugarbeet acreage increased and the crop was in year-round production with planting and harvesting, there was no break in disease cycles. In addition to Beet curly top virus (BCTV, still a problem today), aphid-vectored yellowing viruses were causing increased losses. To address this and other emerging virus diseases, Jim Duffus was hired by the USDA-ARS Sugarbeet Research Center in Salinas after completing his Ph.D. at the University of Wisconsin in 1954.

During this time, there was an expansion to other crops in the region, including cool-season vegetables like lettuce, broccoli, spinach, artichoke, celery, and strawberry. In keeping with the expansion of crops grown in the Salinas Valley, Dr. E.J. Ryder was hired as the lettuce geneticist in 1954. Dr. R.T. Lewellen was hired in 1966 as the sugarbeet geneticist. In 1977, Dr. J.D. McCreight was hired as a horticulturist to address melon and lettuce production, first in Imperial Valley, California and transferred to Salinas in 1979. This valuable combination of expertise in virology, genetics, plant breeding and horticulture at Salinas enhanced progress and advances made in crop improvement for the agricultural community over the 40+ year tenure for each of these scientists.

Being a politically and economically sensitive crop, after 1980, sugarbeet research was slowly reduced due to inflation, low sugar prices, NAFTA, increased imports, artificial sweeteners, high fructose corn syrup, and water availability. Over the next 30 years sugarbeet research was gradually eliminated at Salinas and replaced by research on other crops that were more profitable and suited to the Salinas Valley climate, including increased organic production of diverse crops (personal communication, R.T. Lewellen).

Jim Duffus became world renowned for his research that focused on persistent insect-transmitted viruses of sugarbeet, vegetables, cucurbits and their weed hosts. During his time with ARS, Dr. Duffus served 17 years as research leader of the Sugarbeet Production Research Unit and led a broad research program that included pathology, genetics, nematology, agronomy and development of improved breeding lines. He described over one third of the world's beet viruses, over one-half of California's lettuce diseases caused by viruses and developed an international reputation in the areas of insect transmission and plant virus epidemiology (James E. Duffus, APS Fellow Award, 1982).

Jim had many "firsts" during his career. He was the first to realize that "beet yellows" of sugarbeet was sometimes caused by a complex of viruses, one of which he discovered and named Beet western yellows virus (BWYV) (Duffus, 1960, 1961). This was an important discovery with worldwide implications due to the wide host range of BWYV and its significance in agricultural production. He also was the leader in studying the epidemiology of viruses in the beet yellows complex in the U.S. This work led to the implementation of beet-free periods to help manage these viruses in California.

Through this work he developed a method to inoculate plants with viruliferous aphids on sugar beets in the field for large-scale use in breeding programs. This allowed more rapid development of sugar beet varieties tolerant to BWYV and the yellows virus complex. He demonstrated that BWYV is also an important pathogen of vegetables worldwide and caused many diseases that were previously thought to be due to a variety of causes, including nutritional deficiencies.

Jim discovered the first virus shown to be a pathogen of both plants and its aphid vector. His 1963 paper on Sowthistle yellow vein virus (SYVV) is a classic study of virus vector relationships and suggested that SYVV propagated in the aphid vector due to the extremely long latent period. A significant advancement in the field of plant virus-vector interactions. His initial work in this area stimulated many researchers to further investigate the properties of these viruses that infect plants as well as insects (Richardson and Sylvester, 1969).

Jim's work also dealt with understanding the relationships among the Family of Luteoviruses. In particular, he applied infectivity-neutralization in feeding studies for serological blocking of BWYV transmission by aphids. This method was also applied to BCTV for infectivity studies by the beet leafhopper (Duffus and Gold, 1973; Gold and Duffus, 1967). This new application of infectivity-neutralization to vector transmission studies helped identify relationships (or lack of) between viruses that were not clearly understood at that time (Rochow and Duffus, 1978; Duffus and Russell, 1972).

Jim was the first researcher to discover that the greenhouse whitefly was a vector of plant viruses (Duffus, 1965, Duffus and Johnstone, 1981). This led to numerous studies to examine whitefly species that were important vectors of economically limiting viruses of lettuce, cucurbits, tomatoes and sugarbeet.

Jim always argued that to understand what plant viruses are doing in the field, one must use the insect vector in the laboratory and greenhouse and not rely solely on mechanical transmission. The fruits of his research clearly demonstrate this point.

The rhizomania disease of sugarbeet, caused by Beet necrotic yellow vein virus (BNYVV), was well known in Europe and other beet growing areas but not in the U.S. In 1983, calls came into the Salinas lab about rhizomania-like symptoms in beet fields near Paso Robles, California. At that time, symptoms were being confused with those of the sugar beet cyst nematode (SBCN, *Heterodera schachtii*). Both SBCN and the vector of BNYVV are soilborne. After hauling beets, residual (tare) soil from beets is dumped on the field. Many of the same trucks and commercial harvesters were used to transport beets for processing and to haul

tare soil from the beets delivered to the factory to dump on the field before returning for the next beet load; a perfect scenario for spreading SBCN and rhizomania (or its vector). Jim had previously received antiserum to BNYVV from Dr. G. Mink at Washington State University (Al Musa and Mink, 1981). So, when calls started coming in from sugarbeet production states, serological tests positively identified BNYVV (Duffus et al., 1984). The USDA-ARS in Salinas became the go-to place for rhizomania identification, breeding and collaborations with growers and industry representatives. Through breeding programs like that led by R.T. Lewellen with ARS and sugar industry breeders, resistance genes were identified and incorporated into sugarbeet germplasm and varieties. These are primary resistance genes that are still in use today to develop BNYVV-resistant varieties.

In recognition of his role in plant-insect-virus interactions, Jim was invited to present papers for international meetings and organizations in over nine countries on such diverse subjects as beet virus diseases, virus-vector relationships, virus transmission by aphids and whiteflies, serological relationships, epidemiology, virus diseases of vegetable crops, and disease management practices. These invitations came from organizations not only in plant pathology, his field of emphasis, but from entomological, horticultural, biological, and crop protection organizations.

Jim served on several committees of the American Phytopathological Society, American Society of Sugar Beet Technologists, and the International Society for Plant Pathology. He was elected an APS Fellow in 1983. He received the Savitsky Memorial Award in 2001, the highest award granted by the American Society of Sugar Beet Technologists (ASSBT) and among the most prestigious awards in the sugar industry. The award is not given every year and memorializes the contributions of Viacheslav and Helen Savitsky for their discovery and development of the monogerm gene in sugarbeet. Jim also received the Meritorious Service Award from the ASSBT.

Jim was passionate about science. His research curiosity and enthusiasm for the biology and epidemiology of plant virus-insect interactions was an important factor in the discovery and management of crop diseases in the unique cool-season environment of the Salinas Valley. His passion and quick wit often led to some lively discussions as he frequently challenged scientists on the veracity of their claims, whether it be about insect-virus interactions or correct identification of viruses causing rhizomania. Whether you agreed with him or not, you could be sure he always said what he thought! Amidst the plethora of advanced scientific methodologies today, it is interesting to think back to the early days of Jim's career, when he transferred thousands of individual aphids, whiteflies and beet leafhoppers with a single camelhair artist's brush, to test the transmission properties of that particular insect species and/or biotype and by using infectivity neutralization in feeding studies with the insect vectors to identify relationships between virus isolates. These were valuable methods of that time that were considered major advances in his discipline.

Jim had many interesting stories that were often told at coffee time in Salinas. Early in his career, he had used a camelhair brush to transfer insect vectors for so long that at one point his brush had just a few hairs left to work with. When he asked his research leader at that time, Dr. J.S. McFarlane (who lived through the Great Depression and was known for being very tight with funds) if he could purchase another artist brush for his work, Dr. McFarlane responded that he still had a few hairs left, so he denied Jim's request!

USDA-ARS research scientists are evaluated according to their impact on the commodities and citizens they serve. Jim Duffus certainly fulfilled those expectations through painstaking work in his research discipline, in the unique agricultural environment of the Salinas Valley that included diverse crops, weeds, and insect vector species. His international travels and collaborations were vital in recognition and identification of important viruses of sugarbeet and vegetable crops in the U.S. Jim fully appreciated the research opportunities of the Salinas Valley and of course, its beauty. He often referred to it as "Hills of Heaven/East of Eden" in reference to author John Steinbeck, a native of Salinas and winner of the Nobel Prize in literature and a Pulitzer Prize for fiction.

Jim Duffus was devoted to his family of three children and seven grandchildren. If you knew Jim, you also had the pleasure of knowing Racheal, who accompanied him to numerous scientific meetings, both national and international. Jim and Racheal also enjoyed the farm that belonged to their family in Sturgeon Bay, WI, where they hosted many vacations with family and friends.

The author is grateful to those who contributed to preparation of this tribute to my friend and colleague, Dr. Jim Duffus. These include John Duffus; Jim's youngest son and Vice-President for Sales at The Garlic Company; R.T. Lewellen, retired USDA-ARS sugarbeet geneticist; E.J. Ryder, retired USDA-ARS lettuce geneticist; Sharon Benzen, USDA-ARS Agronomist and field research director; T.K. Schwartz, retired Executive Vice-President, Beet Sugar Development Foundation; J.D. McCreight, retired Location Coordinator and Research Leader; and W.M. Wintermantel, current Location Coordinator and Research Leader, USDA-ARS, Salinas.

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