

tion to see anticipations which are not strictly legitimate. He points out that the Vaisesika theory of motion made only a distant approach to Newton's first law of motion, and that whilst a good foundation was laid for the explanation of the accelerated motion of falling bodies, Galileo's discovery was not anticipated. But there would seem reason to believe that Vâchaspati laid the foundations of solid geometry eight centuries before Descartes, and that Bhâskara (1150 A.D.), in computing planetary motion, appears to have used the differential calculus.

Ancient ideas on acoustics have a remarkable similarity to modern theories. It was recognised that the air was the physical basis of audible sound, and that its propagation was to be conceived on the analogy of waves in water. Various views, however, seem to have been held concerning the precise nature of the air-waves, as to the character of the vibratory movement, and how the molecules of a vibrating bell communicate their motion to the contiguous air-molecules. Echo was supposed to be a reflection of sound as an image in a mirror is a reflection of light. Attempts were made to explain pitch, intensity, and timbre by differences in the characteristics of the air-waves. The nature of musical sounds and intervals was the subject of acute speculation. Medieval compilations explain musical tones and their relations with reference to melody, as harmony was altogether unknown.

The wonderful plant-life of India naturally stimulated attempts at classification, and a short account of the various systems attributed to Charaka, Prâsastapâda, Amara, and others is included in chapter iv. A section is devoted to elementary ideas of plant physiology, characteristics of plant-life, sexuality, and consciousness. It is a curious and suggestive chapter, not without interest to the modern plant-physiologist.

Not less interesting are the early Hindu attempts at the classification of animals based upon mode of origin—whether placental, oviparous, from moisture and heat, or from vegetable organisms. Snakes naturally received much attention, and elaborate accounts are given of the action of the poison of the several venomous families. This is one of the longest chapters in the book, and the accounts of the various systems are given in considerable detail.

Space precludes any attempt to give any description of ancient Hindu ideas concerning physiology and biology. Naturally, the phenomena of metabolism, of the circulatory system, and of the vascular and nervous system; of the seat of consciousness; of foetal development; sex; heredity, received attention, and were the subject of speculation, often based upon acute and accurate observation, always interesting, and frequently highly suggestive. But enough has been stated to show that Dr. Brajendranath Seal has given us a most valuable contribution to the history of science by means of a work which must have involved a vast amount of study and research into a literature which is practically inaccessible to European students of physical science.

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BRITISH FRESH-WATER RHIZOPODS.

The British Fresh-water Rhizopoda and Heliozoa.

By J. Cash and G. H. Wailes. Vol. iii. *Rhizopoda*. Part iii. By G. H. Wailes. Pp. xxiv + 156 + plates xxxiii + lvii. (London: Ray Society, 1915.) Price 12s. 6d. net.

TO say that the volume before us equals, if it does not surpass, its predecessors, not only in scientific value but in general construction, is to award it the highest praise. With the completion of their task by the publication of the concluding volume it will not be too much to state that what Leidy has done for the fresh-water Rhizopoda of North America the authors of this work will have done for the group in Great Britain. Since the publication of the second volume (in 1908) the senior author, James Cash, has died, and a sympathetic biography forms a fitting introduction to this volume from the hand of Mr. John Hopkinson, who, as is well known, rendered him material assistance in the preparation of vol. ii., and to whom the present instalment is indebted for a series of synonymies which may well serve as a pattern for all systematists, and may be said to constitute a practically complete bibliography of the subject.

The volume furnishes a very extended addition to our knowledge of the distribution of these organisms in the British Isles, especially by the incorporation of the splendid results of the labours of Mr. G. H. Wailes (which were embodied in his monograph of the group published in the reports of the Clare Island Survey), who now joins Mr. Hopkinson as one of the authors of this book. By the addition to the British list of Paulinella and Clypeolina, and the representation of Gromia by Allogromia and Rhynchogromia, the number of fresh-water Rhizopoda recorded as British is raised from forty-seven to fifty. The confused species *Euglypha alveolata* is divided into *E. acanthophora* and *E. tuberculata*, a simplification which will be welcomed by students of the group, supported as it is by a remarkable synonymy comprising no fewer than 157 well-considered references.

The authors direct attention to the specialised method of collecting reserve scales by *E. cristata*, and the contrivance by which the apex of the test is closed in *E. mucronata*. The new classification of the Gromiinae will appeal as much to students of the marine as of the fresh-water Rhizopoda. In this section the preoccupied name Pamphagus is replaced by Lecythium, as the outcome of a laborious study of the existing synonymies. We do not agree with Rhumbler (who is followed by the authors) that Dujardin failed to notice the anastomosing reticulations of the pseudopodia of *Gromia oviformis*; his four papers published in 1835 (Ann. Sci. Nat., 1835, "Infusoires," 1841) make the contrary view clear, but for taxonomical purposes Rhumbler's sub-family, Allogromia, is undoubtedly useful. An interesting account is given of the reproductive processes of *Microgromia socialis*, as also of the indifferently marine or fresh-water genera, Lieberkuehnia and Rhyn-

chogromia. The late J. D. Siddall was of the opinion that his remarkable genus, *Shepherdella*, shared this indifference to habitat, but did not publish his conclusions on the matter.

The twenty-five plates in colour and monotone are worthy of the best traditions of the Ray Society. Vol. iv., which will complete this admirable work, will consist of two parts: the first an addendum to vols. i. and ii., comprising species recorded as new to Britain since their publication; the second, dealing with the Heli-ozoa, will be the work of Messrs. Hopkinson and Wailes.

E. H.-A.

MATHEMATICAL TEXT-BOOKS.

- (1) *The Essentials of Descriptive Geometry*. By Prof. F. G. Higbee. Pp. vi+204. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 7s. 9d. net.
- (2) *Five-Figure Mathematical Tables*. Compiled by E. Chappell. Pp. xvi+320. (London: W. and R. Chambers, Ltd., 1915.) Price 5s. net.
- (3) *Mortality Laws and Statistics*. By R. Henderson. Pp. v+111. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) 5s. 6d. net.
- (4) *Arithmetic for Carpenters and Builders*. By Prof. R. B. Dale. Pp. ix+231. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 5s. 6d. net.
- (5) *Handy Logarithmic Tables*. By Y. Uruguchi. Pp. 7. (Tokyo: Y. Uruguchi, 1915.) Price 3d.

(1) THE author assumes on the part of the reader no previous knowledge of descriptive geometry, and only quite a superficial acquaintance with ordinary plane geometry. The course follows mainly the customary lines, including points, lines, angles, planes, surfaces, and model-making. There are three reasons why its general character should commend itself to the ordinary student. First, the diagrams are numerous, clear, and unusually large; secondly, the style of exposition is admirably lucid; and thirdly, each chapter closes with a set of simple exercises; it would be a distinct improvement if answers were added, where possible.

(2) This book of five-figure tables includes logarithms of number and their reciprocals, anti-logarithms (called illogs), logarithms of logarithms (called lologs), anti-"logarithms of logarithms" (called illologs), the trigonometric functions and their logarithms, and a table of various constants. To lessen, in using the lolog tables, the chance of error which would occur from failure to notice whether the logarithms are positive or negative, numbers less than unity are shown in red, and those greater than unity in black. This is a wise precaution. The book is well printed and arranged in a convenient fashion.

(3) The author sets out in scientific form the results of investigations into the duration of human life and the mathematical theory required for it. The book is a treatise for actuaries or for mathematicians interested in the theory of proba-

bility. The author has excluded the combination of life contingencies with the theory of compound interest, annuities, etc., and has confined himself strictly to life contingencies.

After opening with an historical account of the way in which mortality tables came to be compiled and improved, he proceeds to discuss the construction and graduation of tables now in use, and gives various modern tables in an appendix.

(4) This small text-book is admirably suited to meet the needs of the practical workman. It deals with the elements of arithmetic, but includes also a great deal of general and technical information, such as the use of tools, cost of material, economy of arrangement, and simple designs. The student who reads and works thoroughly through its pages will acquire a considerable store of valuable information: a worthy addition to an excellent series.

(5) These four-figure tables are printed on a thickish sheet of paper, 7 in. high, 31 in. long, folded into seven parts, and contain proportional parts, logarithms of number and their reciprocals, and anti-logarithms. We doubt whether they possess any advantage over the ordinary forms in use.

OUR BOOKSHELF.

The Mathematical Theory of Probabilities and its Application to Frequency Curves and Statistical Methods. By A. Fisher. Translated by W. Bonyng. Volume i. *Mathematical Probabilities and Homograde Statistics*. Pp. xx+171. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1915.) Price 8s. 6d. net.

It is remarkable that, in spite of the number of older works in English on the theory of probabilities and the great attention that has recently been devoted to statistical method, no modern work on the subject in our own language existed. Mr. Fisher's work will do much to fill this gap.

After an introduction on the general principles and the philosophical aspect of the subject, and a somewhat slight historical sketch, he develops the fundamental theorems of probabilities, the laws of mathematical expectation, probability *a posteriori* and Bayes's theorem, the law of large numbers, and the theory of dispersion. This theory is then applied to games of chance and to statistical problems. A second volume is promised on the theory of frequency curves.

The treatment is very lucid—the chapter on Bayes's theorem may be selected as a marked example—and the work will be of considerable service to the statistical student. It is to be regretted, however, that the author has not taken up some of the more difficult problems of statistical work and has stopped short at the elementary comparison of the actual dispersion of a series with the combinatorial dispersion.

There is no index, and it is to be hoped the promised second volume will supply one. In a future edition the spelling of proper names should receive attention.