purely sporting articles, we may confidently state that, in spite of a certain number of errors and shortcomings, like those mentioned above, the "Encyclopædia of Sport" supplies in the main exactly the kind of information on natural history subjects the sportsman is likely to require.

R. L.

THE PROPAGATION OF EARTHQUAKE WAVES.¹

"DOS PALABRAS," or "two little words," has a much more friendly sound than the abrupt word "preface." "Preface," standing by itself, is suggestive of a snappy military command, something like "halt" or "quick march," whilst "Dos Palabras" is the kindly invitation of a writer to the public, asking them to read his work. In the "Dos Palabras" we are told that the ordinary person only thinks about earthquake prediction and that which is utilitarian, whilst the principal object of the seismologist is to extend human knowledge about the interior of our planet.

This memoir, which was presented to the American International Congress of Science held in Buenos Ayres in 1910, although dealing especially with the propagation of earthquake waves, gives in an introduction of forty-two pages a rapid review of many problems with which modern seismology deals. From the velocity with which earthquake waves are propagated through our world, we have already learned something new about the constitution of its interior. The conclusions arrived at by these velocities as bearing upon the rigidity of our world, together with investigations made by Lord Kelvin and others on the same subject, are briefly mentioned. References are made to the investigations of Prof. Rico which indicate a relationship between the value of gravity and the seismic and volcanic phenomena of a district. But the more general relationship between the abnormal movements of magnetic needles, earthquake disturbances, and the value of g in localities characterised by the presence of volcanic rocks, has been overlooked.

Sunspots, unusual movements in bodies of water, the times at which geysers erupt, barisal guns, microphonic disturbances, abnormal earth currents and other phenomena, are pointed to as subjects which should arrest the attention.

Unexpected side issues in the daily work of a seismologist—as, for example, the effect of tidal load, the transpiration of vegetation, which is always wrinkling the face of our globe, the emotional effects produced by earthquakes upon man, their effects on the behaviour of certain animals, and the exploitation of many other byways—have been overlooked. These, however, have nothing to do with Dr. Negri's chief subject, which occupies the next seventy-three pages of his publication. This entirely deals with the velocity with which earthquake motion is propagated. He starts out with the assumption that in a teleseismic record we frequently see many phases, P_1 , P_2 , &c., and that there are as many corresponding velocities which are distinguished as V_1 , V_2 , &c. He derived this idea from the publications of Dr. Ōmori. With this assumption V_1 has a velocity of about 12½ kilometres per second, V_2 would be about 2 kilometres per second, and V_{20} , if there is such a value, would be less than 0.5 per second, *i.e.* if all these phases of earthquake motion started from an origin at the same time. We fear that many seismologists will not readily accept this hypothesis, and to explain

the rising and falling in amplitude and changes in period exhibited in teleseismic writings will require some other assumption. P_1 , P_2 , P_3 , and their corresponding velocities, are explicable by the existence of three types of waves, but the lengthening of the caudal appendage of a megaseism as it travels into and sometimes beyond its quadrantal region is a phenomenon about which many explanations have been offered, but the one to be accepted does not appear so far to have been decided on.

In his conclusion to this section, Dr. Negri says that the relation of $\frac{V_1}{V_2}$, $\frac{V_1}{V_{31}}$ (*sic*), $\frac{V_1}{V_5}$, &c., represents a series in increasing arithmetical progression. All that the majority of seismologists at present recognise is that in round numbers V_1 equals 12 kilometres, V_2 equals about 6 kilometres, and V_3 about 3 kilometres per second, and we fear that they are not yet in a position to accept values which might correspond to P_{20} or P_{40} . In an appendix the author shows that his acquaintance with modern seismology is rather one-sided. He gives a bibliography of 176 books and papers, nearly all of which are in the Italian or Spanish language. Japan is credited with thirteen papers, England with five, whilst two or three are in French. The first exhibition of seismological instruments, we are told, was represented by a section in the International Exhibition of 1900 in Paris. The exceedingly popular exhibition of earthquake instruments held in Tokio twenty years earlier is not even mentioned. The author concludes his memoir by two queries: Why do not all the students of seismology in South America combine? Why does not the national authority do something to bring about this union, which would be for the good and progress of science in general? It is my prophecy, says Dr. Negri, that these desires will very soon become realised.

JOHN MILNE.

PROF. GEORGE CHRYSAL.

THE lamented death of Prof. George Chrystal, of Edinburgh University, removes an outstanding personality in academic and educational circles. Aberdeen and Cambridge claim him as a distinguished alumnus. In 1875 he was bracketed with Prof. Burnside as Second Wrangler and First Smith's Prizeman. Even then he showed his leaning towards applied rather than pure mathematics; for Prof. Tait, who was one of the examiners, used to say that Chrystal excelled all the others in the way in which he solved physical problems.

After two years as professor of mathematics in St. Andrews University, Prof. Chrystal in November, 1879, began his life's work as occupier of the like chair in Edinburgh. The nature of his work compelled him to give his best mind to the teaching of mathematics and the training of the mathematical teacher. In those days every student of arts had to graduate in the same seven subjects. There were no options. Even the comparatively mild problem-solving mathematics of the old school, of which Kelland had been a shining light, had made many a man of classical and philosophical attainments tremble as he entered the examination hall and sat down to tackle the algebra or the Euclidean geometry paper. But the first year of Chrystal's professoriate struck terror to their hearts. Keen, rapid, logical, full of suggestions as to higher fields of mathematical delights, Chrystal transformed the whole atmosphere of the class-room. Eagerly the mathematical minds followed his fascinating lead; despondingly and despairingly those not so gifted fell hopelessly behind, faintly perceiving, if at all, the finely knit sequence

¹ "Velocidad de Propagación de las Ondas Sísmicas." By Dr. G. Negri. Traducción de Alfredo Torcelli. Pp. 143. (La Plata: Observatorio Astronómico, 1911.)

of ideas which formed the thread of his discussions. These, sad at heart, thought simply of their degree, and wondered how they were going to surmount the mathematical barrier. Chrystal had far other conceptions in his mind; but with all his strenuous and successful labours to raise the standard of mathematical teaching he was essentially just, and knew well that minds of the highest quality are not always able to appreciate the convergency of series or the mysteries of probabilities. When the time for testing came, the really intelligent, hard-working student got full credit for his limited mathematical powers.

It was a great pleasure to see in these early days the enthusiasm of the mathematical students, for whose sakes Chrystal never spared himself. The "coaches," all alive to the necessities of the situation, quickly got hold of the methods; and as the graduates passed out into the schools they carried with them the mind of their master. To Chrystal, more than to any other, the great development of mathematical teaching in the schools may be traced.

From the first, as Tait never failed to remind us, Chrystal's was essentially a physical mind. As a Cambridge undergraduate he had—as some thought—"wasted" his time with Maxwell in the Cavendish Laboratory, fiddling with wires, when he should have been practising the writing out of problems. His careful investigation into the truth of Ohm's law is a standard piece of work showing clear perceptions and careful manipulation. The articles on "Electricity" and "Magnetism" in the ninth edition of the "Encyclopædia Britannica" contain in a wonderfully small compass the very best up-to-date account of these sciences, both theoretical and experimental, ever put together. Had they been printed in book form a few years after their first publication they would have been the *vade mecum* of the advanced student. Their merits are a clear, flowing, forceful style, and a remarkable discrimination in selecting material. The great advances of the last twenty years have been along the lines clearly indicated in these articles. On coming to Edinburgh, Chrystal, though he gave his principal attention to his real class work, did not allow his physical work to fall behind. There was no summer session in those days; and the summer months which most other professors spent in holiday were spent by Chrystal in Tait's laboratory. Here he brought to full fruition his theory of the differential telephone. His paper on the subject is published in the Transactions of the Royal Society of Edinburgh, and constitutes the first truly scientific discussion of the action of the induction-balance.

Outside his own particular experimental work, Chrystal was an ever-present source of inspiration to the students. Several of the investigations which were carried through in Tait's laboratory during the early 'eighties were suggested by Chrystal, who really acted the part of a second professor of natural philosophy. With the increasing care of his own department, he was compelled after a few years to give up his experimenting. Another reason, as he once expressed it, was that he found he was usurping the use of all the best instruments in the place, so that the students were not able to get their best work done.

The personality of Prof. Chrystal soon made itself felt on board and senate. He was elected a vice-president of the Royal Society of Edinburgh in 1887, at the unusually early age of thirty-six. For two terms of six years he filled the same important post, and, in 1901, on Prof. Tait's death, he was chosen general secretary. The duties of this office he performed in a manner which it is impossible to praise too highly. Only a man of Chrystal's alertness of mind, clearness of vision, knowledge of affairs, fair-

mindedness, and yet determination to have the society's rights recognised, could have successfully manoeuvred the society through the time of strain when its status and efficiency were threatened. The Scottish members of Parliament stood loyally by the society, and by their sympathy more was achieved than was at first hoped for. Through all the cross-currents of opinion, it was Chrystal who was the real steersman. The present habitation of the Royal Society of Edinburgh is a lasting monument to the memory of its general secretary, who secured from the Government of the day a generous recognition of the claims of science.

The same keen personality combined with business faculties of a high order made Chrystal the right man in the right place, when in 1891 his colleagues elected him the dean of the faculty of arts. The new ordinances which came into effect at that time were soon found to be hampering and unworkable in the interests both of teacher and pupil. Strenuously Chrystal applied himself to the reorganisation of the whole arts curriculum, and the reward of his labours he lived to see in the sanctioning of a new ordinance which grants autonomy to each university within reasonable limits.

To these administrative duties he added for some years the chairmanship of the Provincial Committee for the Training of Teachers. He was, in fact, the first chairman, and probably did more than any other single man to mould this committee into a serviceable administrative body. He was also for several years a member of the committee appointed by the War Office to advise the Army Council regarding the preliminary education of officers.

With all this administrative strain, Chrystal continued to develop his department of mathematics to greater and greater effectiveness. His text-books on algebra are well known; but it is not perhaps so well known that he was the inventor of the very appropriate phrases the "freedom equations" and the "constraint equation" of a curve. These show again how his mind moved in dynamical regions.

Chrystal's literary output is perhaps smaller in quantity than that of most men of equal reputation; but the quality is high. He communicated to the Edinburgh Mathematical Society an admirable account of the properties of lenses and doublets, to the study of which he was led in his recreation as a photographer. He was very skilful in all photographic manipulation, his attachment to the art dating from his Cambridge days, when dry plates were unknown.

In addition to several mathematical papers in the Proceedings and Transactions of the Royal Society of Edinburgh, he enriched the science of hydrodynamics by his researches on seiches. His attention was directed to the subject by Sir John Murray, and the whole problem, experimental and theoretical, seized hold of his mind in a marvellous way. This recent work is too well known to need discussion now. Not only did he vastly improve the mathematical theory of these movements in lakes and bays, but he invented instruments and obtained records which shed a new light on the whole set of phenomena. The work is stamped with all the thoroughness and ingenuity of a fine intellect.

What Chrystal undertook to do he did to the utmost of his powers. He left no ragged ends. All was carried through with celerity, yet with thoughtfulness and accuracy. Quick in his apprehension, and impatient of humbug, he was a terror to the student who was not an honest seeker after truth, but to the genuine student he gave of his best, and nothing delighted him more than when a pupil showed originality and power of research. His knowledge of human affairs was wide and deep. He was splendid

company among congenial friends, and in his own home he was the best of hosts. He was remarkably regular in his attendance at the meetings of the Royal Society Club, and there his appreciation of a good story and his own powers as a raconteur were always in evidence. Like most Scotsmen, he was reserved in his expression of the deeper feelings, but his sympathies were true and his friendship staunch.

C. G. KNOTT.

NOTES.

HIS MAJESTY THE KING has been pleased to approve of the following awards this year by the president and council of the Royal Society:—a Royal medal to Prof. George Chrystal, Sec.R.S. Edinburgh, for his researches in mathematics and physics, especially his recent work on seiches and free oscillations in the Scottish lakes; and a Royal medal to Dr. W. M. Bayliss, F.R.S., for his researches in physiology. The following awards have also been made:—the Copley medal to Sir George H. Darwin, K.C.B., F.R.S., for his scientific researches, especially in the domain of astronomical evolution; the Davy medal to Prof. Henry E. Armstrong, F.R.S., for his contributions to chemical science; and the Hughes medal to Mr. C. T. R. Wilson, F.R.S., for his investigations on the formation of cloud and their application to the study of electrical ions.

THE following is a list of those who have been recommended by the president and council of the Royal Society for election into the council for the year 1912 at the anniversary meeting on November 30:—*President*, Sir Archibald Geikie, K.C.B.; *treasurer*, Mr. Alfred Bray Kempe; *secretaries*, Sir Joseph Larmor and Sir John Rose Bradford, K.C.M.G.; *foreign secretary*, Sir William Crookes, O.M.; *other members of the council*, Lieut.-Colonel A. W. Alcock, C.I.E., Prof. W. H. Bragg, Sir A. H. Church, K.C.V.O., Mr. L. Fletcher, Prof. J. S. Gardiner, Mr. W. B. Hardy, Prof. M. J. M. Hill, Prof. F. S. Kipping, Mr. H. R. A. Mallock, the Duke of Northumberland, K.G., Sir Ronald Ross, K.C.B., Prof. E. Rutherford, Prof. S. P. Thompson, Prof. Sir J. J. Thomson, Mr. H. W. T. Wager, and Prof. E. T. Whittaker.

A REUTER message from Stockholm states that the Swedish Academy of Science has decided to award the Nobel prize for chemistry to Mme. Curie. Prof. W. Wien, professor of physics in the University of Würzburg, is to receive the prize for physics. The value of each prize this year is 7773l.

WE regret to see the announcement of the death of Mr. John Brown, F.R.S., of Longhurst, Dunmurry, Belfast, on November 1, at sixty-one years of age.

THE Physical Society's annual exhibition will be held on Tuesday, December 19, and will be open both in the afternoon and evening.

THE Berthelot memorial lecture of the Chemical Society will be delivered by Prof. H. B. Dixon, F.R.S., on Thursday, November 23.

THE eighty-sixth Christmas course of juvenile lectures, founded at the Royal Institution in 1826 by Michael Faraday, will be delivered this year by Dr. P. Chalmers Mitchell, F.R.S., secretary of the Zoological Society, his subject being "The Childhood of Animals."

THE death is announced of M. E. F. André, whose works in landscape gardening are widely known in the horticultural world. Among various books of which he was the

author are "L'Art des Jardins," 1879, with numerous plates and more than 500 illustrations in the text, and a volume on the bromeliaceous plants collected in Colombia, Ecuador, and Venezuela. For nearly thirty years he edited *La Revue Horticole*, which has always held a high place among botanical periodicals.

THE Royal Geological Society of Cornwall at its annual meeting on October 31 presented the Bolitho gold medal to Mr. Clement Reid, F.R.S., in recognition of the able and conscientious manner in which he had superintended, during the past ten years, the geological resurvey of the county, the final memoirs of which are in the press. Mr. Reid, in returning thanks, said that the work done has widened the horizon and opened up new possibilities for Cornish geologists; but there is still a great deal to be done.

THE Royal Society of Arts will begin its 158th session on Wednesday, November 15, with an address from Lord Sanderson, G.C.B., the chairman of the council. Five meetings are announced before Christmas, at which papers will be read on the industrial progress of America, by Prof. James Douglas; the efficiency of the aeroplane, by Mr. A. E. Berriman; British Guiana, by Mr. J. A. J. de Villiers; London transport, by Mr. W. Yorath Lewis; and Bengal fisheries, by Dr. J. Travers Jenkins. Four Cantor lectures on "The Carbonisation of Coal" will be delivered by Prof. Vivian Lewes, and two juvenile lectures on "Soap Bubbles" will be given in January by Mr. C. V. Boys, F.R.S. A long list of papers for the meetings to be held after Christmas is also published.

THE winter session of the British Fire Prevention Committee was commenced on November 1 with a meeting to conduct a series of fire tests dealing with a small hand extinguisher intended to put out electrical and petrol fires. There was a large attendance at the committee's Regent's Park Testing Station, the Earl of Londesborough, K.C.V.O., Mr. Alexander Siemens, and Mr. Edwin O. Sachs, members of council, receiving the visitors, among whom were leading officials concerned in fire matters from the War Office, Board of Trade, and other public departments. There will be another series of tests this month dealing with the flannelette question, which is of such importance to child life; and in December some fire-resisting doors and partitions from the United States will be under investigation.

AUTHENTIC details of the recent Wright gliding experiments are now to hand, from which it appears that the machine used was very similar to a recent type of Wright aeroplane with power. The glider had no front elevator, but an elevating tail placed 12 feet in the rear of the trailing edge of the main planes. The dimensions of the main planes were 32 feet by 5 feet respectively, with a smaller camber than that used in the powered machine. Otherwise the only alterations made were to increase the size of the vertical rudder in the rear and to cut down the length of the skids. With this glider Mr. Orville Wright, starting from one of the sand-hills near Kill Devil Hill, twice succeeded in remaining in the air for rather more than 1m. 25s. The height of the hill from which he started was 75 feet. With regard to the automatic stability device which is stated to have been tried, no details are yet available. The objects of the gliding trials were to decrease the head-resistance of the machine, and incidentally to solve in a practical manner several problems in wind pressure.

By the death, at the age of seventy-one, of Mr. W. Irvine, a retired member of the Indian Civil Service,