Environmental and Molecular Mutagenesis 47:147–149 (2006)

In Memoriam

In Memory of Anthony "Tony" Carrano

Anthony ''Tony'' Carrano 1942–2005.

Dr. Anthony ''Tony'' V. Carrano, a highly respected pioneer of the international Human Genome Project and past-president of the Environmental Mutagen Society (EMS), lost his personal battle with lymphoma on Oct. 10, 2005.

''Tony was an outstanding scientist, an insightful leader, and a gentleman,'' said Director Michael Anastasio of the Lawrence Livermore National Laboratory (LLNL), where Dr. Carrano served as Associate Director of the Biology and Biotechnology Research Program from 1992–2000. Under Tony's leadership and management, LLNL significantly expanded its biosciences programs in genomics, biotechnology, and health effects research.

Born in New York City in 1942, Tony received a BS in Chemistry from Rensselaer Polytechnic Institute. After serving in Vietnam as a captain in the Marine Corps, he and his family moved to California where he obtained a Masters degree in Bioradiology and a PhD in Biophysics from the University of California at Berkeley, working under the mentorship of Sheldon Wolff. He completed a postdoctoral fellowship at Argonne National Laboratory in 1972, and joined LLNL in 1973 where he worked until retirement in 2000.

One of the first people he hired at Livermore, Linda Ashworth, said, ''It was always so much fun to work with Tony in the lab. He made it a joy to come to work every day.'' Sheila Galloway of Merck Research Laboratories, former president of the EMS and Tony's research colleague in cytogenetics wrote that: ''Tony's combination of being able to be firm but at the same time inclusive and humorous was rare and very effective. He enlisted people with his enthusiasm and like him we rolled up our sleeves and worked hard. Truly a fine leader.''

Former Associate Director, Mortimer (Mort) Mendelsohn, recalls that ''Tony was strongly recommended by Shelly Wolff, his PhD supervisor. LLNL needed a cytogeneticist and Tony seemed an ideal candidate. Arriving at LLNL in 1973, he quickly fulfilled this role and soon expanded his interests into mutational mechanisms, working with Larry Thompson. In short order, Tony became a Section Leader of Biomedical Sciences, and continued in that role until he replaced me as Associate Director in 1992. In midcareer, he developed a keen interest in DNA sequencing. When chromosome sorting opened the possibility of sequencing a human chromosome, Tony led the charge for LLNL to do chromosome 19. Soon after, the Human Genome Project began, with Tony leading the DOE effort. Biology and biotechnology at LLNL expanded rapidly and effectively under Tony's leadership.''

Tony championed the importance of biotechnology in the assessment of the human health effects of ionizing radiation and environmental toxicants. In 1984, an international meeting of molecular geneticists evaluated the potential for DNA-oriented methods to detect heritable mutations in the children of persons who survived the atom bombs in Japan. This problem was so challenging that large-scale, detailed sequencing of the entire human genome was proposed to answer it. In 1986, DOE became the first federal agency to commit to the goal by launching its Human Genome Project, and later joined with NIH and other institutes across the world to kick off the Human Genome Project, the largest biological research project ever undertaken. Dr. Carrano was a leader in these efforts.

Tony's scientific interests in biotechnology at LLNL began with his applications of image analysis to cytogenetics. A decade later, with the development of flow cytometry and its highly successful sorting of human chromosomes, Tony committed heavily to the Livermore and Los Alamos joint project to produce gene libraries

DOI 10.1002/em.20207

Published online 27 February 2006 in Wiley InterScience (www.interscience.wiley.com).

Environmental and Molecular Mutagenesis. DOI 10.1002/em

for every human chromosome. Armed with a cosmid library for human chromosome 19 and several Livermore discoveries of repair genes on this chromosome, Tony sparked the idea of mapping the chromosome by reassembling its fragments. This strategy spearheaded the DOE thrust to sequence the human genome, and it placed Tony in a crucial position to lead this effort.

In 1996, as Associate Director for the LLNL Biology and Biotechnology Research Program, Tony helped form the Joint Genome Institute (JGI) that was designed for high throughput DNA sequencing. This collaboration of the Livermore, Berkeley, and Los Alamos National Laboratories led to the sequencing of human chromosomes 5, 16, and 19. The present LLNL Director Anastasio praises that Tony ''was instrumental in DOE's foundational contributions to the Human Genome Project and led the team at Livermore that mapped human chromosome 19. The Joint Genome Institute in Walnut Creek and the Laboratory's pioneering work in DNA forensics and DNA diagnostics are a lasting credit to Tony.''

Tony was an exceptional advocate of science education, holding academic titles at several California universities, and participating in numerous academic activities. He was also well-known for his hands-on approach to the problems of national and international science organizations. In 1996, he was appointed as vice president of the international Human Genome Organization (HUGO) and President of HUGO Americas. His leadership as a founding member and first president of Genetics and Environmental Toxicology Association (GETA) in 1979 was a key factor in shaping that organization for ongoing success. As Treasurer (1983) and then as President (1987) of the EMS, Tony brought the Society through an extremely difficult financial period and at the same time helped to establish it as the leading society for the study of the effects of environmental mutagens. Dick Albertini, emeritus professor of medicine and microbiology and molecular genetics and a research professor of pathology at the University of Vermont, worked closely with Tony during those challenging times and fondly remembers him as ''the single individual in 1983 to define precisely the problems in EMS' financial arrangements and plot a course to overcome them... His ethical standards were so high... an impressive individual and one of my heroes.''

Throughout his career, Tony remained an accomplished researcher and productive scientist. Early in his career, he published seminal research papers in cytogenetics, mutagenesis, and DNA repair with his colleague, Larry Thompson. His resume totals over 150 publications with contributions in the fields of cytogenetics, genetic toxicology, food mutagens, DNA repair, gene mapping, DNA sequencing, and genomic biotechnologies.

Tony was a respected contributor and official on the editorial boards of numerous scientific journals, on governmental and corporate scientific committees and advisory boards, including Odyssey Thera, Inc., and remained active in these even after his retirement from LLNL. He was always viewed as an expert and as a source of guidance to colleagues.

Tony Carrano and Larry Thompson in 1978. They had just published a paper in *Nature* on the relationship between chromosomal rearrangements and gene mutations.

Tony was highly respected for his vision in genomic sciences and biotechnology. In a 1999 commentary, he saw beyond the completion of the Human Genome Project: ''other species are beginning to be sequenced, including the mouse, plants, and microbes [providing] insight into human disease, crop improvement, bioremediation, and pathogen diagnostics. The Human Genome Project primed the pump for this bioscience revolution. Today, bioscientists' visions are not focused on whether they can sequence the genome, but how fast they can do it, and how we as a species can capitalize on the information for the diagnosis, prevention, and treatment of disease.''

In a 2000 commentary, he foresaw the importance of understanding the molecular machines of microbial life and the value of microbial sequencing in the face of the growing threat of bioterrorism. ''The plethora of microorganisms, both good and bad, leaves one in awe of their genetic diversity, of the roles they play in maintaining our ecosystem, and of the elaborate but utilitarian machinery that has evolved over billions of years to allow them to maintain their niche in life. From the metabolic pathways that regulate the utilization of carbon to the biochemical pathways that precisely control the mechanisms of infection, these organisms deserve our respect. As members of the Joint Genome Institute, we are sequencing the DNA of several microbes important for carbon sequestration, nitrogen fixation, and bioremediation. In addition, as part of our national security role, we are focusing on those microbes that could be used in bioterrorism.''

Tony also made significant contributions and influenced many outside the sphere of science. He encouraged and challenged those around him to learn more and to better them. He led by example. A member of St. Michael's Church in Livermore, Tony volunteered at the school as

well as the parish.* A friend, colleague, and mentor of many throughout his life, he will be remembered for his scientific excellence as well as his good-natured sense of humor, dedication to his wife and children, and joie de vivre. He was an excellent dancer and truly enjoyed laughter. We cherish what he taught us and the lasting inspirations he has provided; we miss him deeply.

ACKNOWLEDGMENTS

With contributions and support from Michael Anastasio, Linda Ashworth, Leilani Correl, Larry Thompson, Jane Lamberdin, David DeMarini, Jack Bishop, Jim Felton, Jim MacGregor, Shiela Galloway, Jim Tucker, John Heddle, Heinrich Malling, Irene Jones, and Dick Albertini.

Andrew J. Wyrobek, Ph.D.
Lawrence Livermore National Laboratory
University of California
Livermore, CA

R. Julian Preston, Ph.D.
National Health and Environmental Effects
Research Laboratory (NHEERL)
Office of Research and Development
U.S. Environmental Protection Agency
Research Triangle Park, NC

Mortimer Mendelsohn, M.D., Ph.D.
Lawrence Livermore National Laboratory
University of California
Livermore, CA

*Contributions in memory of Dr. Carrano may be sent to St. Michael School and will be used for educational purposes. They can be made payable to St. Michael School, In Memory of Anthony Carrano, c/o St. Michael School, 345 Church St., Livermore, 94550; Attn: Sister Emmanuel.