general processes, that makes this book interesting.

A number of books have been written about models of thinking and about complex organizations, and this is one of the very best. It is authoritative and at the same time provocative—a rare combination.

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"Behavior"

Ethology of Mammals. R. F. EWER. Plenum, New York; Logos, London, 1968. xiv + 418 pp., illus. $26.

A book dedicated to meerkats can't avoid being interesting. When those meerkats are named Gollum, Gandalf, and Gimli, one knows without reading further that the book must have been by R. F. Ewer and that prejudices in its favor are justified. In fact, I did read *Ethology of Mammals*, so my declarations are based on more than empathy with keepers of meerkats.

Ewer has set herself three goals. First, she has attempted to describe various kinds of behavior in a variety of mammals. In doing this she has considerably broadened the amount of descriptive material available on library shelves, especially since she has included examples from the lesser—at least less well known—breeds. Her categories of behavior are conventional—communication, feeding, fighting, courtship, for example—and, for the most part, the species described are presented in phylogenetic sequence. Hence, although not encyclopedic in scope, the book does provide a useful reference supplement to such volumes as Bourlière's *Natural History of Mammals*. The style is sufficiently light to be entertaining, yet the documentation is adequate to the needs of the student. The usual pious pronouncement of the publisher that "this volume will appeal to amateur and specialist alike" is justified.

A second goal was an explication of traditional ethological theory, as annunciated by Lorenz and his disciples. In this, too, Ewer has acquitted herself well—too well, I would add, for she will surely convince the uncritically uncommitted. And, niceties of style notwithstanding, in this I believe Ewer to be perpetuating a major misconception. "Behavour is something which an animal has got in the same way as it may have horns, teeth, claws, or other structural features," she writes (p. 4), and this is where I take issue. The notion that behavior is a "noun," a palpable entity, has been responsible for much of the nonsense that ethologists have uttered. We read of "aggression" accumulating and needing discharge, as if it were a fluid liable to seep through cracks in the cranium. I believe we "contain" aggression about as much as a radio "contains" the music we hear issuing from it. Hardin ["Meaninglessness of the word protoplasm," *Sci. Monthly* **82**, 112 (1956)], extrapolating from the work of Benjamin Lee Whorf (*Language, Thought and Reality*, Wiley, 1956), has tried to show how the grammatical forms of English have influenced biologists' conceptions of the body. The polarized structure of our language, requiring phenomena to be described by sentences that consist of nouns *and* verbs, has often distracted us from the realization that a particular event might not lend itself to such treatment. Thus, "*it* thunders," and "lightning flashes," tautologies that obscure the "nounverb" nature of these events. In the study of behavior this kind of reification has done even more to retard understanding than in the areas discussed by Hardin (Klopfer, "Instincts and chromosomes," *Amer. Naturalist*, in press, and see a forthcoming volume on evolution and behavior by G. Bermant). Ewer, unhappily, has contributed to the retardation, though I grant she has provided a clear statement of the Lorenzian premises and arguments.

Finally, Ewer has sought to relate laboratory findings to naturalistic observations. This she has done, with understanding and clarity.

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The Fungi

Fundamentals of Mycology. J. H. BURNETT. St. Martin's, New York, 1968. xiv + 546 pp. + plates. $13.95.

This book is a landmark in mycological literature. Nothing like it has appeared since De Bary's classic work of the last century.

In this book Burnett presents many of the more recently discovered facts about this unique assemblage of plants, the fungi. The focal point happily is always the fungus, whatever aspect may be under discussion. In this respect the book is a biologist's paradise.

Since De Bary's time, experimental mycologists have uncovered a vast, nay stupendous, number of facts about fungi. These include many of the details of the ultrastructure of fungal cells, vegetative growth and morphogenesis, asexual and sexual reproduction, mating systems, production and germination of spores, mechanisms of transport of materials, primary and secondary metabolic pathways, interactions with other organisms, heterokaryosis and heteroplasmons, methods of genetic recombination, and speciation. As a consequence Burnett's book tends to be encyclopedic: there just may be too much material to down in one swallow.

The text is made even more complicated by the author's tendency to join independent clauses into long, cumbersome sentences. It is consequently not an easy book to read through, but it is the only one of its kind. Experimental mycologists and others interested in fungi will be grateful for Burnett's effort. If the book also alerts the writers of our general biology texts to the existence of the world of the fungi it will have served still another purpose.

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Physiological Measurement

Principles of Applied Biomedical Instrumentation. L. A. GEDDES and L. E. BAKER. Wiley, New York, 1968. xvi + 480 pp., illus. $13.50.

This book does not begin to cover the field of biomedical instrumentation, nor is that its intent. It is designed to describe, primarily to the life scientist, the basic principles by which physiological events are measured. This is an area in which the authors are recognized experts, and they are to be commended for resisting the temptation to include a variety of subject matter classified as biomedical instrumentation but outside their realm of expertise. However, considering the rather limited objective of the book, a more appropriate title would have been that of the first chapter, "The transduction and measurement of physiological events."

The authors, who are trained in both engineering and physiology, state

that the book is "principle-oriented" rather than "problem-oriented" because basic principles endure whereas applications change with time. However, each principle of measurement is illustrated by examples of its application, and the original references are cited.

The first half of the book (255 pp.) is devoted to describing the principles of operation of a variety of transducers applicable to the detection or measurement of physiological events. In the first chapter the authors discuss the advantages of transforming physiological events into electrical signals, and distinguish between transducible properties and principles of transduction. Most important, they caution that the measuring instrument must not alter the event being measured or distort the information obtained. Consideration of the terms "accuracy" and "precision" leads into a short discussion of the use of statistical techniques in interpreting physiological measurements.

The next ten chapters discuss methods of transduction. The historical background, physical principles underlying the operation of the transducer, and examples of applications to physiological measurements are presented. Operating characteristics such as selectivity, conversion efficiency, power dissipation, and temperature dependence are mentioned along with the advantages and disadvantages of each method.

Resistive transducers such as thermoresistive devices, metallic strain gauges, and potentiometers are treated in chapter 2. The discussion of thermistors is disappointingly short, considering the wide applicability of these devices to physiological measurements; the old problems of hysteresis and aging which are mentioned have been solved through modern techniques of fabrication and annealing, and the reproducibility and stability of thermistor characteristics are remarkable when the device is used within its appropriate temperature range. Similarly, the specific principles by which strain-gauge elements are used to measure blood pressure are not described, even though commercial devices such as the Statham pressure transducers are the most widely used of all physiological transducers.

A thorough treatment of the mechano-electronic transducer tube (RCA 5734) comprises the next chapter, one of the more useful in the book. Following discussions of inductive and capacitive transducers, a chapter is devoted to photoemissive tubes, photovoltaic cells, and photoresistive devices—the photoelectric transducers. Consideration of the characteristics of these devices, with emphasis on spectral response, precedes useful sections covering their colorimetric and noncolorimetric applications. The photomultiplier tube receives only brief attention. Solid state photodetectors, such as the photo-field-effect transistor and high-speed photodiode, are excluded entirely even though because of their small size, rapid response, low voltage requirements, and high sensitivity their use is being explored in a growing number of biomedical applications. Brief discussions of piezoelectric and thermoelectric transducers comprise the next two chapters. Chapter 9 is devoted to examining methods of transducing molecular and ionic concentrations in the measurement of pH, pCO_2, pO_2, and ions such as sodium, potassium, and calcium.

The recent interests of the authors are evident in the lengthy treatment of impedance techniques. Impedance transducers, their measuring circuits, and their diverse applications are described. The authors point out that the impedance method is subject to the limitations inherent in indirect measurement techniques; that is, that the signal is usually obtained at a distance from the phenomenon, so that resolution is compromised and calibration in true physiological terms is difficult. However, they believe that, because of the great flexibility of the method for detecting a wide variety of physiological events simply and without penetration of the skin, impedance techniques should prove useful for the many purposes for which relative rather than absolute measurements are sufficient.

A discussion of the characteristics of various types of recording electrodes—skin, extracellular, intracellular, and multielement neurological types—comprises chapter 11. Beginning with a brief explanation of the genesis of the action potential in excitable tissues, chapter 12 then shows how these local "bioelectric generators" establish potential distributions that make it possible for electrodes placed at the surface of the body to detect attenuated versions of the original bioelectric signal, as in electrocardiography and electroencephalography. These concepts introduce a rather sound presentation of the theoretical basis and methods of recording vectorcardiograms. The authors claim that although vectorcardiography has been of little direct clinical value, its ability to display small, beat-by-beat changes in the rate of cardiac depolarization and repolarization has helped in interpreting the electrocardiogram and has made the technique a useful teaching aid. The chapter ends with a fascinating historical account of the pioneering experiments on the recording of bioelectric events.

Since the signals obtained from most physiological transducers and electrodes are too small for direct recording, electronic amplifiers are used to increase their magnitude. The principles and operating characteristics of the active elements, vacuum tubes and transistors, and of various types of amplifiers are presented in chapter 13. Although a great deal of useful information concerning the input and output characteristics of amplifying circuits is given, perhaps too much space is devoted to design considerations. Since this book was written, the off-the-shelf, multipurpose, operational amplifier and the 35-cent multielement integrated circuit have become fact, and there is now little need for the life scientist to design and build amplifiers from scratch. Moreover most of the design data presented are readily available from handbooks put out by manufacturers.

The last chapter, actually an appendix to chapter 1, discusses the contributions of bandwidth, amplitude linearity, and phase linearity to the faithful reproduction of analog data.

Although the measurement of physiological events generally requires a three-part system including components for transduction, for amplification, and for reproduction, this book does not contain a section on the large variety of analog and digital recording devices used to display the biological signal. It is surprising that this subject is so neglected.

In spite of this omission, which leaves the book incomplete as a treatise on the transduction and measurement of physiological events, and some questions concerning the desirability of such an extensive discussion of amplifiers, the book is a commendable effort to cover an area not satisfactorily considered in more general texts on biomedical instrumentation.

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