

crushing machinery. A worn "Era" manganese steel compound tramway crossing may be inspected here; it was in service during a period of twelve years, and thirteen and a half million cars passed over it. There is also a good display of machined steel forgings, and two crushing machines for stone. Rustless steel is also represented, and there is a large and interesting collection of projectiles ranging from an 18-inch armour-piercing projectile to a small 12-pounder. There are also several examples of armour plates and gun shields. The non-magnetic character of "Era" manganese steel is illustrated by means of a powerful magnet in a glass case.

Messrs. Thos. Firth and Sons have also an interesting exhibit, and the uses of stainless steel may be observed at this and neighbouring stands. These include some fine examples of optical plane mirrors and a section of the test turbine wheel, to which reference has already been made in our columns, in which stainless steel blades were compared with 5 per cent. nickel steel. Visitors may compare for themselves the corrosion and erosion of the latter blades with the undamaged stainless blades.

The Wallsend Slipway and Engineering Co. was a pioneer in the burning of oil fuel in marine boiler furnaces, and examples of the different classes of burners made by this firm may be inspected at their stand. Both Messrs. John I. Thornycroft and Co. and Messrs. Yarrow show several models of ships

constructed by them; the first-mentioned also show several marine oil motors and the latter have a Yarrow water tube boiler so arranged that its entire construction may be understood.

The Institute of Metals has a unique display in the scientific section illustrative of the corrosion of condenser tubes. The diagrams shown indicate that the rate of corrosion is mainly dependent upon the properties of the scales formed upon the tubes in sea-water. A novel method is shown for protecting aluminium from the action of sea-water, especially under conditions in which the aluminium is liable to be alternately wetted and dried.

The English Electric Company is represented in the power station, as has been mentioned above, and has a stand in which is shown a 30,000 horse-power twin turbine, built for the Behira station of the Tata Company. The enormous Pelton wheel of this turbine attracts a good deal of attention.

It is impossible to do justice to the contents of the Palace of Engineering within the limits of a short article, and those interested in engineering will find that several visits are required in order to become even moderately acquainted with the exhibits. The engineers of Great Britain have done extremely well for the British Empire Exhibition; the result is one to be proud of, and cannot fail to impress visitors from Great Britain and other countries.

Obituary.

DR. C. W. ANDREWS, F.R.S.

BY the death of Dr. Charles William Andrews on May 25, British palæontology loses one of its foremost exponents. Born at Hampstead in 1866, he graduated in both arts and science in the University of London, and began his career as a schoolmaster. He was, however, always deeply interested in biological and geological science, and in 1892 he became the successful candidate in a competitive examination for an assistantship in the Department of Geology in the British Museum (Natural History). Here he found ample scope for following his inclinations and exercising his abilities, and in 1900 he received the degree of D.Sc. in the University of London, as a recognition of the value of his original researches.

When he entered the British Museum, Dr. Andrews took part in curating the fossil vertebrata, and soon began to specialise in studying the extinct birds. In his first paper, published in the *Geological Magazine* in 1894, he described the remains of the largest known running bird from Madagascar, which he named *Aepyornis titan*. He next devoted attention to some of the extinct birds of New Zealand, and in 1896-97 examined a large collection of fossil bird-bones from the Chatham Islands, obtained by Lord Rothschild for the Tring Museum, contributing three papers on them to the *Novitates Zoologicae* of that Museum. Later he wrote on the extinct birds of Patagonia, and to the end he retained an interest in all fossil remains of birds. His last important paper on the subject was a description of the sternum of the largest known flying bird from an Eocene formation in southern Nigeria.

Dr. Andrews, however, did not neglect the other groups of higher vertebrates, and he specially studied the marine reptiles of the Oxford Clay collected by

Mr. Alfred N. Leeds in the neighbourhood of Peterborough. He began by describing the development of the shoulder-girdle in a Plesiosaur in 1895, and finished by preparing a great monograph of the whole collection, which was published by the Trustees of the British Museum in two well-illustrated volumes in 1910-13. He also made several other valuable contributions to our knowledge of the extinct marine reptiles, among which may be specially mentioned descriptions of Plesiosaurs from the Lias of Northampton and the Wealden of Sussex, published so recently as 1922. His last paper, read to the Zoological Society this year and now in the press, describes and discusses the skin of Ichthyosaurus.

In 1897 the late Sir John Murray was beginning to exploit the phosphate deposits on Christmas Island in the Indian Ocean, and he proposed to the Trustees of the British Museum that they should explore the island, at his own expense, before the fauna and flora were disturbed by man and his introductions. Dr. Andrews was selected for the work, and he spent ten months in 1897-98 in collecting natural history specimens and making a geological survey of the island. It proved to be a typical oceanic island composed of volcanic rocks and coral reefs, and the results of the exploration were published by the Trustees of the British Museum in a small volume in 1900. Eight years later, Dr. Andrews visited Christmas Island again, at the invitation and expense of Sir John Murray, to examine the changes in the fauna and flora which had taken place during man's occupation, but found little to report.

After his first visit to Christmas Island, Dr. Andrews began to show symptoms of an affliction which handicapped him for the rest of his life, and by the generosity of one of the Trustees of the British Museum he was

able to recuperate in Egypt during the winter of 1900-1901. He joined Mr. Beadnell, of the Geological Survey of Egypt, in the Fayum, where there are freshwater deposits of early Tertiary age, and his keen eyes soon detected numerous remains of mammals which had not previously been noticed. Among these he recognised two successive ancestral elephants more primitive than *Dinotherium* and *Mastodon*, which he described under the now familiar names of *Moeritherium* and *Palæomastodon*. He thus showed that the African region was probably the original home of the Proboscidea, and in a paper published in the *Philosophical Transactions of the Royal Society* in 1904, he described various specimens illustrating the early stages in the evolution of these strange mammals. In 1902 Mr. Beadnell discovered the large horned mammal *Arsinoitherium* in the same district, and between 1902 and 1906 Dr. Andrews again paid visits to the Fayum, thanks to the generosity of the late Mr. W. E. de Winton, and obtained valuable specimens of the most important extinct mammalian fauna which has been discovered during the present century. The whole collection made both by himself for the British Museum and by Mr. Beadnell for the Geological Survey of Egypt, was eventually discussed by Dr. Andrews in "A Descriptive Catalogue of the Tertiary Vertebrata of the Fayum, Egypt," published by the Trustees of the British Museum in 1906. This deals especially with the beginnings of the Proboscidea, Hyracoidea, Sirenia, and Cetacea, and will always remain one of the classics of vertebrate palæontology.

Between 1911 and 1914 Dr. Andrews described and interpreted other important early Tertiary fossil mammals collected by Mr. C. W. Hobley and Dr. Felix Oswald in British East Africa, extending especially his observations on the Hyracoidea. At the time of his death he was looking forward to receiving another collection made last April by Mr. E. J. Wayland in a locality in Uganda whence a toe-bone of *Chalicotherium* was obtained a few months ago.

In the intervals of these more important researches, Dr. Andrews found time to deal with many smaller discoveries which were brought to his notice at the Museum. He was ever helpful and encouraging to visitors who submitted fossils for his consideration. His genial kindliness, which endeared him to both colleagues and friends, stood him in good stead as a curator, and he attracted many valuable gifts to the collection of the Museum. His keen insight into the meaning of the facts he observed illumined all his writings and made them fundamental contributions to science. The indomitable energy and enthusiasm with which he pursued his researches between the frequently recurring periods of illness during his later years, were altogether admirable. His scientific worth was recognised by his election to the fellowship of the Royal Society in 1906, and by the award of the Lyell Medal of the Geological Society of London in 1916. His personal worth was appreciated by a large circle of devoted friends, both in Great Britain and abroad, who sincerely mourn his premature end. A. S. W.

The many friends of Dr. Andrews will appreciate the following tribute from his surgeon:

"Like all surgeons I have had the privilege of meeting men who have faced the ordeal of a painful operation

with courage. Andrews, however, will always remain in my mind as one of the bravest men I ever met. It is possible to hide the whole truth from some patients, so that their ignorance saves them distress. In the case of a scientific man this is impossible, and Andrews knew for many years that a time must come when nothing more could be done for him. None the less while he could work, he worked, and quite shortly before his death he was correcting the proof-sheets of a palæontological paper. He never complained, he never lost his courage, even when he was faced with not one but many operations. What this means only those who have to do with surgery can really understand. His personal charm and thoughtfulness for others were known to all his friends, but to no one were they more evident than to those whose lot it was to be with him in his time of pain.

His scientific work is well known and will ever remain his monument, but I would like to add to his epitaph not only that he was a very kindly and lovable man but that he was a very brave one." A. E.

PROF. E. F. NICHOLS.

ACCORDING to a note by Prof. A. Trowbridge of Princeton University in the issue of *Science* for May 9, Prof. Ernest Fox Nichols, formerly professor of physics in Yale University, died suddenly on April 29 while addressing a meeting in the hall of the National Academy of Sciences at Washington.

Prof. Nichols was born in Kansas in 1870, and, after studying at Cornell University and spending two years on research at Berlin, he received the doctorate of science in 1897. He was professor of physics at Colgate and Dartmouth Colleges and Columbia University in succession, but in 1909 abandoned for a time scientific for administrative work and became president of Dartmouth. In 1916 he took up the professorship of physics at Yale, but on the entry of the United States into the War, he joined the Naval Ordnance Department. In 1920 he became director of the pure science research laboratory of the National Electric Lamp Works. For a short time in 1921 he was president of the Massachusetts Institute of Technology, but the state of his health led him to resign after a few months. He took a prominent part in the establishment in 1916 of the National Research Council and in its subsequent organisation.

Prof. Nichols's first paper was published in 1893 while he was still at Cornell, and its title, "Studies of Transmission Spectra of Substances in the Infra Red," suggests the field in which a large proportion of his research work was done. Three years later he was co-operating with Rubens in Berlin in the production and measurement of infra-red radiation, and his last paper, published in 1923, dealt with the same subject. In conjunction with Hull he succeeded in 1901 in measuring the pressure exerted by radiation on a body on which it falls, although the total force involved was only of the order of 10^{-5} dyne.

WE regret to announce the following deaths:

Prof. H. O. Hofman, emeritus professor of mining and metallurgy at the Massachusetts Institute of Technology, and an original member of the Institute of Metals, on April 28, aged seventy-one.

Mr. F. Merrifield, formerly president of the Entomological Society, on May 28, aged ninety-three.