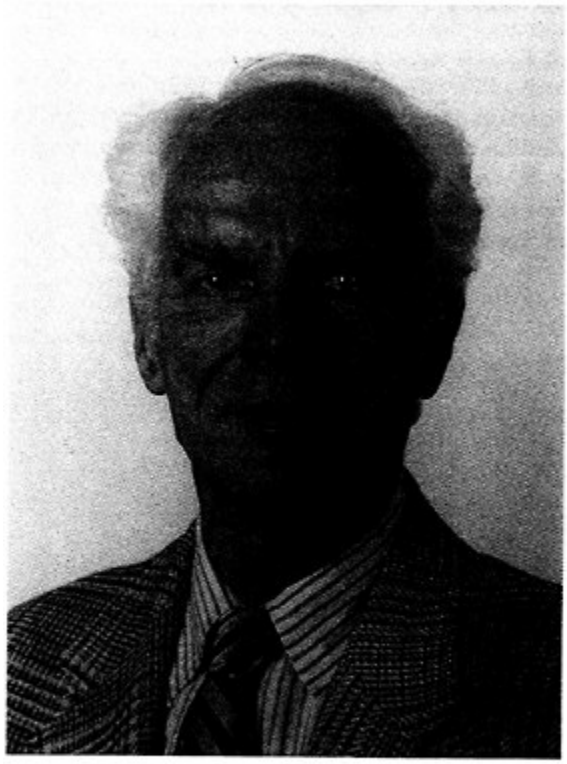

A. Pharo Gagge

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1908–1993

BY HENNING E. VON GIERKE

A. PHARO GAGGE, a world-renowned biophysicist and pioneer investigator of the interaction of varied environments with human body temperature, died at his home at Branford, Connecticut, on February 13, 1993, at the age of eighty-five. His research results and his active involvement in their applications contributed to safety, comfort, and the working efficiency in industrial, military, space, and home environments.

Elected to the National Academy of Engineering in 1979, he was—in research as well as in his government positions—an early supporter of interdisciplinary collaboration in the biophysics and bioengineering areas. He was active to the last days of his life as professor emeritus of Yale University School of Medicine and consultant and fellow emeritus of the John B. Pierce Foundation Laboratory, both at New Haven, Connecticut.

Dr. Gagge was born in Columbus, Ohio, on January 11, 1908. Growing up in Richmond, Virginia, he received his B.A. degree with honors in mathematics and his M.A. in physics at the University of Virginia (1930). After earning his Ph.D. in physics at Yale University in 1933, he joined the John B. Pierce Laboratory, an independent research laboratory affiliated with Yale University and dedicated to exploring the impact of the environment on human health and comfort. His research and teaching activity there started his lifelong career on the reaction of the human body and its temperature regulation to variations in atmospheric

conditions, radiation, convection, air movement, and clothing. Joining the U.S. Air Force (USAF) in 1941 he was involved in, and later as head of the Biophysics Branch responsible for, research and development efforts at the Aero Medical Laboratory at Wright-Patterson Air Force Base, Ohio (1941–1950). His work showed that to keep blood oxygen saturation at safe levels when flying at very high altitudes, the oxygen pressure in the lungs had to be increased. In 1941 he performed the first chamber experiment wearing prototype pressure breathing equipment to an altitude of 43,000 feet. This work led to the development of the operational pressure breathing equipment delivered to the combat units in October 1943. Other experiments being conducted with human subjects using the laboratory's all-weather room and refrigerated low-pressure chamber evaluated equipment as well as physiologic effects under climatic stresses such as temperature, wind, humidity, and solar radiation. Leaving the laboratory in 1950, where he served as director of research and acting chief during the last years, he headed the Human Factors Division of the Research and Development Headquarters, USAF, Washington, D.C. (1950–1955) and advanced as colonel to the USAF Office of Scientific Research, serving at the end as its commander (1955–1960). From 1960 to 1963 he served at the Advanced Research Projects Agency, Office of the Secretary of Defense, as program manager in the Cloud Physics, Weather Modification, and Joint Services Electronics Program.

Retiring from the USAF in 1963, he continued his academic career at Yale University School of Medicine as associate professor of physiology and epidemiology, as professor of epidemiology (environmental physiology) (1969–1976), and as professor emeritus from 1976 to 1993. During the same years he was active at Yale University, he was fellow and deputy director of the Pierce Laboratory (1963–1978) and fellow emeritus for the following years.

During his almost fifty years of professional activity, Dr. Gagge served on many advisory groups, boards, and committees for the U.S. government, National Research Council (NRC), and technical societies. He served as consultant to the Army/Air Force Scientific Advisory Group under Theodore von

Kármán's directorship (1944–1945); as a member of the Research and Development Board, Coordinating Committee on Medical Research, Human Resources, and Psychological Warfare (1950–1956); as vice-chairman, Governing Board of Bio-Sciences Information Exchange, Smithsonian Institution (1954–1956); as senior resident military representative to the NRC (von Kármán) study at Woods Hole on long-range scientific and technical trends (1957–1958); and as Executive Council member (1965–1968) and chairman (1967–1968), NRC Committee on Hearing, Bioacoustics, and Biomechanics. For the American Physiological Society he was a member of the editorial board (1966–1972), section editor of the *American Journal of Physiology* for environmental physiology and exercise (1972–1976), and associate editor of the *Journal of Applied Physiology* (1977–1984).

Among the awards Dr. Gagge received are the Legion of Merit (1945), the Army Commendation Ribbon (1945), the Oak Leaf Cluster (1960), and the Defense Commendation Ribbon (1963). The Aerospace Medical Association honored him in 1973 with its Eric Liljencrantz Award for basic research into the problems of acceleration, altitude or weightlessness, and the American Society of Heating, Refrigerating, and Air-Conditioning Engineers with its Louise and Bill Holladay Distinguished Fellow Award (1981).

The scientific contributions of Pharo Gagge's long, productive career are documented in over 137 publications and are reflected in many reports, handbooks, and standards. Some of the concepts he introduced are today the standard quantities to characterize human responses to the environment. They include, among others, *Operative Temperature* (combining air and radiant temperature), the *Clo unit* (quantifying clothing insulation), the *Met unit* (quantifying metabolic activity), *Effective Temperature* (quantifying the effects of temperature and humidity on human thermoregulation), and his widely used *Two Node Model* of human thermoregulation and comfort. His activities, results, and advice impacted the field from environmental physiological studies to practical comfort criteria and the engineering of our man-made environments in our homes, in industry, in military, and in space missions.

Active until the end, he led a long productive life of dedication to science and its practical applications to human safety, health, and comfort. All of us who worked with him benefited from his broad knowledge, advice, objective judgment, and contributions. Above all, we enjoyed his friendship, remember Pharo with thanks, and will miss him.

Frederick W. Garry