and their corresponding functions are, the author explains, "by no means sharply distinguished from one another even in theory, but fall along a gradation or spectrum within our political system. At one end of the spectrum, pure science is concerned with knowledge and truth; at the other end, pure politics is concerned with power and action. But neither ever exists in its pure form." These broad and inexact categories provide the author with an expository scheme for an enlightening exploration of a new "constitutional relativity" in which he foresees the emergence of an important principle: the closer the estate is to the end of the spectrum that is concerned solely with truth, the more it is entitled to freedom and self-government; the closer the estate gets to the exercise of power, the less it is entitled to autonomy. That is to say, the scientific estate has a valid claim to govern itself, but the political estate must be subordinate to the ultimate decision of the electorate, while the professional and the administrative estates presumably enjoy intermediate claims to autonomy.

These categories of estates have their evident uses to the author's exposition of broad contemporary aspects of the relations of government and science. That they have their costs is also evident. One consequence is that the discussion is persistently lured into treating the subject in terms of what-ought-to-be, while often appearing to be describing what-is. This tendency is most clearly demonstrated by the contrasts that emerge when the author turns to the description of actual events—for example, his engaging and insightful case study of recent attempts to establish a national program of oceanographic research—events in which real-life scientists, professionals, administrators, and politicians behave with minimum regard to the respective roles expected from them by their supposed membership in separate estates. (Nor can it be prudently assumed that they will act very differently in subsequent comparable situations, even though all may in the meantime have thoughtfully read *The Scientific Estate*.) The oceanographic research example, so persuasively analyzed by the author, suggests that the expository device of four estates does not effectively explain the event in either its origins, progress, or culmination. Nor does the estate concept serve as a successful explanatory tool in any of the several other concrete situations examined in the volume. The utility of the concept appears thus to be limited to the exposition of the ways in which the members of the separate estates *should* behave; that is, the concept is hortatory, not heuristic.

The Scientific Estate is a highly valuable essay in political and constitutional theory. It is strikingly original in its sweep, imaginative in approach, and informed by a high intelligence. The argument which it presents is graceful and persuasive in style, and is supported by an intimate knowledge and sharp perception of the arena in which politics encounters the "new science" in the United States. Its excellence as a venture in theory stands as a strong invitation to an empirical testing of its wide-ranging conclusions.

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Retinal Interaction Processes

Mach Bands: Quantitative Studies on Neural Networks in the Retina. Floyd Ratliff. Holden-Day, San Francisco, 1965. xiv + 365 pp. Illus. $13.95.

One hundred years ago, Ernst Mach described a visual effect that now bears his name. The phenomenon, a Mach band, occurs when a spatial distribution of luminance shows, at some point, a sharp change in gradient. When the change is negative, a band, brighter than its surroundings, appears in the region of the sharp change. When the change is positive, a dark band appears. The phenomenon was investigated in great detail by Mach in five papers between 1865 and 1868. A sixth appeared in 1906. The papers are fully translated in part 2 of Ratliff's book.

Of course no physical basis exists for Mach bands; they have a physiological basis. Mach's experiments provided the beginnings of a theoretical understanding of retinal interaction processes, in particular, of inhibitory effects. Mach saw clearly the implications of his experiments for this type of process which today plays an accentuated role in neurophysiology and psychophysiology.

Mach's experiments were done during the years when the great figures in the study of vision—Helmholtz, Hering, Maxwell, and others—were providing a great surge of research and theory, unmatched certainly until the present time, and possibly not even now. Unlike the work of the other great workers, Mach's theories and results received little attention; his findings were nearly forgotten until about 1950. It is true that the bands were "rediscovered" by other individuals a number of times in the interval, but little attention was paid to them.

After World War II, a number of developments caused new interest in Mach's work, and it became clear that Mach's statements on retinal inhibition merited consideration in line with newly developing concepts of neural networks to which Hartline and Ratliff's studies on *Limulus* have contributed a great deal.

Ratliff considers six models of neural networks including Mach's, the oldest. Among the others, the next oldest was described in 1948. Of the theoretical and experimental contributions made since 1948, those of Ratliff and Hartline are probably the most important.

Like Helmholtz, Mach was interested in several areas, specifically, physics, physiology, psychology, and philosophy. Both men were probably more attuned to the spirit of Hume than they were to the then prevailing types of German philosophy.

Ratliff characterizes an important motivational aspect of Mach's personality in the statement, "He sought only to adopt a view of science that he would not have to abandon each time he moved from one special area of his diverse interests to another." The author considers in the fifth chapter of the book some implications of Mach's philosophical position, including his well-known attitude toward atomic theory. In a later chapter Ratliff takes up, under the title "Appearance and reality," some issues involved in the concepts of (i) reality as appearance and (ii) reality as transcending appearance. He considers how problems centering on these issues have been resolved in actual scientific practice. An interesting section deals with the meaning of objectivity.

The book is important not only because it reviews and explicates Machian theories, experiments, and doctrines. It also gives an evaluative account of the life of this giant of science and philosophy. Most importantly, it traces in their Machian background some roots of important segments of modern science and shows how they developed in line with one man's need not only to know but to know consistently within an embracing context. Ratliff has written an unusual and valuable book.

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Biomedical Engineering

Biomedical Electronics. Howard M. Yanof. Davis, Philadelphia, 1965. xii + 361 pp. Illus. $12.50.

With the growth of biomedical engineering, numerous attempts have been made to write electronic engineering textbooks for biologists and physicians [Brown's *Instrumentation with Semiconductors for Medical Researchers* (Thomas, 1964); Donaldson's *Electronic Apparatus for Biological Research* (Butterworth, 1958); and Whitfield's *An Introduction to Electronics for Physiological Workers* (Macmillan, ed. 2, 1960)]. The present text, *Biomedical Electronics*, tries to provide a textbook for biologists and physicians and also to educate engineers regarding problems and instrumentation in biomedicine. Its outstanding merit is the comprehensiveness of its survey of instruments and techniques, which is supplemented by a great number of excellent photographs and line drawings. It will be a very valuable source book of information about commercially available electronic instruments and systems.

The book, however, has serious inadequacies with regard to its primary purpose—that of training biologists and physicians in electronics. In this respect, it does not differ greatly from most of the other texts in this field, for none of the authors seem to appreciate fully the magnitude of the task they are undertaking. Yanof devotes seven chapters (159 pp.) to this end. He covers the appropriate topics in chapters entitled "Basic physical concepts," "Introduction to ac circuit theory," "The measurement of voltage and current," "The rectifier and the diode," "Amplification," "The oscillator," and "The power supply." The second section, comprising about six chapters (158 pp.), covers biomedical instruments, transducers, signal display and recording, noise and its elimination, and examples of biomedical instrumentation. The first section covers the material in the same fashion that a jet plane covers a terrain from 40,000 feet. If the reader is already familiar with the subject, he will recognize familiar concepts. It seems unbelievable that a novice could obtain any firm understanding of electronics from this treatment. In my experience, to educate a biology student in electronics requires four or five classroom and laboratory hours per week for several semesters of work. In order to succeed with this program, the student must be adequately prepared in general physics and mathematics including a working knowledge of the calculus. Most texts in this field, including the present volume, try to teach elementary calculus. I consider this an exercise in futility.

The second section will serve as a useful survey of current instrumentation for engineers who are trained in physiology. Biologists will not be able to appreciate fully the discussion of instrumentation problems if their training is limited to the presentation of electronics given in the first part of this book. To add to the students' problems, the text in both sections is marred by careless mistakes—for example, formulas 2.42 and 2.43 and the formula for source noise on page 308.

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Fundamentals of Botany Series

Vascular Plants: Form and Function. Frank B. Salisbury and Robert V. Parke. Wadsworth, Belmont, Calif., 1964. viii + 184 pp. Illus. $2.35.

This volume is one of a series of seven paperback volumes edited by W. A. Jensen and L. G. Kavalijian; the other volumes are *The Plant Cell* by Jensen; *Reproduction, Heredity, and Sexuality* by S. A. Cook; *Nonvascular Plants: Form and Function* by W. T. Doyle; *Plants and the Ecosystem* by W. D. Billup; *Evolution and Plants of the Past* by H. C. Banks; and *Plants and Civilization* by Herbert G. Baker.

In a volume of only 184 pages some areas of interest must be omitted. The authors wisely left out discussions of photosynthesis and respiration. They have included chapters on growth, hormones, transpiration, translocation, photobiology, biological time measurements, the physiology of flowering, and the physiology of germination.

Unfortunately some important recent work has been omitted. In the discussion of plant growth the elegant work of Erickson and others on root growth is not mentioned, nor is the concept of the Plastichron index as a new and important measure of plant growth.

No indication about the authors' intended audience is given in the foreword; presumably it is a student audience. If so, there is a serious lack of reference information; a general bibliography is included, but there are no specific citations in the text. For example, the important term *vapor pressure deficit* is mentioned parenthetically in the text. A specific reference to one of the standard works would be helpful to the reader who is puzzled about the relationship between vapor pressure deficit and transpiration.

Those parts of the book that deal with plant taxonomy and morphology are basically sound and well presented.

The first chapter includes comments on the nature and methods of classification and provides a system of classification in keeping with present-day knowledge. Some readers, however, may be startled to find the bryophytes and vascular plants included along with the green algae in the Division Chlorophyta, which is given equal rank with such units as the Euglenophyta, Cyanophyta, and Rhodophyta. In this chapter, the major groups of vascular plants are described in capsule form, a presentation that is remarkably successful despite its brevity.

Errors, such as incorrect use of the word "isodiametric" in connection with cork cambium and ray cells, are few.

As the information about plant science becomes more extensive and, at the same time, more specialized, books such as this have a place in the literature along with the research paper, the