10^{-4} microcuries of radium, which may be taken as the biological equilibrium of the radium burden of human beings in relation to the general environmental radium content of the upper 1 foot of soil. This amount (10^{-4} microcuries) is 1/1000 the maximum permissible radium burden of 0.1 microcurie and more nearly one 1/10000 the minimum amount that is known to have produced injury to human beings.

Natural radium and strontium-90 in fallout have differences in properties which may influence the ease with which they pass from soils into biological systems; therefore, one cannot conclude that, for any given soil content of strontium-90, the equilibrium human burden would be the same as the equilibrium body burden of radium at the same soil level. However, it is worth noting the minuteness of the present strontium-90 values in relation to the amount of radium present in all soils and, more particularly, in relation to the very much larger concentration of radium that could be safely tolerated.

A more direct method of evaluating the significance of the strontium-90 fallout is to measure the presence of this isotope, not only in soils, but in plants, animals, and human foodstuffs. Fortunately modern radiochemical techniques are sufficiently sensitive so that it is feasible to detect this isotope at concentrations comparable with that of radium and other naturally occurring isotopes. Measurements of this type have been undertaken and have succeeded in demonstrating the absorption of strontium-90 in foods. The concentration of this isotope, as expected, is dependent on the calcium content of the food, and for this reason the results can be expressed best as strontium-90 activity per gram of calcium. On this basis, milk in the United States during early 1956 contained about 3 micromicrocuries of strontium-90 per gram of calcium. One microcurie of strontium-90 (7) is the commonly accepted permissible content for the adult skeleton (*8*). The skeleton contains about 1000 grams calcium, and the permissible concentration would thus be 1000 micromicrocuries per gram of calcium, or about 350 times the presently observed concentration in milk.

According to the National Academy of Sciences (*9*), "Already some children have accumulated a measurable amount of radioactive strontium in their bodies. The amount, however, is quite small—a thousandth of what is considered a permissible dose."

References and Notes

1. M. Eisenbud and J. H. Harley, *Science* **117**, 141 (1953).
2. ———, *ibid.* **121**, 677 (1955).
3. We express our appreciation to our colleagues who participated in this program of fallout collection. In particular, A. E. Brandt is responsible for the IBM reporting of computations as well as the statistical analyses. Edward P. Hardy, Jr., and Robert S. Morse performed the soil analyses, and Naomi A. Hallden assisted in developing the procedure for computation of the gamma dose. C. L. Dunham made a number of helpful suggestions in the preparation of the manuscript. The continued cooperation of Lester Machta and his staff at the U.S. Weather Bureau has been invaluable.
4. H. F. Hunter and N. E. Ballou, *Nucleonics* **9**, No. 11, C-2 (1951).
5. G. M. Dunning, *Sci. Monthly* **81**, 265 (1955).
6. W. F. Libby, *Science* **122**, 57 (1955).
7. *Natl. Bur. Standards U.S. Handbook 52* (1953).
8. The permissible concentration of strontium-90 is probably lower by a factor of 10 than the concentration that would produce injury. On the other hand, the 1-microcurie level was established for occupational exposure, and the National Committee for Radiation Protection recommends that such levels be reduced to 10 percent for public exposure.
9. *Biological Effects of Atomic Radiation.* Report to the public (Natl. Acad. Sci.–Natl. Research Council, Washington, D.C., 1956); *Science* **124**, 60 (1956).

E. C. Crittenden, Physical Standards Expert

Dr. Eugene C. Crittenden died in Washington, D.C., on 28 March 1956 at the age of 75. He had been a member of the American Association for the Advancement of Science for 40 years. Born at Oswago, Pennsylvania, 19 December 1880, he graduated from Cornell University in 1905 with a B.A. degree—not, as his many associates assumed, in physics—but rather in classical languages. He did, however, have a divided interest in physics and remained as a graduate student and instructor at Cornell University until he accepted an appointment at the National Bureau of Standards as an assistant physicist in July 1909.

Dr. Crittenden was first assigned to the photometric laboratory, where he subsequently made many important contributions. He was named chief of the bureau's electrical division in 1921 and continued in this position until 1946. Under his leadership, the program of the division expanded substantially, keeping pace with the rapid developments in radio and electronics. Major organizational units of the bureau developed from nuclei assembled under Dr. Crittenden's leadership. These include the former ordnance development division, now the diamond ordnance fuze laboratories of the Department of the Army, and the bureau's central radio propagation laboratories at Boulder, Colorado.

In 1933, Dr. Crittenden was made assistant director of the bureau. Subsequently, this title was changed to associate director. Until his retirement in 1950, he was the bureau's senior associate director and, in this period of changing administration and directors, was often called upon to serve as acting director of the bureau. For his outstanding contribution to the Government and to science, he was honored with many awards and recognitions.

For his outstanding contributions to the work of the bureau, Dr. Crittenden was awarded the Department of Commerce gold medal for exceptional service in 1949, which was the year that these awards were established. In 1946 he was honored with the gold medal of the Illuminating Engineering Society for "meritorious achievement conspicuously furthering the profession, art, or knowledge of illuminating engineering." Also in 1946, the Case Institute of Technology awarded him an honorary D.Sc. degree as "a devoted servant of the public, exponent of precise measurement, and international authority on the standards of science and industry."

Dr. Crittenden took an active part in American and international scientific societies. He was president of the Illuminating Engineering Society in 1925, president of the U.S. National Committee of the International Electrochemical Commission from 1939 to 1946, and president of the Optical Society of America in 1932–33. He served as an associate editor of the *Review of Scientific*

Instruments and as chairman of the editorial board of the National Bureau of Standards. He was chairman of the Interdepartmental Screw Thread Committee in 1952. He was very active in the standardization work of the American Society for Testing Materials; American Standards Association, in which he was chairman of the standards council; the International Organization for Standardization; and the American Institute of Electrical Engineers. The esteem of his associates is well indicated by his election to the presidency of the Cosmos Club of Washington.

Outstanding in Dr. Crittenden's achievements was his participation in the establishment of international standards in electricity and photometry and the writing of the Public Law 617 of the 81st Congress, passed on 21 July 1950, in which the Congress adopted these international standards as the nation's standards and then placed the standards and units of electricity and photometry on the same legal and commercial basis as our standards of mass, length, volume, and time.

As vice president of the International Commission on Illumination from 1939 to 1948 and president of its U.S. National Committee from 1928 to 1935, he played a major role in the establishment of modern photometric units, standards, and methods of measurement. These activities culminated in the international adoption of the "candela" in 1948. In recognition of his outstanding leadership in the field of illumination, he was elected an honorary life member of the International Commission on Illumination in 1950. As the United States representative on the International Committee on Weights and Measures from 1946 to 1954, and its vice chairman from 1950 to 1954, and as chief of the bureau's electrical division for many years, he was a leading scientific figure in replacing the obsolescent international system of electric units by the so-called absolute electric units.

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R. S. Breed, Bacterial Taxonomist

Dr. Robert Stanley Breed, whose death occurred 10 February 1956, distinguished himself in three fields of bacteriology, first in the dairy field, then in public health and sanitation, and finally in the nomenclature and classification of microorganisms. It is the last of the three fields to which he gave chief attention during the last decade of his life and for which he is likely to be longest remembered.

Born in 1877 at Brooklyn, Pennsylvania, he spent his college years at Amherst, from which he graduated in 1898 and then took an M.S. degree at the University of Colorado and a Ph.D. degree at Harvard in 1902. He began his professional career by teaching biology at Allegheny College, Meadville, Pennsylvania. His early training and teaching experience in general biology determined his approach to bacteriology. As a result, although his attention to the practical aspects of bacteriology in dairying and sanitation was great, the interest closest to his heart was taxonomy.

He was called to the New York State Agricultural Experiment Station at Geneva, New York, to take over the division of bacteriology that had been started by H. A. Harding a number of years previously. One of his first efforts in that division was to establish a general feeling for bacteriology as a science, bringing this about by calling frequent seminar meetings to discuss general bacteriological problems. He did not neglect the practical side, however. Before coming to Geneva, he had already established a reputation in sanitary milk inspection, because of his proposal to use the microscope as a quick method of counting bacteria in milk. It was natural, therefore, that his chief activities, during his first years at Geneva were in the dairy field. It was another logical development for him to turn to milk sanitation and related public-health fields. He served for many years, in the American Public Health Association, as chairman of the Committee on Standard Methods for Analysis of Dairy Products. At one period of his life, he was best known in this public-health field, and he remained active in it until the mid 1940's. During this same period, in addition to belonging to several nonprofessional organizations, he became especially active in the Society of American Bacteriologists and served as its president in 1927.

It was in the 1920's, during the period of his greatest activity in the bacteriological society, that he became especially interested in the *Manual of Determinative Bacteriology*, prepared by an earlier president of the society, D. H. Bergey of the University of Pennsylvania. Dr. Breed collaborated with Bergey in getting out the second, third, and fourth editions of the book and, after Bergey's death in 1937, became chief of a board of editors of three members, who took over the manual and developed it through two more editions, each larger and more complete than the preceding. He developed this manual into a cooperative undertaking in which some 100 collaborators were taking part. Although they all contributed, he was always the guiding spirit. A seventh edition was in preparation at the time of his death, and, although he left it far from finished, the remaining editors hope to complete the undertaking without too great delay.

As editor of this manual after Bergey's death, Breed contributed much to systematic bacteriology. In 1948 he retired from the experiment station and gave the remaining 8 years of his life to this undertaking. It was a labor of love with him, and he kept diligently at it until the day he died, even through a period of ill health about 1950 and a siege of eye trouble during his last 6 months. His ability to keep the numerous details of bacterial nomenclature in his head was astonishing to everyone who was associated with him.

Bacteriology has lost one of its outstanding members. Dr. Breed will be missed by many, especially by those who were associated with him in the activities of his last years.

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