Binghamton sheets. Other instructive sheets are Bath, Wayland and Tully.

The Long Island Valleys

The only American streams used as evidence of erosion by rotative deflection are the creeks and brooks along the south side of Long Island. And this fact hints at the weakness of the theory.

In a belt about fifty miles long, with direction S.S.W. by E.N.E. some thirty weak streams with southerly flow, in sand and gravel, reach the Atlantic Ocean. The longest is less than ten miles. The valleys are shallow, few being twenty feet deep. The west banks of the shallow valleys are steeper than the east banks, as described by Lewis and by Fuller, and confirmed by Gilbert. The deeper valleys do not present the difference in the walls.

The claim for earth rotation as the cause of the difference in the slope of the valley walls has been made without any reference to other possible and more potent dynamic factors. Yet the most effective agency appears evident. Next to gravity the winds are the greatest force affecting water surfaces.

The Long Island streams have some protection from the west winds in the highlands about New York Bay and the Hudson River; and on the north in the nearby range of morainal hills. But on the south and east the area is exposed to the full force of the winds off the Atlantic. And it is to be noted that the most forceful winds of the district are those of the coastal cyclones and the tropical hurricanes that occasionally sweep the northern coast.

One gale from the southeast or east has more effect on these streams than months of the moderate winds from the west. Moreover, when a stream had developed a steeper west bank that condition aided in protection from the west winds.

It must be admitted that the diminutive streams on Long Island have been more influenced in erosional work by the east than by the west winds. And that excess, however small, is perhaps a thousand times more effective than the force from earth rotation.

The conclusion from this study is that the rotative deflective force, of vast effect on air currents and free-moving bodies, is so small in its effect on stream erosion, especially when masked by forceful agencies, that it is immeasurable and negligible.

For the mathematics of this paper the writer has received help from Professor F. C. Fairbanks, of Rochester, and the keen criticism of Dr. W. D. Lambert, of Washington.

Addendum. Since this paper was submitted another article on the subject appears in Science, June 3, page 584, by Professor Richard J. Russell; whose paper of November 13, 1931, provoked the present discussion.

Professor Russell's interesting and quite conclusive article is in practical accord with the above writing. He cites further references to the literature, noting especially the early writing by Babinet, in 1849, and the computative paper by von Baer, in 1866; and revives the appellation, "Baer's Law."

The following references to the literature of the subject have been transmitted by Dr. Lambert.

Colin Maclaurin (1698–1746); who also suspected that the winds were affected by the earth's motion.

Collier Cobb, in *Jour. Elisha Mitchell Sci. Soc.*, 1893, page 26.

M. P. Rudski, in "Physik der Erde," 1911, page 495.

K. Wegener, in *Petermanns Mitteilungen*, vol. 71, 1925, page 195.

THE NOBEL PRIZE IN PHYSIOLOGY AND MEDICINE FOR 1932

It was announced on October 27 that the Nobel Prize in physiology and medicine had been awarded jointly to Sir Charles Scott Sherrington, Waynflete professor of physiology at the University of Oxford, and Edgar Douglas Adrian, Foulerton professor of the Royal Society at Cambridge, for their analysis of the functional activity of the neurone, the ultimate anatomical unit of the nervous system. Few awards could bring greater satisfaction to physiologists and neurologists, especially in this country, where both recipients are well known through their writings and through large numbers of former students. Sherrington's American pupils include Harvey Cushing, R. S. Woodworth, Lewis Weed, Alexander Forbes, Henry Viets, H. C. Bazett, Wilder Penfield, John Fulton, Stanley Cobb, Grayson McCouch and many younger investigators who have had the privilege of working in the Physiological Laboratory at Oxford since the war. Adrian has similarly had numerous students from this side of the Atlantic, including, among others, Alexander Forbes, Hallowell Davis, J. M. D. Olmsted, Detlev Bronk, McKeen Cattell, H. Hoagland and Sarah Tower.

It has been well said that what William Harvey did for the circulation of the blood, Sherrington has done for the nervous system. His earlier work by its careful, progressive and logical advance laid the foundation of our present beliefs concerning the functions of the brain and spinal cord. While a student at Cambridge under Michael Foster, Sherrington became interested in the physiology of the brain. His first investigation had to do with an examination of the brain-stem of one of Goltz' decorticated dogs, and the results were described in 1884 in a paper by Langley and Sherrington, entitled "Secondary Degeneration of Nerve Tracts Following Removal of the Cortex of the Cerebrum in the Dog."[1] This was supplemented a few months later by a shorter paper, "On the Secondary and Tertiary Degeneration in the Spinal Cord of the Dog," under Sherrington's name alone.[2] These, Sherrington's first papers, represented an attempt to turn neuroanatomical facts into physiological language, and this proved to be the theme of his subsequent life's work. For a short time he turned his attention to pathology, studying in Berlin (1885–86) in the laboratories of Virchow and Koch, and he subsequently published several papers with Roy and Graham Brown on the pathology of cholera. With Charles Ballance in 1889 he wrote a joint contribution on the formation of scar tissue[3] and later published independently an important work on the microorganisms of the sweat glands.[4] But apart from this early pathological work and several later papers on the circulation Sherrington has devoted himself almost solely to the field of the nervous system, and he has continued to publish an average of three or four papers a year since 1885. He is perhaps best known for the Silliman Lectures delivered at Yale University in 1905 and subsequently published in 1906 as a monograph, "The Integrative Action of the Nervous System," which has become one of the great classics of physiological literature. At the time the Silliman Lectures were given it had come to be tacitly assumed that all nervous and mental phenomena are in the last analysis explicable in terms of the combined or "integrated" activity of the individual neurones of the central nervous system. These ultimate anatomical units, however, had until 1928 eluded isolation as functioning entities, and it was therefore quite impossible to formulate a satisfactory theory of nervous activity. During the period prior to 1928, Sherrington had established the reflex character of the knee-jerk, the existence of sensory nerves to muscle, had described decerebrate rigidity, and defined the proprioceptive system and the principle of the final common path; in addition, he had made notable observations on the nature of posture and the central inhibitory and excitatory processes. These contributions, important in themselves, served also to illuminate certain of the most baffling problems of clinical neurology, and it would be difficult to say whether Sherrington's influence has been greater in the clinic or in the laboratory.

[1] *Jour. Physiol.*, 5: 49–65.
[2] *Ibid.*, 6: 177–191.
[3] *Jour. Physiol.*, 10: 550–576.
[4] *Jour. Path. and Bact.*, 1893, 1: 258–275.

Between 1928 and 1930 Sherrington and his pupils succeeded in isolating for study the group of muscle fibers innervated by a single neurone of the spinal cord (the "motor unit"); they measured its tension development directly and indirectly, studied its rate of impulse discharge and made the important observation that a single nerve fiber may innervate as many as two hundred muscle fibers. An account of these epoch-making studies has been given by Sherrington and his pupils in a book published only a few months ago entitled, "Reflex Activity of the Spinal Cord" (Oxford Press).

Professor Adrian is a distinguished product of the Cambridge School of Physiology. In his student days he was a pupil and associate of Keith Lucas and he has extended the Lucas tradition of beautifully conceived and executed experiments made possible by the ingenious development and application of new physical methods. With the exception of his medical service during the world war, all his work has been carried out at Cambridge, where he has been a fellow of Trinity College since 1913, a lecturer in physiology from 1920–1928 and Foulerton professor since 1928. His only visit to America was in 1931, when he came to give the Eldridge Reeves Johnson Foundation Lectures at the University of Pennsylvania.

Adrian is best known for a series of brilliant experiments that have revealed the nature and context of nerve "messages." Long an outstanding worker in the field of neurophysiology, his experimental skill has in recent years enabled him to record impulses in single sensory and motor nerve fibers and thus to make possible a better understanding of the physical basis of sensation and the mechanism of muscular control.

This series of discoveries dates back about eight years to the time when he made his first records of the nerve impulses from sense organs. The variations in electrical potential that are associated with the propagation of such impulses were amplified many thousand times, by means of a vacuum tube amplifier, to a value sufficient to operate a rapid electrical recording device. This early work indicated the possibility of great advances in the physiology of sensation by thus recording the sensory nerve messages, but it gave little information of fundamental importance because the large number of fibers in independent activity masked the response of the individual units. Records of nerve impulses from a single sensory ending were needed in order to give definite information regarding the mechanism of the end organ. With characteristic directness and simplicity of attack he overcame the apparently great difficulties. By cutting away all but one sense organ, *e.g.*, the tension receptors in a muscle, subsequent stimulation gave impulses in a single sensory nerve fiber. It was thus shown that the discharge from a sense organ consists of a series of nerve impulses of a definite frequency, which increases with the intensity of the stimulus and decreases with the duration of a constant stimulus. He thereby demonstrated that the objective basis for varying intensities of sensation and the subjective phenomenon of adaptation is a variation in the frequency and number of nerve impulses reaching the central nervous system. The fundamental character of the messages from a wide variety of sense organs he has shown to be the same, as for instance from the receptors for tension, pressure, touch, light, pain and indeed from even an injured isolated nerve fiber itself. These two researches laid the foundation for a more intimate understanding of pain.

Subsequently Adrian extended his work to an investigation of the impulses in single motor nerve fibers, developing a technique which made it possible to transect the nerve trunk so as to leave intact but a single unit. Thus it was found that the characteristic discharge from a motor nerve cell is a series of impulses of a frequency depending upon the intensity of central excitation. It was further discovered that the strength of the muscular contraction is regulated by the frequency of this motor discharge as well as by a variation in the number of active units. He has recently applied a similar analysis to the sympathetic nerves that go to the blood vessels and control the contraction of their walls thus regulating blood pressure.

In summary, the work of Sherrington has indicated how the sensory impulses recorded by Adrian act on the central nervous system and build up a state of central excitation which gives rise to the impulses going out to the muscles to regulate movement. The one series of researches has been concerned with the messages going into and out of the central nervous system, the other with the manner in which they are integrated to give the coordinated activity of the complex living organism.

SCIENTIFIC EVENTS

THE ANDREW BALFOUR MEMORIAL

A TABLET in the entrance hall of the London School of Hygiene and Tropical Medicine to the memory of Sir Andrew Balfour, the first director of the school, was unveiled by the Earl of Athlone, chancellor of the University of London, in the presence of a distinguished gathering, on October 6. The *British Medical Journal* reports that the tablet, by Mr. Allan Howes, who has already carried out work in the school, is of Roman stone, with a bronze portrait head in bas-relief. The inscription runs:

A TRIBUTE OF GRATITUDE AND AFFECTION
TO
ANDREW BALFOUR
K.C.M.G., C.B., M.D., LL.D., F.R.C.P.
1873–1931
IN MEMORY OF HIS DEVOTION TO THE
CAUSE OF TROPICAL HYGIENE AND OF
HIS SELF-SACRIFICING LABOURS AS
DIRECTOR OF THIS SCHOOL
"THROUGH THE BATTLE, THROUGH DEFEAT,
MOVING YET, AND NEVER STOPPING,
PIONEERS! O PIONEERS!"

Sir Holburt Waring, on behalf of the Court of Governors and the Board of Management, in inviting the chancellor to perform the ceremony, explained the origin of the memorial. The school council originally set up a small committee, to which were added a number of friends of Sir Andrew Balfour outside the school staff. It was decided to open a memorial fund with the object of erecting the tablet and of providing means to enable students, preferably from over-seas, to pursue courses of study at the school. The total subscribed to date was £1,200, and a promise of a bequest of £1,000 had been received. He read a letter from Sir James Crichton-Browne, a kinsman of Sir Andrew, in which he wrote of him as one "who combined the finest traits of the Scottish character with world-wide sympathies and breadth of view, and added to intellectual grasp a singular capacity for friendship."

The Earl of Athlone said in part:

> Andrew Balfour was a man of a thousand endearing qualities, and for every such quality he drew to himself a thousand friends. He reminded the gathering of the outstanding events in his career, his choice of public health as his lifework, his service in the typhoid camp at Pretoria during the South African war, his appointment as director of the Wellcome Tropical Research Laboratories at Khartum, his transformation of the insanitary Khalifa into a model town from the precincts of which malaria was banished, his service during the great war in France, Salonika, Egypt and East Africa, his membership of important expert committees and service as adviser to colonial administrations during the post-war era, and finally, the last of his labors, the building, equipment and organization of the London School of Hygiene and Tropical Medicine, where the memory of his inspiring personality was still so vivid.

Professor W. W. Jameson, who received the memorial in the absence of Sir Austen Chamberlain, said