obituary

Lord Adrian, 1889–1977

LORD ADRIAN disliked his christian names, Edgar Douglas, and was invariably known to his family and friends as Adrian; he will be called Adrian in this article which is concerned mainly with his scientific work, and particularly with the events which led up to the discoveries described in his first two books *The Basis of Sensation* (1928) and *The Mechanism of Nervous Action* (1932).

In order to understand the full extent of Adrian's contribution to science and medicine we must first consider the changes which have come over physiology since he started work with Keith Lucas in the Physiological Laboratory at Cambridge in 1911. It is easy to appreciate the effect of the development of electronic equipment for, as Adrian himself once said, 'The history of electrophysiology has been decided by the history of electric recording instruments'. But there have also been overwhelming changes in ideas and these are harder to take in, for, as historians of science know only too well, it is extraordinarily difficult to put ourselves in the position of our scientific ancestors who did not accept some scientific law or principle of nature that we now regard as self-evident.

One must, for example, remember that although Bowditch established the all-or-nothing law for heart muscle in 1871, in 1911 it was still uncertain whether the same law applied to nerve. The work which Adrian did before 1914 helped to show that in a single nerve fibre the size of the impulse is independent of the strength of the stimulus, provided the latter is large enough to evoke a response; it also removed some of the difficulties which had persuaded scientists as perceptive as Max Cremer or F. Hofmann of the opposite.

Then there was a complete muddle about the contraction of skeletal muscle and it was widely held that the quick and slow movements of voluntary muscle were brought about by different contractile mechanisms activated by two types of nerve fibre, or even by two forms of nerve impulse. This situation was not cleared up until Adrian and Bronk carried out their famous experiments in the late 1920s.

Adrian, who was not at all fussy about laboratory accommodation, has

Douglas Glass

given an entertaining description about life in the old Physiological Laboratory at the time when he started work there. "In those days the Cambridge School of Physiology was at the height of its fame. It was housed deplorably, judged by modern standards, and run so economically that there was no mechanic and no common stock of tools or apparatus. The research rooms were barely rooms at all. Keith Lucas was lucky to have a small cellar all to himself. It was approached through a larger cellar which housed A. V. Hill and many cages of rats on which Hopkins was carrying out his classical work on the vitamins. A side door led to a dark chamber in which all the frogs were kept and beyond this was the centrifuge driven by a large gas engine of obsolete design which shook the building and added the smell of warm oil and half-burnt gas to that of frog and rat: upstairs worked Barcroft, Mines, [W. B.] Hardy, Anderson, Fletcher, Langley, to name only those who were in permanent occupation, and their accommodation was little better."

In 1913 Adrian wrote a thesis on *The conduction of the impulse in the nerve fibre* which won him a Fellowship at Trinity College, of which he was later to become Master (1951–1965).

In July 1914 Adrian went to St Bartholomew's Hospital where he qualified in record time, just over a year; he then worked on nerve injuries and shell shock, first at Queen Square and later at the Connaught Military Hospital at Aldershot where he remained to the end of the war in spite of strenuous efforts to get to France.

There are several interesting papers of a clinical nature from this period, but much the most remarkable is one published in 1917 in the *Lancet* with L. R. Yealland on the treatment of some common war neuroses. The paper describes a highly successful method of dealing with hysterical paralysis, which the authors applied with at least 95% success to more than 250 cases, including all the common hysterical disorders such as mutism, deafness, paralysis of limbs and so on. No great originality was claimed for the method which depended on persuasion and suggestion, usually employing electrical stimulation to evoke sensation or movement, but it is evident that the authors applied the method with much ingenuity and understanding of human nature. The article is also remarkable for sympathetic references to psychoanalysis which bear witness to the width of Adrian's interests, as does the manuscript of an unpublished lecture 'Freud without tears' given in 1919.

After the war, Adrian continued for several years with analytical electrophysiology of the type which he had started with Keith Lucas (who was killed in an aeroplane accident in 1916). But about 1925 he began to use valve amplifiers and made what in the jargon of today (which Adrian detested) would be called a break-through.

The transformation is best described in his own words. "Alexander Forbes had been working with me in Cambridge and I had learned a great deal from him about string galvanometers and about mammalian preparations, but the experiments I had started became more and more unprofitable. You know the sort of thing that happens—they became more and more complicated and the evidence more indirect, and after a time it was quite clear that I was getting nowhere at all."

Adrian then describes how he had built a 3-stage valve amplifier to the design given him by Gasser and had

connected it up to a capillary-electrometer recording from the sciatic nerve of a nerve-muscle preparation. He was distressed by a rapid electrical oscillation which appeared whenever the muscle was hanging down freely and disappeared when it was supported. Then "The explanation suddenly dawned on me, and that was a time when I was very pleased indeed. A stretched muscle, a muscle hanging under its own weight, ought, if you come to think of it, to be sending sensory impulses up the nerves coming from the muscle spindles, signalling the stretch on the muscle. When you relax the stretched muscle, when you support it, those impulses ought to cease.

"I don't think it took more than an hour or so to show that that was what the little oscillations were. I was able to make photographic records of them, and within about a week I was nearly certain that many of these oscillations were action potentials coming up sensory fibres in the nerve, and what was more, that many of them came from single nerve fibres and that by some extension of the technique it ought to be possible to find out exactly what was happening in single nerve fibres when the sense organs attached to them were stimulated.

"That particular day's work, I think, had all the elements that one could wish for. The new apparatus seemed to be misbehaving very badly indeed, and I suddenly found that it was behaving so well that it was opening up an entire new range of data. I'd been bogged down in a series of very unprofitable experiments and here suddenly was the prospect of getting direct evidence instead of indirect, and direct evidence about all sorts of problems which I had set aside as outside the range of the techniques that one could use. The other point about it was that, as I said, it didn't involve any particular hard work, or any particular intelligence on my part. It was one of those things which sometimes just happens in a laboratory if you stick apparatus together and see what results you get."

The comment that one wants to make about the last sentence is that when most people stick apparatus together and look around they do not make discoveries of the same importance as those of Adrian.

The initial advance made by Adrian was rapidly followed by three important papers with Zotterman which showed beyond doubt that the nerve impulse was invariant, that the intensity of sensation was conveyed by the frequency of nerve impulses and the quality by the type of nerve fibre in action. Another very important point is that adaptation to a steady stimulus takes place peripherally and that some

sense organs, like those concerned with touch, are rapidly adapting, whereas others like muscle spindles are slowly adapting.

These early experiments on sense organs are beautifully described in *The Basis of Sensation* which is written in such simple and elegant language that it is difficult for a student of today to appreciate the novelty and importance of what is being said.

At about this time Adrian's small group was joined by B. H. C. (now Sir Bryan) Matthews who followed up Adrian and Zotterman's work in two classical papers on muscle spindles. Matthews also introduced the oscilloscope which bears his name and which proved extremely suitable for the type of work done by Adrian and his school. Later Adrian and B. H. C. Matthews collaborated in important studies of the Berger rhythm and on the interpretation of potential waves in the cortex; these papers laid the foundation of modern work on electroencephalography in man.

Other famous collaborative papers from the period 1926–1944 were those with Rachel Matthews on the action of light on the eye, with Bronk on the discharge of impulses in motor nerve fibres and with Moruzzi on the motor cortex and pyramidal tract. The paper with Bronk cleared up the long-standing puzzle of the origin of 'tonus' in mammalian skeletal muscle by showing that during weak discharges motoneurons fire at slow rates, ten per second or so, giving an incomplete tetanus in individual motor units but a smooth movement of the whole muscle because the discharges are not synchronised.

In 1937 Adrian who had previously held a Foulerton Research Professorship of the Royal Society, succeeded Sir Joseph Barcroft as Head of the Department of Physiology, a post which required much teaching and administration and which he held until 1951 when he became Master of Trinity.

In addition, Adrian was President of the Royal Society from 1950–1955, of the British Association in 1954 and of the Royal Society of Medicine from 1960–1961, Chancellor of Leicester University from 1957–1971, Vice-Chancellor of Cambridge from 1957–1959 and Chancellor of Cambridge from 1968–1976.

Adrian shared the Nobel Prize with C. S. Sherrington in 1932, was awarded the Order of Merit in 1942 and received a host of other honours which testify to the esteem in which he was held throughout the world; he was made a peer in 1955. He was a superb lecturer and after-dinner speaker and was much in demand in both capacities;

in addition he served on several time-consuming and important committees such as the Medical Research Council, the University Grants Committee and the Chemical Board.

After contemplating the list of positions held by Adrian from 1937 onwards one might be forgiven for thinking that he had little time for research in the Laboratory, or at least that he would be forced to rely mainly on help from colleagues. This was very far from the truth. From 1937 till 1959 Adrian was constantly in the Laboratory and published a number of excellent papers dealing with subjects as diverse as hearing, the sense of smell, vision, the cortex and the thalamus, and using animals as large as a pig or a Shetland pony or as unusual in a physiological laboratory as an alligator or a hedgehog. Much of this work was done alone, Adrian's custom being to dispense with the help of his faithful assistant Hatton as soon as the animal was anaesthetised and a single pair of hands could cope.

Edgar Douglas Adrian was born on 30 November 1889. He read classics at Westminster School and became interested in philosophy, partly at least through his friendship with C. D. Broad. This interest can be seen in all three of his books but most strikingly in *The physical basis of perception* which skates round the problems of mind, brain and consciousness in a most engaging manner. The book also contains a fascinating summary of the experiments which he carried out during the latter part of his scientific life.

In 1923 Adrian married Hester Pinsent who later became famous for her work on mental health; she died in 1967 to the sorrow of a wide circle of friends. Adrian relied greatly on her enterprise and ability and there is no doubt that she made an important if indirect contribution to his scientific achievements. They had three children, Mrs Anne Keynes, Mrs Jennet Campbell and Richard Hume Adrian, FRS who succeeds to his father's title.

After Hester's death, Adrian returned to Trinity, the College which he loved so well, to live in a beautiful set of rooms in the corner of Neville's Court. Until failing health intervened, it was his custom to entertain scholars and many other undergraduates to lunch or dinner about once a week. He remained in Trinity until a few weeks before his death in the Evelyn Nursing Home at the age of 87 on 4 August 1977.

A. L. Hodgkin

¹ *The Mechanism of Nervous Action*, 2. (Oxford University Press, 1932).

² From Adrian's chapter in the account of Keith Lucas published in 1934 (W. Heffer: Cambridge), 90–91.

³ *Memorable experiences in research* by E. D. Adrian and others. (*Diabetes*, 3, 17–27, 1954).