found. The percentage absorption depends on the temperatures T_s , T_a of both source and air; it increases as T_a increases, but decreases as T_s increases, because of the increased importance of shorter wave-lengths, where water vapour absorption is smaller. The emission is equal to the absorption when $T_s = T_a$; considered as a fraction of the black-body emission at the same temperature, it decreases slowly as T_a increases. The results for long absorbing columns do not suggest that there can be any great transparency of water vapour beyond 17μ .

Brooks⁶ has recently indicated how such measures can be used as the basis for a study of atmospheric radiation. He has to ignore the variation of the percentage absorption and emission with T_s and T_a , and to assume that the quantities of water vapour, carbon dioxide and ozone in the atmosphere bear a constant ratio to each other. In theory, it is far better to consider the radiation in the separate wave-lengths; but because of the inadequacy of experimental data, Brooks's method has much to recommend it.

Another question, which has been studied for many years, is that of the total radiation reaching the earth from the atmosphere from all directions and in all wave-lengths. This is most easily studied at night, and is therefore usually called the nocturnal radiation of the atmosphere; it can, however, also be studied during the daytime. The radiation depends markedly on the ground temperature T and the vapour pressure e at the ground. Brunt has found that at any place it is given roughly by $\sigma T^4(a + b\sqrt{e})$, where σT^4 is the black-body emission at temperature T , and a , b are constants the values of which differ, however, from place to place. Brunt suggests that the variation in a and b may be due to differences in the instruments used by different observers; but part may well be due to differences of pressure of the temperature- and humidity-gradients, and of ozone emission.

Strong⁴ has interpreted the factor $a + b\sqrt{e}$ in Brunt's expression as follows. At certain wave-lengths, air radiation is due to the emission of carbon dioxide and ozone, and does not vary with e ; at others, water vapour is so opaque that it emits like a black body of temperature T , whatever e . Such wave-lengths contribute the term a . At yet other wave-lengths, water-vapour absorption is small and obeys the square-root law (in our earlier notation, $\Delta \propto (mp)^{1/2}$). These contribute the term $b\sqrt{e}$. The explanation is suggestive, but incomplete, since there are wave-lengths in which water vapour is not opaque, but its absorption is too large to obey the square-root law, and these wave-lengths vary somewhat with the zenith distance and the humidity. The factor σT^4 in Brunt's expression also needs explanation, both since the temperature of the emitting air may differ somewhat from T , and because the emission in the wave-lengths at which the atmosphere is opaque need not follow the T^4 law characteristic of a black body emitting all wave-lengths.

Besides depending on T and e , the nocturnal radiation of the atmosphere must vary with the ozone content of the upper atmosphere. The ozone band between 9.1μ and 10μ comes in a range of wave-lengths where the atmosphere is otherwise nearly transparent, and so emission in this band at high levels appreciably affects the radiation reaching the ground. Conversely, radiation leaving the ground is able directly to influence the temperature of the stratosphere because of ozone absorption. Since it receives radiation direct from the ground, ozone tends

to produce a higher stratospheric temperature than water vapour and carbon dioxide, which receive radiation from the cold upper troposphere. The effect of the ozone absorption is the more considerable because there is little water vapour at great heights. For this reason, Dobson has suggested recently⁷ that stratospheric temperatures may be largely influenced by ozone absorption. His suggestion makes the temperature of the stratosphere depend on the relative amounts of ozone and water vapour present, and explains qualitatively the high stratospheric temperature at the poles, and the advance in phase of the annual variation of temperature in the stratosphere relative to that at any lower level.

¹ Adel, A., *et al.*, *Phys. Rev.*, **47**, 580 (1935); **49**, 288 (1936); also a series of papers in *Astrophys. J.*, beginning in vols. 84 and 87.

² Fowle, F. E., *Smithson. Misc. Coll.*, **68**, No. 8 (1917).

³ Elsasser, W. M., *Astrophys. J.*, **87**, 496 (1938); *Phys. Rev.*, **53**, 768 (1938).

⁴ Strong, J., *J. Franklin Inst.*, **232**, 1 (1941).

⁵ Falckenberg, G., *Met. Z.*, **53**, 172 (1936); **55**, 174 (1938); and **56**, 72 (1939). Elsasser, W. M., *Mon. Weath. Rev.*, **69**, 1 (1941).

⁶ Brooks, F. A., *Mass. Inst. Tech. Papers in Phys. Oceanography and Meteorology*, **8**, No. 2 (1941).

⁷ Dobson, G. M. B., at a joint meeting of the Royal Meteorological Society and the Physical Society, held on May 20.

OBITUARIES

Dr. C. D. Sherborn

THE sudden death of Charles Davies Sherborn on June 22, within a week of his eighty-first birthday, came as a shock to his many friends. The staff and other workers at the British Museum (Natural History), with which he was continually associated since 1886, will mourn the loss of a distinguished and much-loved colleague, and will sadly miss the inspiration of an outstanding personality.

Born in Chelsea, he was the eldest son of Charles William Sherborn, the celebrated line-engraver and etcher. He received some of his early schooling at the hands of Miss Elizabeth Rye, then a noted educationist, and afterwards went to St. Mark's College School, Chelsea. At the age of fifteen he went into business, first with a bookseller and stationer, and later with a tailor. Then abandoning business for a scientific career, he set off for Switzerland and Germany, and during 1886-87 studied at the University of Strasburg.

At this period of his life Sherborn seems to have been first attracted to the study of geology and palaeontology, and worked with Thomas Rupert Jones on the Foraminifera and Ostracoda. His "Bibliography of the Foraminifera" (1888), and his "Index to the Genera and Species of Foraminifera" (1896), indicate the first approaches to what was to become the ruling passion of his life. In 1890, in collaboration with Sir Arthur Smith Woodward, he published "A Catalogue of British Fossil Vertebrata", and at about the same time he catalogued the collections and library of the Geological Society of London, from which body he received the Lyell Fund in 1890. From 1892 until 1899 he was a member of the editorial board of *Natural Science*, and during this period prepared a new edition of a catalogue of the library of the Linnean Society of London. He was invited to examine and arrange the letters and papers of Sir Richard Owen at Sheen Lodge, and assisted in the preparation of the scientific part of Richard Owen's life of his grandfather (1894). Between 1894 and 1908 he undertook a survey of the "White Chalk

of the English Coast", in conjunction with the late Dr. A. W. Rowe, and surveyed western Cornwall with Upfield Green. The Geologists' Association, of which he was honorary secretary for nine years, published the results of the chalk survey.

Inspired by the projected "Index Kewensis" for plants, Sherborn put forward in 1890 a scheme for an "Index Animalium", designed to provide a complete list of all generic and trivial names from 1758 to 1850, with a reference to the date and place of publication of each name. This stupendous task, involving the extraction of more than 415,000 references from the original sources, proceeded steadily, and, in spite of a serious breakdown in Sherborn's health during the early stages, the first volume (1758-1800) appeared in 1902. The ten volumes comprising the second section (1800-1850) were published under the auspices of the British Museum (Natural History), and the final part did not appear until 1933—forty-three years after the inception of his self-imposed task!

Sherborn's published papers, many of them of a bibliographical nature, number nearly two hundred, commencing with one on Jurassic fossils in 1886 and ending with his extremely useful booklet "Where is the — Collection?" in 1940. In addition, his bibliographical work led him to amass copious notes in manuscript, which have been consulted at the Museum by numerous workers and proved invaluable when a catalogue of the Museum's library was prepared by the late B. B. Woodward. He found time to investigate the history of his own family, a labour of love which resulted in "A History of the Family of Sherborn" (1901) and "A Sketch of the Life of Charles William Sherborn" (1912).

Sherborn was an honorary fellow of the Zoological Society of London, and served on the Publication and Finance Committees for many years; an associate of the Linnean Society of London; president of the Society for the Bibliography of Natural History; and an honorary life fellow of the Metropolitan Museum of New York. In 1931 the University of Oxford conferred upon him the honorary degree of doctor of science—a fitting recognition of his life's work.

Such, in brief outline, was the professional career of a man whose liberal culture and diversity of interest and activity were a constant surprise even to those who knew him well. Possessed of a very modest income, and living what to others appeared a most spartan life, he was able to indulge his passion for collecting stamps, coins, books, manuscripts, prints, and antiquities of all kinds. His valuable series of Byzantine coins, on which he was a recognized authority, was presented shortly before his death to the Fitzwilliam Museum, Cambridge, and his prints to the Art Department of University College, London. His many donations to both branches of the British Museum and to other institutions, together with his generous gifts to colleagues and friends, provided a practical expression of one of his most cherished convictions—that objects of special interest or value should ultimately rest in the hands of those who would best appreciate them.

Of the many qualities that endeared him to all, his kindness, toleration, ready wit and equable temper, and, above all, his abundant generosity, stand out, and few who were admitted to friendship with "The Squire" can have failed to benefit by the association. His ready hospitality to foreign visitors and to other lonely folk provides but one example

of his thought for others, and an invitation to "smoke and chat" at his house gave promise of an entertaining and instructive evening. His alleged dislike of women was probably a pose, and those wives of his friends who were lucky enough to gain his friendship soon discovered the kindly and sensitive nature beneath the cloak of gruff misogyny. He was unmarried, and is survived by two brothers.

J. R. NORMAN.

Mr. R. G. McConnell

RICHARD GEORGE MCCONNELL died in Ottawa, Canada, on April 1, 1942, in his eighty-sixth year. His death removed one of the last of Canada's outstanding geological explorers. He was born in Chatham, Quebec, on March 26, 1857, received his B.A. degree from McGill University in 1879 with first-class honours in natural sciences and in 1880 began geological exploration for the Geological Survey of Canada. His first work with the Geological Survey was done in Quebec province, but during 1881-1914 he was engaged every summer in geological studies mainly of reconnaissance and exploratory nature in the west and north-west of Canada. In 1914, he was appointed Deputy Minister of Mines, which position he held until his retirement from the Department in 1921. For several years thereafter he carried on consulting geological work and spent two summers on geological work for the Ontario Department of Mines.

McConnell's field work in the west as an officer of the Geological Survey covered a tremendous area. For five years he dealt with southern Alberta and Saskatchewan, providing much new information on the stratigraphy and coal areas. For three years he studied and mapped the Rocky Mountains west of Calgary, and was the first to recognize and interpret the great thrust faults along the mountain front. For four years he carried on geological mapping in the highly metalliferous West Kootenay area in British Columbia. For a ten-year period his work lay in Yukon, where among many important contributions may be mentioned his study of the Whitehorse copper belt, the Klondike placer field and his persistent recommendations for dredging which were later carried out with considerable profit. For eight years he worked in various parts of British Columbia, dealing mainly with the Portland Canal district, Texada Island, Finlay and Omenica Rivers and Rainy Hollow. For two years he covered ground north of Lesser Slave Lake, including the Athabaska tar sand area. For one winter he remained in the far north, and during the preceding and following field seasons made one of the longest and most remarkable Canadian exploratory trips when he travelled from Wrangell via Telegraph Creek, Dease River and Liard River to the delta of the Mackenzie, returning by way of Porcupine and Yukon Rivers to Skagway. As a result of this trip down through the Grand Canyon of the Liard he was the first explorer to recognize the fact that the Rocky Mountain system ended at latitude 60° N. The results of his field work were published on many geological maps and in some forty reports of the Geological Survey.

McConnell was a fellow of the Royal Society of Canada; he was elected in 1913 and president of Section 4 in 1918. He was elected a fellow of the Geological Society of America in 1889. He became a member of the Canadian Institute of Mining and Metallurgy