Book Reviews

Great Decades in Neurophysiology

Charles Scott Sherrington. An Appraisal. RAGNAR GRANIT. Doubleday, Garden City, N.Y., 1967. 210 pp., illus. $6.

Now, some 15 years after the flood of biographical writing that followed upon the death of Sir Charles Scott Sherrington, it is good to have this full-length account of his life and work. Ragnar Granit, until recently director of the Nobel Institute for Neurophysiology in Stockholm (and a 1967 Nobel laureate in medicine), is one of the few men fresh from the laboratory who can write of Sherrington from personal experience. Granit asks, What made Sherrington great? Why is he important to succeeding generations? How did he find neurophysiology and how did he leave it? What of his has survived the cruel test of time? What did he anticipate? What more has been learned?

In his attempt to answer these questions Granit offers not only a fine portrait of a man but also a good and remarkably compact introduction to modern neurophysiology through a succinct review of its recent history.

Charles Sherrington's scientific thinking was shaped during the great flowering of British and German physiology toward the end of the 19th century (around 1880). Between the time he declared for physiology and 1900 his main discoveries and generalizations were made or prefigured. They were brought together in his *The Integrative Action of the Nervous System*, first published in 1906 and still a powerful book.

Granit identifies as Sherrington's greatest contribution the proof that inhibition is central and that neurons to antagonistic muscles are reciprocally excited or inhibited so that a limb always does one thing at a time, never two opposite things. In short, the action of the limb is always integrated.

Basic to all Sherrington's work was the translation of the neuron theory into physiological thinking which, many years later, was to win him the Nobel prize (shared with Adrian). The familiarity with the cell and the microscope that Sherrington had gained as a pathologist and his acquaintance with Ramón y Cajal's work enabled him to develop the concept of neurons joined end to end synaptically (clasped) but separated by their two cell membranes—"contiguity without protoplasmic continuity." Thus the synapse became an arena where excitation and inhibition, each drawn from many sources, including the brain, battled for possession or interdiction of the spinal neuron passing to the skeletal muscles.

Another contender for primacy among Sherrington's contributions to physiology was the discovery of decerebrate rigidity and its analysis in terms of a reflex originating in sense receptors in the muscle, with impulses reflected back to the particular muscle. He stressed the adaptive significance of the stretch reflex—the maintenance of erect posture. Muscle tone, long a mystical concept, and the knee jerk, long considered a muscle phenomenon, were proved to be reflexes.

The way a scientist thinks is difficult to capture. Granit hints at an important aspect of Sherrington's mind when he quotes von Brücke (the elder): "Teleology is like the kind of woman people do not want to be seen with in the street, yet are prepared to tender their love to in secret." I have always believed that Sherrington was a teleologist, though a secret one. He held public opinions based on evidence and opinions expressed privately based on whether or not a finding made good sense biologically. Although he never used purpose as proof, I believe he used it as a guidepost. Sherrington was much concerned with purpose (adaptation), as is evidenced by the asking of such down-to-earth questions as, How does a dog scratch a flea? How does an animal stand? Or walk?

Granit describes the period of Sherrington's professional life from the end of World War I to about 1925 as one of quantitation. The concepts developed in the earlier period were tested and refined by an inertia-free system which recorded photographically the *forces* of rapid muscle contractions. Quantitative electrical and mechanical methods for eliciting reflexes were developed, and the string galvanometer recorded muscle action currents. From muscle contraction Sherrington could reason back to the events at the synapse. By 1925 he could formulate clearly the occurrence of two distinct events at the synapse, which, though opposite, were almost identical in their properties.

In a classic paper in 1925 Sherrington marshalled detailed evidence to prove that inhibition was a distinct entity obeying all the laws he had set down for central excitation. He conceived of excitation and inhibition interacting algebraically at the synapse—he used the chemical analogy of a base neutralizing an acid. Sensitive on the one hand to the discoveries of chemical transmission in the visceral nervous system and on the other to the concepts of prolonged nerve cell membrane changes, with characteristic caution he left room for both as the basis for excitation and inhibition. Had he done otherwise, his work might have been the focus of polemics and might not have stood as the framework in which modern neurophysiology still operates.

In the late 1920's Sherrington had learned virtually all that was to be learned about reflexes with the use of the isometric myograph. Had he, like Adrian at Cambridge and Gasser and Erlanger at Washington University, exploited the rapidly growing field of electronics, what an Indian summer there could have been in his scientific career. Though he developed the "single unit" concept, he never recorded from one electrically. However, since many scientific lives end at 40 or on assumption of a chairmanship, we should not regret what might have been in Sherrington's after age 70! Many of the first generation of his students, such as David Lloyd, John Fulton, Sir John Eccles, and Granit himself, and many of the second generation as well, blended the heritage of Sherrington with the electrophysiological heritage of Adrian, Gasser, Erlanger, Hodgkin, and Huxley so that now even the cerebral cortex is not safe from the probing of electrodes to record single neuron activity (Amassian, Jung, Jasper).

Neurophysiology is difficult to understand, but Granit's latter chapters, with the subject set in sharp relief but treated in enough detail, easily permit the reader to grasp the significant discoveries in the field. The reviewer will resist the temptation to catalog the