analysis of nitrogen-elimination curves into 'pulmonary' and 'tissue' components. Dr. Eggleton referred more particularly to the diffusion of nitrogen through fatty tissues and through fats and oils (in which nitrogen is five times more soluble than in water, and through which, on account of their viscosity, diffusion is slow).

The formal programme of the colloquium contained, in all, sixteen communications. This is a very small sample of rheological topics to draw from the whole of biological science, and there is no knowing whether it was representative. The fact that three of the sixteen papers (A. V. Hill, London; F. Buchtal, Copenhagen; and O. Sten-Knudsen, Copenhagen), were concerned with the mechanical properties of muscle, was probably a fair indication, however, of the great interest aroused by this rheological problem, and the substance of these communications illustrated the degree to which this subject has passed beyond the purely descriptive exploratory phase of research into the phase of exact measurement under controlled conditions. Prof. Hill's communication has been printed in *Nature* of September 9 (p. 415), and it is sufficient here to note the interest aroused by his recent results indicating that the stretching of a muscle in the excited state may bring about some endothermic chemical reaction. If a muscle can derive chemical potential energy from mechanical work done upon it, we are far indeed from the simple rheological picture of muscle mechanics—an assemblage of springs and dash-pots—that seemed sufficient twenty years ago.

The two communications referred to above, from the Neurophysiology Department at Copenhagen, illustrated the attempt to simplify the nature of the problem by study of the mechanical properties of single muscle fibres. Buchtal and Kaiser have applied longitudinal vibrations to such individual fibres, and by electrical recording have obtained Lissajou figures on a cathode-ray oscillograph in which the x-component records the alternating applied tension and the y-component the resulting alternating changes of length. The shape of the ellipse produced is affected by the physiological conditions of the fibre and the frequency of the vibration. These authors distinguish between 'elastic stiffness' and 'viscous stiffness'. The former is determined by the resonance frequency of the vibrating system, and the latter by the ratio of load to amplitude of movement at this resonant frequency. The changes in these two dynamic properties induced by electrical stimulation, by loading conditions, by temperature, etc., were the subject of this communication.

Dr. Sten-Knudsen's paper dealt with experiments of similar nature, in which the applied force consisted of an oscillating twist instead of a tension. The response of the fibre to such torsion enables conclusions to be drawn as to the structural forces operating normally to the fibre axis.

Even the stress - strain relations of non-living natural fibres are too complicated to describe in terms of simple viscous-elastic models: Dr. F. Anderson (Copenhagen), described the phenomena of after-stretch or relaxation observable in cellulose fibres subjected to sudden strain. Such relaxation, if attributed (following Eyring and his associates) to 'flow' of cellulose molecules or aggregates, can be used to provide a description of the rheological properties in terms of molecular structure—to determine, for example, the size of the aggregates between which slip is occurring.

Perhaps the most fundamental topic discussed at the meeting was that raised by Dr. M. Joly (Paris). It concerned the structures—transient and microscopic structures—present even in many relatively simple colloidal solutions. The flow characteristics of certain colloids point to the conclusion that reversible dissociation or aggregation of particles can occur as a direct consequence of the shear in the flowing liquid. Extreme examples of such effects are displayed in the phenomena of thixotropy and of rheopexy.

In addition to the communications just described, papers were read by Dr. R. D. Preston (Leeds), on the ascent of sap in trees, Prof. A. Frey-Wyssling (Zurich), on Poiseuille flow in latex tubes, Dr. T. D. Day (Leeds), on the flow of water in connective tissue, and Dr. F. A. Glover (Reading), on the rheology of human uterine secretions; all provoked warm—occasionally heated—discussion, both in and out of the lecture hall.

The success of this colloquium—and those who had attended it appeared all to rate it highly successful—was no chance result, but directly due to the care and forethought of Prof. H. Burström and Dr. A. Deutsch, who acted as local organisers. It was an agreed policy that informal discussion should be an important part of the proceedings; but discussion cannot be brought about by decree. That discussion took place freely and fully was the result of two things. The restricted size of the colloquium made it possible for each member quickly to make the acquaintance of all others; and the provision of a buffet for meals and refreshments in the grounds of the Institute made it unnecessary for members to scatter at intervals in search of sustenance. The generosity of the Swedish Government, which placed a sum of money unreservedly at the disposal of the organisers for hospitality, made it possible to provide this refreshment free of charge, and no better way could have been found to make this hospitality effective.

The proceedings of the colloquium will be published as part of a monograph on "Rheological Problems in Biology" now being prepared by Prof. A. Frey-Wyssling (Pflanzenphysiol. Inst. d. Eidg. Tech. Hochschule, Zürich). The cost of publishing the proceedings is borne by a grant from the United Nations Educational Scientific and Cultural Organisation, to which body the organisers of the colloquium are also indebted for a grant of money towards the expenses of the meeting.

OBITUARIES

Prof. A. W. Conway, F.R.S.

ARTHUR WILLIAM CONWAY, by general consent the most distinguished Irish Catholic man of science of his generation, was born at Wexford on October 2, 1875, and died in Dublin on July 11, 1950. He was educated at University College, Dublin, and Corpus Christi College, Oxford, and was elected a junior fellow of the Royal University of Ireland in 1900 and a senior fellow in 1901. In the latter year he was appointed professor of mathematical physics in the old University College, being continued in a similar office when the new University College was created in 1909.

Conway's earliest papers, which appeared from 1902 onwards, were concerned with problems in the electromagnetic theory of light—the reflexion of electromagnetic waves from moving conductors, the propagation of light in crystals, and general properties of the partial differential equations of physics: in 1904 he made notable advances in the study of fields of force due to moving electrons. These researches led him naturally to the question of the origin of spectra. At that time (some years before Rutherford's discovery of 1911 that the atom is like a miniature solar system, or Bohr's discovery of 1913 that a spectral line is generated when an electron falls from one orbit to another), it was generally supposed that spectra were produced in the same way as sounds are produced by the free vibrations of a material body: that is to say, the atom was regarded as an electrical system of some kind, which had a large number of natural periods of oscillation, corresponding to the aggregate of its spectral lines. Conway, in a paper of only two and a half pages in the *Scientific Proceedings of the Royal Dublin Society* in 1907; was the first to break with this conception, and to enunciate the principles on which the true explanation was to be based: namely, that the spectrum of an atom does not represent the free vibrations of the atom as a whole, but that an atom produces spectral lines one at a time, so that the production of the complete spectrum depends on the presence of a vast number of atoms. In his view an atom, in order to be able to generate a spectral line, must be in an abnormal or disturbed state; and in this abnormal state, a single electron, situated within the atom, is stimulated to produce vibrations of the frequency corresponding to the spectral line in question. The abnormal state of the atom does not endure permanently, but lasts for a time sufficient to enable the active electron to emit a fairly long train of vibrations.

As compared with Bohr's paper of six years later, Conway's work falls short in two respects: first, he associated the spectral line with a single state of the atom, whereas Bohr associated it with the transition between two states; it should, however, be remembered that Conway wrote before Ritz's paper of 1908 had convinced spectroscopists that the frequency of a spectral line is the difference of two 'terms'. Secondly, he did not connect the phenomenon with Planck's quantum of action. For these reasons, Conway's theory did not prove immediately fruitful, as Bohr's did; but the very revolutionary general principles he suggested were perfectly sound, and show a remarkable physical insight.

Conway was probably the most accomplished living manipulator of the quaternion calculus: and in a number of his later papers, he showed its superiority for the formulation both of special relativity and of quantum mechanics. He had a personal devotion to the memory of its discoverer: and had a chief share in persuading the Royal Irish Academy to undertake the publication of a collected edition of Hamilton's works. For the two sumptuous volumes which have so far appeared, and which contain a great amount of matter hitherto unknown, he acted as chief editor.

Conway held the chair of mathematical physics in University College, Dublin, until 1940, when he was elected president of the College, a position from which he finally retired in 1947. He was elected a fellow of the Royal Society in 1915, and served on its Council during 1935–36; he was for terms of years president of the Royal Irish Academy and of the Royal Dublin Society, vice-chancellor of the National University, and chairman of the School of Theoretical Physics in the Dublin Institute of Advanced Studies. He was an honorary fellow of Corpus Christi College, Oxford, and received honorary degrees from the Universities of St. Andrews, Dublin, and the Royal University of Ireland. In 1939 he was appointed a member of the Pontifical Academy of Sciences.

His wife predeceased him; but he is survived by his son and three daughters.

EDMUND WHITTAKER

Dr. L. O. Howard

LELAND OSSIAN HOWARD, who died on May 1 at the age of ninety-two, was a well-known American biologist, administrator and writer, and chief of the Bureau of Entomology of the U.S. Department of Agriculture for thirty-three years. He was born on July 11, 1857, at Rockford, Illinois, and was the eldest child of Ossian Gregory Howard and his wife Lucy Dunham (Turber) Howard, of the famous Pickering family of Massachusetts from whom there also came several other men of science. He was also distantly related to Senator Jacob M. Howard, of Michigan, one of the founders of the Republican Party in the United States, and to William Howard Taft, ex-president of the United States. While still in his infancy his parents removed to Ithaca, New York. He early became interested in outdoor life and natural history, and particularly in the birds and insects. In 1873 he entered Cornell University, and, during the four years that followed, he not only made excellent progress with his studies, but also was particularly fortunate to come under the influence of some outstanding men of science, notably John Henry Comstock, S. H. Gage and the elder Agassiz, whose lectures he had the good fortune at times to attend. Perhaps most important of all, however, he came to know Prof. C. V Riley. Riley succeeded Towend Glover as entomologist of the Federal Government, and on the recommendation of Prof. Comstock he appointed young Howard, then newly graduated from Cornell at the age of twenty-one, to be his assistant. This was the humble beginning, on November 13, 1878, of a period of Government service that continued for more than forty-nine years. In due course he was assigned to preparation of a manual on silk culture. This formed the beginning of a long series of publications that were issued year after year prepared by Howard and published under name of his chief—a practice not uncommon in those days.

Howard, when thirty-seven, was appointed chief of the Division of Entomology. It is of significance to note that when he became chief the total annual appropriation for Federal entomological work of all kinds was only 30,000 dollars; when he retired, thirty-three years later, in 1927, at the age of seventy, the annual appropriation was 3,000,000 dollars. During the ten-year period that followed from 1894 to 1904, there occurred three events that fixed the attention of the whole country upon the importance of entomological work: the first of these was the discovery of the gypsy moth in Massachusetts in 1889; the second was the discovery of the San José scale in the United States in 1893; and the third was the discovery of the Mexican cotton boll weevil in Texas in 1894. The research work performed on these problems was in addition to that on other insect pests previously being studied, and obviously required considerable additional funds and increased