plications of Detection Theory (part 3) includes tasks involving multiple or repeated stimulus presentation, temporal structure, and signals of uncertain frequency. Some of these data are used to explicate the notion of the "critical band" of the ear. There is a chapter on applications to speech recognition. The final chapter covers preliminary applications to various substantive problems bordering on psychophysics, including animal psychophysics, sensory physiology, reaction time, time discrimination, vigilance, attention, subliminal perception, and recognition memory.

The authors' aim of providing a source book and a textbook is realized in the appendixes and the problem sets (with even a few solutions) at the end of the first eight chapters. Appendix 1 gives the elements and only the elements of probability theory required to follow the development of statistical decision theory. It is compact and admirably done. Appendix 2 presents some basic concepts of waveform analysis. It is quite uneven in level of difficulty. Appendix 3 is a compendium of techniques both useful and necessary to supplement the discussion of the book.

Signal Detection and Psychophysics is very nearly the most important single monograph on psychophysics published yet in this century. It will be and deserves to be widely influential, because it is a lucid presentation of the not quite revolutionary ideas of the new psychophysics. Since this is so, a few cautionary words are in order. The theory has not been reinterpreted very far in terms appropriate to human behavior, being still tightly bound to electrical systems. A consequence is that most applications are mere analogs, or are far-fetched, and some depend on outrageous assumptions. The ideal-observer theory is a normative theory and could have the effect of delaying rather than inducing a search for actual mechanisms. Because the human observer may and no doubt does introduce unknown noises, an appropriate ideal observer may never be found. Few if any serious tests have been made of the crucial, almost certainly wrong, assumptions that noise and signal trials are independent and that sequential effects hardly matter. Data are fitted by eye to theoretical ROC curves because optimal tests "have not yet been devised," though such fits are widely interpreted as being favorable to the theory.

Whatever the degree to which one can accept the psychophysical signal-detection theory, it is a seminal theory and has already revitalized psychophysics and its applications. It will be seen 25 years hence as a major influence, if only because of having made a clear distinction between sensitivity and criterion. *Signal Detection and Psychophysics* is an excellent source book and is highly recommended for use as a text, though it is far more than a textbook.

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Hepaticology

The Hepaticae and Anthocerotae of North America—East of the Hundredth Meridian. Vol. 1. RUDOLF M. SCHUSTER. Columbia University Press, New York, 1966. 822 pp., illus. $20.

Rudolph Schuster's latest contribution to hepaticology is indeed impressive in its dimensions, and the abundant illustrations are very well executed. The bibliography is extensive, and the historical outline is interesting and instructive. Unfortunately, the quality of the work progressively deteriorates after the historical outline until, in the systematic section, the text has become so encumbered with technical errors, both of omission and of commission, as to render it of little value.

The extensive coverage of evolution in the Hepaticae is included under seven subheadings in four chapters and involves much redundancy and numerous cross-references. This material is notably slanted in favor of the author's concepts. A misleading footnote on page xi notwithstanding, the bibliography contains references through 1965 and the text itself contains abundant references up to and including 1966. Such important works as those of Church (1919), Fulford (1951, 1964, 1965), Proskauer (1960), and Mehra (1957), however, are given irrelevant or merely incidental mention or none at all.

Little of the adequately documented material included in the voluminous section on morphology will be new to the professional, while much of it is badly confused and contains numerous, often startling errors. The poor quality of the writing, coupled with the author's repeated allusions to exotic genera and species and the frequent untranslated quotations from German, Latin, and French sources, will quickly discourage the casually interested professional as well as the beginning student.

The final section of the book, devoted to systematics, is poorly organized and written, and established rules of nomenclature are disregarded. For example, pages 726–37 are devoted to an elaborate discussion of the genus *Lophochaete* Schust (December 1960). This name exists only as a synonym of the genus *Pseudolepicolea* Fulford & Taylor (February 1960).

In conclusion, I must say that the nonspecialist will find little of value in this book aside, possibly, from the illustrations, while the experienced professional will have need for it merely in the interest of documentation. Finally, in view of the quality of the text and the fact that the National Science Foundation "undertook most of the cost of publication" (p. x), I consider the price of the book to be exorbitant.

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Extracellular Fluids

Brain Tissue Electrolytes. A. VAN HARREVELD. Butterworth, Washington, D.C., 1966. 183 pp., illus. $7.95.

This small volume deals with an extensive and widely scattered literature on a subject that has generated considerable interest and controversy during the past decade. Because Van Harreveld has been an imaginative and resourceful contributor to investigations of the composition and volume of extracellular fluid his book is of special interest. A most useful aspect of the book is the discussion of specific impedance of central nervous tissue and its relationship to the phenomenon of spreading depression, and of the relationship between tissue resistance and the size of the extracellular fluid compartment. It was these questions that initially stimulated Van Harreveld's interest in the general subject of brain electrolytes. His discussion leads to a description of the work he has done, using histochemical methods, on the anatomical locus of chloride and the movement of this ion to an intracellular site during asphyxia and spreading depression. The section on electron microscopy deals primarily with Van Harreveld's important work in applying the technique of freeze-

substitution in the central nervous system and his finding of greater extracellular distances in normal tissue, especially in unmyelinated axon fields. The book also deals with the extensive literature on experimental studies using "extracellular" indicators, although the most recent studies defining the "sink" effect of cerebrospinal fluid on the steady-state concentration of certain substances in brain have not been included. This is the natural hazard of publication in a rapidly evolving field.

It was a pleasure to read Van Harreveld's lucid account of this intriguing biological subject. It is particularly useful to have his own work brought together in a single volume and to have his concise, personal synthesis of the current status of the problem of the magnitude of the extracellular compartment of the central nervous system.

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Analyses of Materials

Archeological Chemistry. Papers presented at a symposium held in Atlantic City, N.J., September 1962, sponsored by the Division of History of Chemistry, American Chemical Society. MARTIN LEVEY, Ed. University of Pennsylvania Press, Philadelphia, 1967. 365 pp., illus. $8.50.

Although this reviewer ordinarily takes a dim view of books made from "proceedings" because of their miscellaneous content and their uneven quality, he must admit that this selection contains much information that is useful. The authors are persons well known within this small field; most of the authors, who include industrial chemists, college professors, and research scientists, pursue archeological chemistry as a subordinate occupation, but some are museum staff members and conservators. Because many are well known to the reviewer he would like to mention all by name and subject, but regrettably this is impossible within the confines of this review. Collectively the papers illustrate how well modern analytical techniques, both chemical and physical, can assist in the full interpretation of the material cultures of the ancients. Nearly the whole range of modern techniques is employed. In the lead paper it is told how infrared spectrophotometric analysis made possible the identification of dyes used on 1800-year-old woolen textiles recovered from caves in the Judean desert. There are two papers on ancient glass, one reporting many wet chemical analyses on glass from central Asia, the other giving spectrochemical analyses on early glass objects from the Middle East, that lead to conclusions about raw materials of glass manufacture, including colorants and opacifiers. There are eight papers that deal primarily with metals; they show how wet chemical analysis, x-ray fluorescence spectrophotometry, x-ray diffraction, electron microbeam probe analysis, radiography, metallography, and even hardness testing can all contribute to knowledge of how the ancients won and worked metals. One paper deals with cement mortars of Poland, another with ceramics of India, and finally there is one on the pigments, natural and artificial, used over a span of 2000 years by painters of Japan.

This fine collection of reports, useful as it is, brings to focus a matter that has long disturbed the reviewer. Chemists for well over a hundred years have published many hundreds, even thousands of quantitative chemical analyses made on ancient objects of all kinds. Unfortunately, many of these are of limited value, or have no value at all, because of failure to describe the exact provenance or source of the objects, to describe their condition, or even to illustrate them. More seriously, the analyst often has not troubled to mention the method of sampling, the size of the sample taken, or the method of analysis (although this can often be inferred from the data or the context). In spectrochemical analysis there is often failure to mention limits of detection or elements sought and not found. Seldom is mention made of the accuracy claimed. Averages of multiple analyses are sometimes listed without giving the range of the data averaged; hence the data are not statistically meaningful. The result is that many times the analytical data of different investigators, even where they employ the same general method, cannot be compared. These oversights not only annoy later investigators who want to make use of the data but, more seriously, they lead archeologists or other nonprofessional users of the data into pitfalls. The latter are inclined to believe that analytical chemistry is an exact science—even to the third doubtful decimal place—which is not the case. Analytical chemistry is still an art based on scientific principles. The cautious analytical chemist speaks of his findings as an "estimate." If the archeologists were better acquainted with indirect methods of analysis based on "standards" they would accept analytical findings with more reserve.

Among the papers in this book nearly all the sins possible in reporting analytical data are illustrated. (The paper of Sayre and Smith on glass analysis is an exception.) Editors must share some of the blame. They should recognize such deficiencies and require of authors additional detailed information about procedures. Among these papers a few short footnotes could have provided all the missing information. Let us suggest that the next symposium on archeological chemistry choose as its theme "The Presentation and Interpretation of Analytical Data in Archeological Chemistry."

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The Color Center

F-Centers in Alkali Halides. Solid State Physics, Supplement 8. JORDAN J. MARKHAM. Academic Press, New York, 1966. 412 pp., illus. $16.

More than a century ago Kirchoff and Bunsen, each of whom was much better known for other things, found that ordinary salt took on a beautiful color when heated in sodium vapor. Pohl, who at Göttingen in the '20's and '30's saw the connection between Bunsen's coloration and the electronic properties of photoconductors and phosphors and fathered a whole new field of research, named the principal colored species the *Farbenzentrum*, or "*F* center." Thanks to magnetic resonance we now know that this center is just an electron trapped in a negative-ion vacancy.

Even in this age of specialization, it is not often that one comes across a book so unabashedly specialized as Markham's *F-Centers in Alkali Halides*. Although the number of known color centers is now well over 20 and the *F* center has many interconnections with the others, Markham sticks to his title and concerns himself primarily with what an *F* center *is*, rather than with processes in which *F* centers are involved. Readers expecting to learn, for example, how *F* centers migrate together to form *M* centers or how *Z* centers are made from *F* centers and impurity atoms, or to inform themselves