vessel. There are reports that the Soviet Government intends to send an ice-breaker to the rescue. This plan holds out more hope. On the other hand, the floe may continue its drift towards north-east Greenland. In that event the explorers may be able to effect their own rescue by travelling over closely packed ice, held by the land, to the safety of the shore. It is much to be hoped that these gallant men, who have risked much in the cause of scientific investigation, succeed in reaching safety.

Up to the present, their meteorological records alone have been published, but it is clear that the ocean soundings are going to prove of great interest, as showing a uniformity of depths in high latitudes and defining the width and depths of the ridge connecting Greenland and Spitsbergen. Other oceanographical discoveries were referred to in a previous article in NATURE (**139**, 990, June 12, 1937).

R. N. R. B.

Obituary Notices

Sir Jagadis Chandra Bose, C.S.I., C.I.E., F.R.S.

BY the death of Sir Jagadis Chandra Bose on November 23, a few days before his seventy-ninth birthday, India has lost one of her foremost sons and science one of its most picturesque figures. In India, and indeed elsewhere, Bose's concern for the well-being and progress of his native country has for long been widely known. His reputation as a physicist has been established for several decades. But it is at present not possible, and will not be possible for some time to come, to assess the true value of his contributions to physiology.

Bose's physiological work still remains in an isolated position in spite of decades of indefatigable work on his part, many volumes of published experimental work, and sometimes even unique facilities granted, not only in his own country, but also in Great Britain, the United States and on the Continent, to bring his results personally before the public by means of lectures and demonstrations. (In his earlier days, such facilities were not always available, and it is a tribute to his fighting instinct that he was able to obtain them in the end.)

The reasons for Bose's isolated position in the science of physiology are many and varied. Although he was a pioneer in his own field, he seldom discussed his results with those of his contemporaries. His scientific work was at times almost dramatic, with the result that even at the early stages he attracted much attention from the non-scientific world. Diplomats and high Government officials attended his discourses; Romain Rolland was loud in his praises of him; Rabindra Tagore wrote poems eulogizing his work; and Bernard Shaw was attracted to one of his lectures. Naturally, lay publicity and interest followed such distinguished example; but all this was unhealthy to Bose, the man of science, when so little of his work had received scientific confirmation.

Jagadis Chandra Bose was born in the village of Rarukhal in Vikrampur, a large area in the Dacca District, on November 30, 1858, the son of Bhagaban Chandra Bose. But Bose's father soon migrated as deputy magistrate to Faridpur, the centre of the next District, and it was there that Bose spent his childhood days. Bhagaban Chandra Bose had a profound sense of public duty, and it was doubtless from this source that Jagadis Chandra Bose's supreme love and work for his fellow countrymen had their origin. Bose's father, too, had to grapple with the severe problem of the dacoits in his area, and his success won unstinted praise from the authorities. Such factors were no doubt operative in eliciting that note of strenuous and persistent courage in facing adversities and of untiring combativeness against every difficulty so inherent in Jagadis's character throughout his life.

By his father's wish, Bose received his primary education at the vernacular school in Faridpur, and not the English school. Thus did he at an early age come into contact with the problems of the peasant, and those problems always occupied his mind afterwards. At nine years of age he entered St. Xavier's School in Calcutta, where his taste for natural history veered round to one for physics under the influence of Father Lafont. He graduated B.A. at the age of twenty years.

At this time, his family was financially embarrassed, but chiefly through the help of his mother, Bose was enabled to leave Calcutta for the University of London to study medicine. In later years, he was never tired of describing the thrills he experienced in studying zoology for the first time under Ray Lankester. But his health forced him to leave London, and, having gained a natural science scholarship, he entered Christ's College, Cambridge, in 1881. His first year there was one of indecision, but he was an assiduous student of physiology under Michael Foster and embryology under Francis Balfour. In his second year, he settled down finally to botany under Vines and Francis Darwin, chemistry under Liveing and physics under Rayleigh. He took the Natural Sciences Tripos, obtained his B.A. and at the same time took a London B.Sc. In later years, his former teachers, Lord Rayleigh and Prof. Vines, were appreciative of his researches in physics and physiology, and were sponsors for their presentation before the Royal and Linnean Societies respectively.

Bose returned to India at the age of twenty-five years, and, after serious opposition from the Educational Service and from academic authorities, was appointed professor of physics in Presidency College,

Calcutta. Here his lectures were brilliant and his influence over the students profound. Thus finally did he gain the full approbation of the Principal of his College and the Director of Public Instruction.

Having thus overcome preliminary opposition and difficulties (though there were many more in store), Bose determined that henceforth his life should be devoted not to professional survival or family honour, but to the pursuit of scientific truth. How tenaciously he adhered to that resolution throughout his career is practically common knowledge. Through it, especially in his own country, he won the love and admiration of everyone.

Bose's first researches were on electric radiation, and within a year the Royal Society undertook the publication of his investigations and provided financial help for their continuation. About the same time he was awarded the degree of D.Sc. in the University of London. Thus did his first piece of research work win authoritative approval. Kelvin too was enthusiastic in his praises of Bose's physical researches: but all this meant chiefly one thing to Bose—that India was coming forward in scientific research. So at that time he decided that India should have its own scientific research institute: but he was still faced with much opposition so he concluded that anything done in such a direction must be done by himself. However, it was not until another twenty-five years had passed, during which both he and his wife practised the strictest economy, that he was able to realize his dream and open the Bose Research Institute in Calcutta.

Having justified his claim as a physicist, Bose received every encouragement from his own Government and from the Imperial Government.

About the same time that Lodge was extending Hertz's work on electrical radiation in England, Bose was doing similar work in India. With his perfected apparatus, he carried out his now familiar work on electric waves. He was able to verify the laws of reflection and refraction, determine refractive indices and wave-lengths (by curved gratings) and exhibit polarization and double refraction by pressure and unequal heating. In 1896, this work received the highest praise from Sir Oliver Lodge and Lord Kelvin, and Bose was acclaimed as the first Indian to win distinction through scientific work. On the Continent and throughout Asia, too, his work in physics received distinct approval from such men as Lippmann, Quincke, Warburg, Lenard and others, and as the outcome of it all, British men of science, including Lister, Kelvin, Dr. Gladstone, Poynting, Stokes, Silvanus Thompson successfully appealed to the Government to establish a well-equipped physical laboratory in Presidency College. But there was much delay, and the laboratory did not materialize until 1914, shortly before Bose retired from the chair. Further experiments with his electric refractometer were communicated to the Royal Society in 1898 when he described determinations of the indices of refraction of various substances and the influence of the thickness of the air-space on total reflection of electric radiation. In 1900 he contributed a communication to the Royal Society on molecular changes produced in matter by electric waves, in which he made some interesting observations concerning the phenomenon of fatigue in metals. This marked the beginning of his interest in response in the inorganic and in the living.

At the beginning of this century, Bose's well-known, though little understood, work in physiology began, and he read his first paper on the response of inorganic and living matter before the International Conference of Physics meeting in Paris in 1900. This paper caused considerable discussion, and he read a similar paper at the British Association meeting at Bradford in the same year. Here he described the magnitudes of changes produced in the molecular structure of inorganic and living substances due to an electric stimulus, and was able to show that from this point of view both types of substances are similar. On this basis, he constructed an artificial retina that enabled him to explain many phenomena of vision which up to that time had been obscure. Both physicists and physiologists attended this paper; the physicists were enthusiastic, but the physiologists were cool.

At the invitation of Rayleigh and Dewar, Bose continued his researches along these lines in the Davy Faraday Laboratory of the Royal Institution. He then returned to India. Though during 1900–3 he continued his researches both in England and in India on the theme of response in the inorganic and the living and had his papers read before the Royal Society, they were not published owing to the opposition of some physiologists. A paper was read before the Linnean Society of London under the sponsorship of Vines, Horace Brown and Howes. In this he discussed the electric responses in ordinary plants under mechanical stimulus. His experimental results showed, he claimed, that the response of the ordinary plant organism, so far as fatigue, temperature, poisons, anæsthetics, etc., are concerned, is identical with that of animal muscle and nerve. Similar results communicated to the Royal Society in 1903 were not published. But from 1902 until 1919 he published six volumes of his experimental investigations and conclusions and many papers on his 'physics of physiology'. In his "Responses in the Living and Non-Living" he claimed to have demonstrated "a complete parallelism . . . between plant response on the one hand and that of animal tissue on the other" and, referring back to his earlier physical experiments on the 'electric eye' he claimed to have shown that "there is not a single phenomenon in the responses, normal and abnormal, of the retina which has not its counterpart in the sensitive cell constructed of inorganic material".

Thus did Bose's earlier work in physiology meet with much active opposition: but this gradually subsided and eventually some of his work appeared in the publications of the Royal Society and other societies. On November 30, 1917, he was able to realize his dream of a quarter of a century and open the Bose Research Institute in Calcutta. This includes departments of physics and plant and animal physiology. Active research continues there. The funds were supplied by him and from Government grants.

Bose had a genius for designing delicate and sensitive apparatus for his physiological investigations, fertility in initiating new lines for observation and a clear style of setting out his experimental results and theoretical deductions. Nevertheless, by his resonant recorder and oscillating recorder he actually did for the first time record the delicate movements of leaves of *Mimosa* and *Biophytum* without distortion. He also devised apparatus for demonstrating the effect of sleep, air, food, drugs, excitation, impulse, etc., on plants. He also demonstrated an instantaneous record of growth and death. Thus, according to him, did the plant automatically record its own physiological life-history. In 1919, he announced that he had obtained in plants very definite mechanical and electrical response to wireless impulses, and claimed that the "perceptual range of the plant is inconceivably greater than ours: it not only perceives but also responds to the different rays of the vast æthereal spectrum". His high-magnification crescograph which magnified the growth of a plant ten million times was received with enthusiasm in England in 1919–20. Doubt had originally been cast on the crescograph really recording growth magnification, but after demonstrating his apparatus in University College, London, a letter appeared in *The Times* of May 4, 1920, over the signatures of some of the leading British men of science stating that "the growth of plant tissues is correctly recorded by this instrument and at a magnification of from one to ten million times".

Bose received the C.I.E. for his scientific work at the Delhi Durbar in 1902. In 1911 he was awarded the C.S.I., and in 1915 he retired from the chair in Presidency College as emeritus professor on full pay. In 1917 a knighthood was conferred upon him, and in 1920 he was elected a fellow of the Royal Society.

Comment on Bose's praiseworthy work in physics would be superfluous: but he would be a daring man who attempted any precise evaluation of Bose's work in plant physiology at this stage. His work was prolific and his publications voluminous. He published a large number of books, and the "Transactions of the Bose Research Institute" contain much of his own work and much carried out in collaboration with others. Most of this work has been received in silence, and has neither been confirmed nor openly refuted. In any event, never will it be truthfully said that Bose was not a potent stimulus to contemporary physiologists, especially at the height of his career. A leading physiologist once said that Bose's "more general conclusions will probably not attract so much attention as the new experimental methods he employed". But the application of Bose's methods in experimental physiology by other investigators is still to come.

Of Bose, the man, nothing but the most gracious and kindest thoughts can be entertained. He was a great patriot and took a deep interest in Indian culture; and his wider interests are shown by his former membership of the International Committee on Intellectual Co-operation of the League of Nations. Sir Jagadis is survived by Lady Bose, who for many years was a source of encouragement to him.

Dr. K. J. Saunders

DR. KENNETH J. SAUNDERS, whose death at the age of fifty-three years occurred at Eastbourne on November 22, was an orientalist and authority on the religions of Asia of no little distinction.

Dr. Saunders was educated at Clifton College and Emmanuel College, Cambridge, of which University he was a D.Litt. From 1909 until 1912 he was a lecturer of Trinity College, Kandy, and it was in this period, through his contact with the Buddhist monks of Ceylon, that he acquired an insight into the practical working of the Buddhist faith. This determined his line of approach to the comparative study of the religions of the East as 'ways of life', which he demonstrated most strikingly in his studies of similarities in the doctrines of Buddhism and the teachings of Christ. He was also strongly impressed by the influence of Buddhism in the spread of the culture of India and Ceylon to other countries in Asia. These views on the place of Buddhism in the life and culture of the East were strengthened by a period of residence in Burma, when work for the Y.M.C.A. brought him into intimate contact with native students; and they were confirmed and deepened by pilgrimages to Buddhist shrines and centres in other parts of Asia, especially China and Japan, which he visited after the Great War.

Dr. Saunders was later appointed to the chair of comparative religions in Berkeley University, California, which he held until 1935. In the two following years, he was engaged in lecturing on Asiatic history; but a breakdown in health prevented him from taking up his duties on appointment to the recently founded Spalding chair for the study of comparative religions in the University of Oxford.

WE regret to announce the following deaths:

Dr. O. C. Bradley, principal of the Royal (Dick) Veterinary College, Edinburgh, since 1911, on November 21, aged sixty-five years.

Mr. Edward T. Browne, a governor of the Marine Biological Association of the United Kingdom and a generous benefactor to science, well known for his zoological work on medusæ, on December 10, aged seventy-two years.

Prof. J. Henderson, professor of natural history in the Colorado Museum, an authority on invertebrate palæontology, on November 4, aged seventy-two years.

The Rev. Walter Howchin, emeritus professor of geology in the University of Adelaide, aged ninety-two years.

Prof. A. Hutchinson, O.B.E., F.R.S., formerly professor of mineralogy in the University of Cambridge, lately master of Pembroke College, on December 12, aged seventy-one years.

Prof. Hans Molisch, formerly professor of botany in the University of Prague, on December 8, aged eighty-one years.

Mr. George Philip, chairman of Messrs. George Philip and Son, Ltd., geographical publishers, and author of several valuable library atlases, on December 8, aged sixty-seven years.