side of the circle of Keswick. These are doubtless to be considered in relation to the direction of the chambered cairn at Callernish. The rising of the Pleiades seems to have been in question.

Still another stellar dolmen I measured in S. Wales has already been referred to.

NORMAN LOCKYER.

EXPERIMENTS ON SCREW PROPELLERS.[1]

THE screw-propeller was practically applied to steamships by John Ericsson and Francis Petit Smith about seventy years ago. It speedily became a formidable rival to the paddle-wheel. Long ago it entirely superseded the latter for ocean navigation, and in more recent years it has to a large extent taken the place of the paddle, even in river steamers of the shallowest draught. Accumulated experience over this long period has proved of great advantage, and has enabled naval architects and marine engineers to meet new conditions in ships of much larger dimensions and higher speed; but notwithstanding this wealth of experience—largely based upon "progressive trials" of steamships and the analysis of the results—it is still true that we are on the threshold of exact knowledge in regard to the principles underlying the efficiency of screw-propellers.

Even in recent years, when the limits of experience have had to be surpassed, there have been many proofs of imperfect knowledge. On the whole, it is true that success has been achieved, but not infrequently as the result of numerous and sometimes costly experiments on propellers of different forms. Perhaps the most striking example of this general truth is to be found in the case of torpedo vessels and motor boats, driven at extraordinarily high speeds in proportion to their dimensions; it is also true that, in vessels of large size and of less speed in proportion to their dimensions, remarkable results have been obtained by a simple change of propellers. For instance, the *Drake* class of cruiser in the Royal Navy, which are the fastest cruisers afloat, had a guaranteed speed of twenty-three knots on an eight hours' trial. The guarantee was slightly exceeded in the first trials, but there was evidence that the propellers became relatively inefficient as the highest speeds were approached, and that the blade-area was insufficient. New propeller blades were made with greater blade area, and with these the ship was driven at a speed exceeding twenty-four knots, representing a gain of about 25 per cent. in efficiency. Obviously, incidents of this nature point to the possibility of very large economies if our knowledge of screw-propeller action and efficiency could be made more definite as well as more extensive. Trials in actual ships, especially those of large size, are necessarily costly, and are often impossible to make because the vessels are required on service. Hence, at a very early date, attempts were made to introduce a system of experiments with model screw-propellers, and from these useful information was obtained. It was left for the late Mr. William Froude to perfect the method of experiment in connection with his well-known system of "tank" experiments on models of varying ship forms; and his son, Mr. R. E. Froude, superintendent of the Admiralty experimental tank at Haslar, has carried on and developed the investigation so far as the pressure of other and more urgent experiments connected with the construction of ships for the Royal Navy has permitted.

The model propellers used by Prof. Durand were forty-nine in number, of 12 inches diameter, with bosses of uniform diameter (2·4 inches); all the models had four blades, and all the blades were elliptical in shape. Blade-areas and pitch-ratios were varied over wide limits, going beyond the range of variation occurring in actual practice. For example, the pitch-ratios tried extended up to 2·1 from 0·9 by differences of 0·2, and the blade-areas were carried down to unusually small proportions of the disc area. Great care was taken to shape the model screws truly and to measure the pitch accurately. For each propeller there was a determination of the power absorbed and the thrust developed for a given number of revolutions per minute, and a corresponding record of the speed of advance in undisturbed water. Practically uniform motion was ensured, and accurate measurements were made of time, distance and force. From these experimental data the actual and comparative efficiencies of the model-screws were ascertained, and the percentages of "slip" could be estimated. The facts are tabulated and graphically illustrated in the memoir. They require and deserve detailed study. In this brief notice it is not possible even to mention the most striking features. Prof. Durand briefly summarises his conclusions in regard to the character of the efficiency-curves of the different model screws, and supplements this section by a description of the method he recommends for applying experimental results to propeller design for actual ships.

One cannot peruse this memoir without regretting that, as yet, no British university, or public institution primarily devoted to scientific work, possesses an experimental tank such as is attached to Cornell University, the University of Michigan, and to the Technical High School at Charlottenburg. Its value for purposes of instruction is great; but its importance as a means of research can hardly be overestimated. When tanks are closely associated with the detail-work incidental to the design of actual ships, the opportunities for research are less, and the interruptions of research-work more numerous and serious when undertaken in the intervals of ordinary employment. In other words, research has to give way to urgent demands connected with ship-designs, and the special apparatus required for research has to be removed or dismantled at short intervals. This has been the experience at the Admiralty tank, and at the two tanks attached to the shipbuilding yards at Dumbarton and Clydebank. A great need exists, therefore, in this the greatest shipbuilding and ship-owning country in the world, for an experimental tank in which research work on ship-forms and propellers can be undertaken systematically and uninterruptedly. This need has been recognised for a long time. The Institution of Naval Architects has made efforts to interest ship-owners and ship-builders in the establishment of such a tank at the National Physical Laboratory. Considerable support has been obtained from ship-builders and from a few ship-owners, but hitherto it has not been possible to secure the whole amount needed for the construction and equipment of the tank, estimated at 15,000*l.*, or for its maintenance, estimated at 1500*l.* a year. This failure is greatly to be regretted, and is not creditable to the community interested in shipping. It is certain that the investigations made at such an establishment would secure large economies and enable great advances to be made in the construction and propulsion of ships. In connection with screw-propellers alone there is a great opportunity for economies in coal-consumption, the benefits of which would be secured by ship-owners, and the amount of which in a single year's operations of our immense mercantile marine would far exceed the cost of the research-tank. Seeing that the United States and Germany already have a

[1] "Researches on the Performance of the Screw Propeller." By Prof. W. F. Durand. Pp. 61. (Washington: Carnegie Institution, 1907.)

distinct lead in this matter, it may be hoped that the scheme, which has been long delayed, will be realised before long, and the reproach wiped away that the country which equals all the rest of the world in its shipping and shipbuilding lags behind other countries in utilising the experimental methods due to that great English man of science William Froude.

Until recent years work done by the Froudes and published by permission of the Admiralty furnished the best information available for guidance in propeller design, especially when associated with progressive trials of steamships. The experimental methods introduced at Torquay and Haslar have been adopted and extended of late by other workers having command of specially equipped hydraulic laboratories or tanks. Amongst these the Washington tank, belonging to the United States Navy Department, has taken a leading position under the able superintendence of Naval Constructor Taylor, who received his training as a naval architect at the Royal Naval College, Greenwich. In addition to this establishment, the United States has the great advantage of possessing experimental tanks attached to universities; these tanks are necessarily more available for research-work than any establishment can be which is created primarily and regularly employed for experimental work bearing directly on actual ship-construction. Prof. Durand—whose investigations on screw-propellers specially claim attention in this notice—for ten years past has closely studied the screw-propeller problem. His later experiments have been made at the hydraulic laboratory of Cornell University; they are systematic and thorough within the limits of the scheme laid down. The method and results have been admirably described and summarised in a memoir of about sixty pages. The Carnegie Institution of Washington made a grant in aid of the experiments, and has published the memoir, thereby conferring great benefit on all who are concerned in the propulsion of steamships, and furnishing a fresh illustration of the encouragement given to scientific research in the United States.

NOTES.

THE following fifteen candidates have been selected by the council of the Royal Society to be recommended for election as fellows of the society:—Mr. W. Barlow, the Earl of Berkeley, Mr. Dugald Clerk, Prof. A. Dendy, Prof. H. H. Dixon, Mr. J. Stanley Gardiner, Prof. W. Gowland, Mr. J. H. Grace, Prof. D. J. Hamilton, Mr. C. I. Forsyth Major, Mr. E. N. Nevill, Mr. W. H. Rivers, the Hon. Bertrand Russell, Dr. Otto Stapf, and Dr. J. F. Thorpe.

A SPECIAL general meeting of the Geological Society will be held on April 1 to consider a resolution relating to the admission of women to full fellowship of the society.

IT is reported by The Hague correspondent of the *Globe* (March 3) that Prof. Kamerlingh Onnes, professor of physics in the University of Leyden, has succeeded in liquefying helium.

SIR OLIVER LODGE will deliver his presidential address to the Faraday Society on Tuesday, March 24. The subject of the address will be "Some Aspects of the Work of Lord Kelvin."

THE Paris correspondent of the *Times* reports that Prince Roland Bonaparte has placed at the disposal of the Academy of Sciences a sum of 100,000 francs (4000*l.*) to be employed in promoting discoveries by facilitating the task of investigators who have already given proof of their ability by original work, but who may lack the resources necessary for undertaking or pursuing their investigations.

PROF. J. R. BRADFORD, F.R.S., Sir T. H. Holdich, K.C.M.G., and the Duke of Northumberland, F.R.S., have been elected members of the Athenæum Club under the provisions of the rule which empowers the annual election by the committee of nine persons "of distinguished eminence in science, literature, the arts, or for public services."

DR. ARTHUR KEITH, lecturer on anatomy at the London Hospital Medical College, has been appointed conservator of the museum of the Royal College of Surgeons, in succession to the late Prof. C. Stewart.

PROF. MILNE'S discourse at the Royal Institution on "Recent Earthquakes," announced for Friday next, March 6, has been postponed until March 20. The discourse on Friday next will be delivered by Prof. Love on "The Figure and Constitution of the Earth."

IN a footnote to Cowper's poem (Magnet edition, 1834), a remarkable meteor, August 18, 1783, and a fog which covered Europe and Asia during the summer of 1783 are mentioned, as well as an earthquake in Sicily of unusual severity. A correspondent asks for details of these occurrences, or a reference to records of them.

THE following officers of the Asiatic Society of Bengal have been elected for the ensuing year:—*President*, the Hon. Justice Asutosh Mukhopadhyaya; *vice-presidents*, Dr. T. H. Holland, F.R.S., Dr. G. Thibaut, Mahamahopadhyaya Haraprasad Shastri; *general secretary*, Lieut.-Colonel D. C. Phillott; *treasurer*, Mr. J. A. Chapman.

WE learn from the *Times* that the Russian Government is dispatching a research commission to investigate some recent discoveries of mammoth remains in the Yakutsk province of north-east Siberia. The commission consists of a doctor of zoology, of the Academy of Sciences, the senior curator of the zoological department of the academy, and six junior laboratory students. The expedition, which is expected to be absent for a year or more, is supplied with a grant of 16,000 roubles (1600*l.*).

THE report of the committee appointed by the Treasury to inquire generally into the work now performed at the National Physical Laboratory has been published as a Parliamentary paper (Cd. 3926), which also includes a Treasury minute recording the approval by the Treasury of the recommendations contained in the report of the majority of the committee. The opinion of the 1898 committee, that the work proper for a National Physical Laboratory to undertake should include not only physical research directly or indirectly bearing on industrial problems, and the standardisation and verification of instruments, but also—under proper restrictions—the testing of materials, is in the first place endorsed. The committee then distinguishes "commercial testing" into "contractual" and "investigatory" testing—"contractual" testing being the ordinary testing of materials to ascertain whether their quality and behaviour are in accordance with the requirements of contracts; "investigatory" testing the investigation for commercial purposes of various substances in which no question of contract arises. To place restrictions upon "investigatory" testing would, it is pointed out, hinder the advance of knowledge. The committee thinks that the laboratory should remain entirely free with regard to "investigatory testing," and, as a rule, be debarred from undertaking "contractual testing"—though electrical, thermal, optical, and other physical tests are to