development of a really suitable synthetic resin is a logical extension of Coker's step from glass to celluloid. With the appearance of modern epoxy casting resins, and in particular of 'Araldite *B*', practical materials have become available in adequate sizes; they possess good elastic behaviours, negligible creep, and sufficient optical sensitivity to be useful. With these new materials has come the stress-freezing technique—now more than twenty years old; this opens up an almost foolproof method for the analysis of solid models. By subjecting a model to a heating and loading cycle, it can be persuaded to 'remember' its loading system, and to retain an optical pattern which is equivalent to an elastic system of stress. The solid model can then be sectioned without disturbance of the optical effect, and a three-dimensional analysis can be made. The possibility of doing this was noted in Germany in 1935, but was apparently not known to Filon or to Coker (who was, by then, a sick man). A similar effect had been noted in glass at University College by Dr. F. C. Harris, although its implications for three-dimensional work were not recognized.

It is interesting to note that, with this development, one returns to the original difficulties of measurement which faced Coker. However, his primitive methods have been superseded by the techniques due to Tardy or Sénarmont. Sufficiently accurate measurements can now be made with strains in the model which are not more than ten times the strain in the prototype.

The interpretation of the results found from a model in terms of the corresponding full-scale structure in a different elastic material, and the effect of a tenfold increase in magnitude of strain in the model, was discussed in a review of the present state of knowledge. This was given at University College in two lectures on modern aspects of photoelasticity by Mr. C. Snell. He argued that although the position is not entirely clear, there are good theoretical and experimental reasons for transferring the stress pattern without significant change from model to prototype.

The problem of thermal stressing was exemplified in the exhibition, and the experimental difficulties that have yet to be overcome were mentioned. Dynamic stressing was also illustrated, with a demonstration that problems of dynamic elasticity can sometimes be studied by photoelastic means. In particular, periodic excitation can be investigated in this way unless the periodic time is too short for stroboscopic techniques to be adequate.

The use of optically sensitive layers to show the strain patterns in metals beyond the elastic range is probably the most recent development in photoelasticity. This technique was illustrated in two exhibits and is undoubtedly a promising new departure. Perhaps not so promising—but by no means without interest—was some apparatus (of recent origin) for investigating the optical behaviour of a moving fluid.

Photoelasticity in Engineering

These, and many other, exhibits leave no doubt about the future of photoelasticity. It has been put to use time and time again, particularly in the aircraft industry, where the economical use of material is vitally important. Now it seems clear that the methods will be widely employed in design work on nuclear engineering projects.

Historically, our knowledge of the stress–optical effect is of Scottish origin, the earliest investigations having been made by Brewster and, later, Maxwell. But practical stress exploration undoubtedly grew up in University College, London. It is most unlikely that any other institution could arrange, from its own resources, an exhibition covering so wide a range of productive work within photoelasticity—even if the earlier exhibits of purely historical interest are disregarded. This is a direct outcome of the collaboration of Profs. Coker and Filon—an engineer and a mathematician—and of the subsequent efforts of a small group of workers under the leadership of Colonel Jessop and, since his retirement, Mr. Snell.

R. E. D. Bishop

OBITUARIES

Dr. Paul Chabanaud

Dr. Paul Chabanaud, Chevalier de la Légion d'Honneur, well known for his researches on fishes, died on February 27 at the age of eighty-two.

Although he had been from childhood a keen amateur naturalist, Chabanaud began by preparing himself for a career in the law, but he considered this to have been a false start. Soon after the beginning of the First World War he was declared medically unfit for the Armed Forces and became a voluntary assistant to Prof. Roule at the Museum of Natural History in Paris, classifying and preparing exhibits from the collections of reptiles and amphibians.

In September 1919, Chabanaud received the blessing of the professors of the Museum to fulfil his great ambition of a collecting trip to tropical West Africa. Apart from free passage to French Guinea and free rail travel within the territory, the only financial assistance he received was a grant of ten or twelve hundred francs. He spent about eight months in the field, covering about 1,200 km. on foot, and brought back valuable collections of arthropods, reptiles, amphibians and fishes, as well as considerable ethnological material.

It was only on his return from this voyage that Chabanaud sought any remuneration for his scientific work, and in 1920 he was appointed Préparateur à l'École des Hautes Études, working in the Laboratoires des Pêches et Productions Coloniales d'Origine Animale. From this time his main studies were in ichthyology, and it was in this field that in 1936 he obtained his doctorate, with a thesis on the morphology and phylogeny of the flatfishes (Heterosomata). This penetrating study confirmed the groupings recognized by Tate Regan in 1910 and 1929, and demonstrated a better understanding of the details of flatfish structure than had been possessed by any of his predecessors. His interpretation of this classification, however, was unique. He agreed with Tate Regan that *Psettodes* was a little-modified percoid fish, diverging less from the symmetrical form than any other flatfish. But whereas Tate

Regan looked upon this genus as a survival from the base of the flatfish stem, to Chabanaud it was the latest departure from the path of percoid symmetry, and the more specialized soles and flounders were the modern twigs of earlier asymmetrical branches of the pre-percoid trunk. The fossils so far do not help to resolve this difference, for as Chabanaud himself was to describe, the main groups were already differentiated in the Upper Eocene.

The majority of Chabanaud's numerous publications after 1936 were on details of the morphology and classification of these asymmetrical fishes, in which he found an endless fascination. He applied to them a terminology of his own, which, in spite of its logical classicism, is unlikely to supersede current usage, which has 'just growed'. It was his ambition to write the second volume of the monograph of the flatfishes begun by J. R. Norman, but he began too late in life to analyse the many samples of soles and tongue-soles available to him and never arrived at a satisfactory synthesis.

Up to the eve of his last illness, Chabanaud would leave his flat in the Rue des Écoles at 8 a.m. and walk, painfully of late, to the laboratory in the Rue Cuvier to count more fin-rays and scales and cover more sheets with his endless tables. How I wish that in some Elysium it might be given him to draw from them the crystal truths that he was sure they would eventually yield ! He could be a charming host, and one of his most engaging accomplishments was the relating of reminiscences, plunging into parenthesis after parenthesis without faltering in the elegant use of his mother-tongue and never failing to emerge triumphantly in the end as from a series of Chinese puzzle-boxes.

He was quite unworldly, a man of child-like integrity and innocence of mind. He is survived by his second wife, with whom he spent many years of mutual devotion.

E. TREWAVAS

Prof. J. T. MacGregor-Morris

PROF. J. T. MACGREGOR-MORRIS died on March 18, at the age of eighty-seven. He established the Electrical Engineering Department at East London College (now Queen Mary College) in 1898, and he became the first professor of electrical engineering in this College, a position which he held until he retired in 1938.

He received his education in electrical engineering at University College, London, and, for a time, was personal assistant to Sir Ambrose Fleming. He was keenly interested in research and during the Second World War he did notable work in developing a hydrophone for submarine detection.

An important contribution to electrical engineering education by Prof. MacGregor-Morris was the manner in which during the lean years immediately following the First World War he kept research work alive in his department, despite meagre equipment and small research funds. He kept the department open on three evenings a week, and he inspired and directed the research work of students who attended on these evenings. The students were of good calibre and they did good work. Several of them have risen to important positions in the electrical industry.

Under the leadership of its professor, the Department grew steadily in prestige, and its housing and equipment improved as the years passed. A notable development was the opening of its well-known High Voltage Laboratory in 1938 with the aid of a grant from the London County Council. This Laboratory was an example of Prof. MacGregor-Morris's foresight—he was a good judge of new developments which were likely to become of major importance in electrical engineering. Another example of this was his interest in the cathode-ray tube from its earliest days. He was joint author of one of the earliest text-books dealing with these tubes.

His lectures were interesting, stimulating and unorthodox with his over-riding interest in research always intruding.

His students and particularly his research students were important personages to him. Many of them will recall with pleasure the annual 'get-together' of staff and research students at his home in Hampstead. Mrs. MacGregor-Morris always took an active part on these occasions.

He was a very active man. On most Wednesday afternoons during term time he would play a strenuous game of tennis or badminton. He was keenly interested in music and, when quite elderly, he learned to play the 'cello and became a proficient performer on this instrument. He was a devout Christian and took an active interest in missionary work.

W. J. JOHN

Dr. John Henderson, C.B.E.

DR. JOHN HENDERSON, for seventeen years director of the New Zealand Geological Survey (N.Z. Department of Scientific and Industrial Research), died suddenly at his home on March 6. Born in Dunedin in 1880, his later education was carried out at Otago Boys' High School, then at the University of Otago and Otago School of Mines. Here he completed, in 1902, his M.A. associateship of the School and B.E. (Mining).

For the next eight years he was director of Reefton School of Mines, during which time he devoted much energy to the investigation of the geological structure of the coal and gold mines of Westland and West Nelson, his thesis on the subject gaining him his D.Sc. in 1907.

In 1911 he was appointed mining geologist to the New Zealand Geological Survey. As well as keeping in touch with mining activities in the succeeding years, and reporting on numerous mines, quarries, and mineral properties of different kinds, he also reported on the geological implications of many engineering projects, for example the Arapuni Hydro-electric Dam on the Waikato River. In addition, he carried out extensive regional surveys of the geology and mineral resources of several districts. His bulletins on Reefton, Te Aroha (with J. A. Bartrum), Gisborne and Whatatutu (with M. Ongley), Mokau (with M. Ongley) and Huntly-Kawhia (with L. I. Grange) stand as lasting contributions to the geology of the Dominion.

At the request of the Fiji Government in 1923, Dr. Henderson visited and reported on the geology and mining prospects of gold-bearing quartz lodes in Vanua Levu.

Dr. Henderson, in 1928, succeeded the late P. G. Morgan as director of New Zealand Geological Survey and almost immediately encountered all the administrative difficulties and frustrations resulting from the financial stringency of the great economic depression. Nevertheless, by unremitting work he was able to keep his staff of geologists intact, and so actively to maintain the geological effort of New Zealand. Bulletins could no longer be printed, but