Book Reviews

Josiah Willard Gibbs: The History of a Great Mind. Lynde Phelps Wheeler. New Haven, Conn.: Yale Univ. Press, 1951. 264 pp. $4.00.

It is not to be expected that the biography of a scientist like Willard Gibbs can convey very much to the general reader, except by indirection, concerning the man's work. More than the 200-odd pages of the present account would be needed to give the non-specialist any grasp of Gibbs' varied achievements in thermodynamics, statistical mechanics, vector analysis, and multiple algebra. Yet Gibbs has become a legendary figure not only to chemists, mathematicians, and physicists who encounter his work, but in some degree to the general public as well, which is learning to recognize him as probably America's outstanding scientific figure of the last century. Professor Wheeler's book is not another attempt, like the chapter of J. G. Crowther or the book of Muriel Rukeyser, to explain Gibbs by some sort of alchemy to persons without scientific background. But it will be a valuable companion volume to the serious works on Gibbs.

For a number of years the devoted students and disciples of Gibbs—men like Charles S. Hastings and E. B. Wilson—have been publishing here and there excellent reminiscences and biographical sketches of their teacher. The author of the present volume was also a pupil of Gibbs. A short time ago he presided over the publication of a small volume of Gibbs' early studies in applied mechanics. He has now made good use of the published biographical materials (of which he gives an extensive bibliography), as well as of valuable unpublished letters and manuscripts. With the aid of this material, he has written a clear and unpretentious book that is the only satisfactory study of the Yale scientist yet published, and that is worthy to take its place beside the Donnan and Haas *Commentary on the Scientific Writings of J. Willard Gibbs.*

The general reader will find portions of this book difficult, but there is something for him also. Wheeler gives a charming picture of the family and boyhood of Gibbs, of his early years at Yale, and of his rise to international eminence. It seems clear that Gibbs was genuinely appreciated in this country earlier than is commonly believed. Even the publication of his epoch-making trilogy of papers, "On the Equilibrium of Heterogeneous Substances," which no member of the Connecticut Academy could fully grasp or appreciate, testifies to the respect in which he was held by his colleagues before he had really demonstrated his powers. "We knew Gibbs and took contributions on faith," the president of the academy is quoted as saying. Clerk-Maxwell's prompt assistance in spreading the reputation and discoveries of Gibbs is documented by the letters of Gibbs' British correspondents. In America appreciation of Gibbs' achievement was early displayed by his election to the National Academy of Sciences and to the American Academy of Arts and Sciences and by an offer from President Gilman of a position on the faculty of Johns Hopkins.

One of the paradoxes of Gibbs' work has been the large number of fruitful applications of research that must have struck contemporary Americans as abstract and forbidding in the extreme. The climax of the Gibbs story—and I suppose, from some points of view, its fulfillment—is to be found in the vast literature that burgeoned in the decades following his death out of the few pregnant pages devoted to the phase rule. How fitting was this outcome is evident if we realize what Wheeler is the first to emphasize, namely, that Gibbs began his scientific career with interests that were mainly practical. His earliest ventures in science were concerned with improvements in the useful arts: the invention of a hydraulic turbine and of a railway car brake. His earliest paper, read before a meeting of the Connecticut Academy of Arts and Sciences early in 1866, dealt with the problem of units in mechanics. It is published as Appendix II in this excellent biography. Gibbs stood on the threshold of a new American appreciation of abstract science; his personal transition from practical invention to theoretical science of a most fundamental sort is a bench mark in the development of science in this country.

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The Polarographic Method of Analysis. 2nd ed. Otto H. Müller. Easton, Pa.: Chemical Education Pub., 1951. 209 pp. $3.50.

In keeping with its intended use as a college textbook, the first chapter presents a review of various types of electroanalytical methods. An excellent feature of the chapter is the analogy the author draws between potentiometric titration curves and polarographic waves. This reviewer is less enthusiastic about the discussion of electrode potentials on pages 10–12 in terms of "electron pressure," and the definition of indicator electrode on page 13 that excludes such common indicator electrodes as the silver electrode and the hydrogen electrode.

The emphasis on simple manual equipment in Chapter II on apparatus adds instructional utility to the text. This chapter also contains a discussion of many measurement details that should be useful to the student. Recording instruments are treated much too cursorily even for an elementary text. The biased remarks on page 52 present a very unfair picture of the capabilities of the most recent recording instruments.

Succeeding chapters discuss the factors governing the limiting current, the equations of waves of various types of reactions, and polarometry (amperometric titrations). These are followed by a chapter on spe-

cial techniques, including differential and derivative polarography, oscillographic polarography, and the use of electrodes other than the dropping electrode. The succeeding chapter considers some of the methods of standardizing the dropping electrode in practical analysis and indicates some practical applications. The final chapter, "Suggestions for Practical Polarography," is devoted chiefly to the characterization and selection of capillaries for the dropping electrode according to the "capillary constant" method developed by the author.

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Physiological Mechanisms in Animal Behaviour. Symposia of the Society for Experimental Biology, No. IV. New York: Academic Press, 1950. 482 pp. $6.00.

This symposium is an excellent survey of the theoretical views and recent findings of British and continental students of animal behavior. The primary aim of the symposium was to elucidate the physiological mechanisms that underlie behavior, but the conference was just as much a discussion of comparative psychology. In addition, considerable attention was given to problems of terminology, methodology, and the definition of theoretical aims.

American students of behavior should find this collection of papers refreshing reading, for it affords data on a much wider variety of species than have been studied in this country and presents a good summary of the much-overlooked European theories of behavior. Furthermore, the excellent bibliographies at the end of each contribution make the book a valuable reference work.

It is impossible to summarize the wealth of material the symposium presents. But a number of the more important ideas that came out of the conference can be listed briefly. In the section on the senses, it is pointed out that many invertebrates and lower vertebrates hear, see color, and communicate much more like mammals than has heretofore been suspected.

In the second section, it is shown that there may be far less stimulus control of behavior than prevalent theory assumes. In amphibia, once a stimulus elicits walking, central mechanisms can maintain the response pattern without any further stimulation. And in the case of polychaete worms it was shown that activity cycles are determined by central neural pacemakers in the absence of stimulation.

Many of Lorenz' and Tinbergen's concepts of innate behavior are discussed in the third section. Evidence is brought forward to support the view that specific internal states can lower the threshold of instinctive reactions even to the point where they go off "spontaneously." Typically, however, instinctive patterns are "released" by specific kinds of stimuli. The theory is that animals have evolved special organs and patterns of behavior that provide the releasing stimuli or, in the case of defense against predators, provide stimuli that inhibit the release of instincts.

In the final section on learning it is argued that the same types of learning occur among the lower forms as among the higher: habituation, classical conditioning, trial-and-error learning, insight learning, and imprinting. Imprinting is one-trial learning that can occur only very early in life—e.g., the newly hatched duckling learns to follow the first object it sees, human or inanimate, just as it normally follows its parent. Konorski summarizes in his contribution a theory of the mechanism of learning much like Pavlov's, but perhaps more inclusive. Finally, Lashley points out, on the basis of extensive evidence, that there is no ground for believing that specific memory traces are "stored" in particular neurons in any part of the nervous system. Rather, he believes, we must think of memory as a pattern of excitability imposed on large numbers of neurons by experience or training. Presumably the "memory" is elicited whenever all or some portion of these neurons is induced to produce the pattern. The crucial thing is that the pattern be elicited and not that particular neurons be aroused.

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Scientific Book Register

Fossil Mammals of Africa: The Pleistocene Fauna of Two Blue Nile Sites, No. 2. D. M. A. Bate, L. H. Wells, and A. D. Lacaille. London: British Museum (Natural History), 1951. 50 pp. 15s.

Methods in Medical Research, Vol. 4. Maurice B. Visscher, Ed. Chicago: Year Book Pub., 1951. 306 pp. $7.00.

Collected Papers of the Mayo Clinic and The Mayo Foundation, Vol. XLII. Richard M. Hewitt *et al.*, Eds. Philadelphia: Saunders, 1951. 812 pp. $11.50.

Analysis of the Four-Bar Linkage: Its Application to the Synthesis of Mechanisms. John A. Hrones and George L. Nelson. Cambridge, Mass.: Technology Press; New York: Wiley, 1951. 730 pp. $15.00.

Körpergrösse und Organzahl der Organismen. Hallische Monographien 18. F. A. Schilder. Halle (Saale), Germany: Max Niemeyer, Verlag, 1950. 58 pp. DM 6.80.

The Dinosaur Book: The Ruling Reptiles and Their Relatives. 2nd ed. Edwin H. Colbert; illus. by John C. Germann. New York–London: McGraw-Hill, 1951. Published for The American Museum of Natural History. 156 pp. $4.00.

Mathematische Grundlagen der höheren Geodäsie und Kartographie: Das Erdsphäroid und seine konformen Abbildungen, Vol. I. R. König and K. H. Weise. West Berlin: Springer-Verlag, 1951. 522 pp. DM 46., cloth DM 49.60.

The Invertebrates: The Pseudocoelomate Bilateria: Acanthocephala, Aschelminthes, and Entoprocta, Vol. III. Libbie Henrietta Hyman. New York–London: McGraw-Hill, 1951. 572 pp. $9.00.

Quantum Mechanics of Particles and Wave Fields. Arthur March. New York: Wiley; London: Chapman & Hall, 1951. 292 pp. $5.50.