this year, and elected Dr. Eric Ball and Dr. Eugene F. DuBois to fill the places of Dr. A. P. Mathews and Dr. S. O. Mast, who were made trustees emeriti. Finally, Dr. Lillie was elected president emeritus.

Mr. Riggs, as treasurer, reported that the laboratory is free from indebtedness and has a small reserve fund. The director showed, by means of charts, how the annual income has dropped in the last two years from $170,000 to $130,000. To balance the budget, the executive committee has been forced to make drastic cuts in the appropriations for many of the departments, particularly for research and for the library. While it is true that we can not now buy much apparatus nor receive and pay for foreign journals, we shall presently have to expend considerable amounts for both of these essential items of our equipment.

Dr. Little explained how apparatus now must be repaired and altered to serve new needs, and emphasized the fact that investigators must adapt themselves to these unwelcome conditions. The librarian, Mrs. Montgomery, spoke of the microfilm service which is now in operation. Already it is extensively used. Indeed, we soon may be unable to fulfill all the requests for films.

In the present conditions, it is difficult, if not impossible, to predict the future. But we must assume that next year, research and instruction will continue here at Woods Hole. In the fifty-five years of its existence, this laboratory has maintained these activities without interruption. Every effort will be made to keep them in full operation.—*Dr. Charles Packard, director of the laboratory, in The Collecting Net.*

SCIENTIFIC BOOKS

MATHEMATICS

Mathematics—Its Magic and Mastery. By AARON BAKST. New York: D. Van Nostrand Co., Inc. 1941. $3.95.

To Discover Mathematics. By GAYLORD M. MERRIMAN. New York: John Wiley and Sons, Inc. 1942. $3.00.

Mathematics and the Imagination. By EDWARD KASNER and JAMES NEWMAN. New York: Simon and Schuster. 1940. $2.75.

To tear from mathematics the veil of misconception which obscures it in the popular mind and to reveal it in aspects as antithetical as may be to the cramped or forbidding ones of the elementary schoolroom is a quest which is currently calling forth a swelling volume of literary effort. The reading public is no longer a stranger to prospectuses and prefaces which beckon with promises of easy and painless instruction in the ways and uses of numbers, or which give voluble assurances of a ready entrance into the temple where the beauties and sublimities of mathematics lie revealed, and where all may grasp the grandeur and boldness of its harmonies and symmetries or of its all-pervading utilities. Mathematics, one is assured, is ineradicably ingrained in human thought and achievement. *Ipso facto* some modicum both of understanding of its subject-matter and appreciation of its essence is no less than a *sine qua non* of the educated and cultured man. To supply these desiderata the proffered volumes exist.

As must be, different readers will differently appraise the success which crowns each specific effort. The mark aimed at is high—perhaps too high. Poor and friendless thing though the more standard mathematical textbook may be, it is certainly no parvenu. Its claims of ancestry go back to Euclid often with much more justice than to the name which graces its title page, and over its evolution both savants and pedagogues have labored much. However popular it may be to eschew it, its earmarks will assert themselves, whenever the mere discourse about mathematics yields to any actual presentation of theory or fact. By the same token, the extant body of truly significant mathematical ideas was not easily come by. It was, on the contrary, a halting accretion, the crystallization of inordinately sustained and groping effort. There is small evidence that we are brighter than were our ancestors. It seems a far cry, therefore, from the great Gaus' misgivings as to the wit of the "Boethians," to the ostensibly easy confidence with which many present-day writers essay upon the exposition of abstract and basic ideas to any tyro, if he will but think.

Of the volumes here specifically under review, that which makes least demand upon previous knowledge is "Mathematics—Its Magic and Mastery." Written in an engaging style, and amply supplied with figures and entertaining vignettes, approximately one half of the book's 790 pages are designed largely for amusement. This is the magic of it. Easy discussions of the elementary arithmetic processes are flavored with parlor tricks, with examples of the coincidences which attach to combinations of numbers appropriately adjusted to their base of notation, with interesting visualizations of large numbers or very small ones, with puzzles, codes, etc. This will entertain all who enjoy the manipulation of numbers or who delight in the manifold disclosures of curious and unexpected regularities. In the later pages the domi-

nance of theme passes to the mastery. One meets there, in conjunction with appropriate applications, with progressions, logarithms, exponentials and probabilities, with geometry—plane, solid and analytic, with trigonometry, ballistics, etc. The inexperienced reader will find the going here slower. Upon occasion he will understand better the author's statement: "There was a time when mathematics was regarded as an intricate subject," than he will the assertion: "Fortunately, this day is long past." More experienced readers may learn less, but will enjoy more. There is much here wherewith the more sober presentations of ordinary textbooks can be supplemented and enlivened.

"To Discover Mathematics" is, for all its intentionally informal style, a didactic rather than an entertaining volume. Though chapters may be headed in such manner as: "The Fountain Head," "Magic of the Mind," "Declaration of Independence," etc., these superscriptions, in fact, refer to discussions of elementary algebraic and number theoretic matters, of geometric methods, synthetic or analytic, of logarithms and exponentials, or of trigonometry and the calculus. Professedly the book is designed to expose the utility and beauty of mathematics through the use of elementary but significant material, and to this profession it adheres with considerable success. This reviewer would recommend this book to many an advanced college student. Such will find it easy—perhaps in spots a trifle tedious—but may draw from it on the whole a rewarding synthesis of many disparate topics.

The proclaimed mission of "Mathematics and the Imagination" is "to extend the process of haute vulgarization to those outposts of mathematics which are mentioned, if at all, only in a whisper; which are referred to, if at all, only by name; to show by its very diversity something of the character of mathematics, of its bold, untrammeled spirit, of how—as both an art and a science—it has continued to lead the creative faculties beyond even imagination and intuition." The reader will find here clever discussions of the possibilities of largeness in numbers and of smallness, of the finite versus the transfinite, of the limiting process, of analytic geometry (to n dimensions), of Euclidian and non-Euclidian geometries, of mathematical pastimes and paradoxes, of probability, topology and the calculus (to space filling curves, and curves without tangents). It goes without saying that with a program so broad the discussion is far from exhaustive, nor was it the intention that it should be so. Lest the reader regard the subjects as too profound, the author gives incidental assurances to the effect that the "high and mighty mumbo jumbo" in terms of which they are usually couched, is wholly dispensable, since "High priests in every profession devise elaborate rituals and obscure language as much to conceal their own ineptness as to awe the uninitiate." Even in the face of such an exhortation, one might still hold that the mathematically sophisticate will glean more from this book than will the novice. For those already in possession of some outlook in mathematics and who wish either to broaden it, or at least to militate against its ossification, this book is wholly recommendable.

The authorship of books such as these is a laudable and withal no simple task. Of the beauties and essentials of mathematics a few, to be sure, are easily accessible. For a proper appreciation, however, even these frequently demand a deeper understanding. By and large, what lies near the surface of the subject belongs much more often among its trivia than among its profundities. The navigable literary channel between the Scylla of unintelligibility and the Charybdis of tediousness, is thus prevailingly narrow. Is it surprising, therefore, that the discovery of a royal road to mathematics is not yet to be signalized? That is, perhaps, after all, a hopelessly Utopian vision.

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SPECIAL ARTICLES

THE INORGANIC CONSTITUTION OF BONE

THROUGHOUT the last century there has been active discussion regarding the inorganic constitution of bone. Analyses show that the principal constituents are calcium, phosphate and carbonate with minor amounts of magnesium and sodium. Bone gives an x-ray diffraction pattern similar to that of the mineral apatite, the unit of structure of which contains $Ca_{10}(PO_4)_6F_2$. Various substitutions, such as $(OH)^-$ for F^- and Mg^{+2} for Ca^{+2}, are known to occur in the apatite lattice without producing significant changes in the diffraction pattern.

Suggested formulas for the phosphate compound of bone and their latest proponents are: $Ca_5H_2(PO_4)_4$, Berzelius (1845); $Ca_{10}(PO_4)_6CO_3$, Gassman (1937); $Ca_{10}(PO_4)_6(OH)_2$, Klement (1938); a neutral compound containing carbonate, Logan (1938); $(Ca,C)_{8\text{-}9}[(P,C)O_4]_6Ca(OH)_2$, Gruner, McConnell and Armstrong (1937).[1] In the last formula carbon is present not only in hypothetical $[CO_4]^{-4}$ groups but also as C^{+4} ions replacing Ca^{+2} ions.

[1] References are to be found in recent review articles; C. Huggins, *Physiol. Rev.*, 17: 119, 1937, and S. Eisenberger, L. Alexander and W. D. Turner, *Chem. Rev.*, 26: 257, 1940.