

Upon this is placed the microscope slide, with an intervening drop of cedar-wood oil, so that total reflection does not occur again until the upper surface of the cover glass is reached, when the ray is again sent downwards and passes away through another bevelled edge. It will be understood that the preparation does not contain air. On this plan no immersion liquid can be employed in the usual place between the cover glass and the objective, but, on the other hand, the rays diffracted by small particles come off from the main beam at angles considerably smaller than a right angle.

Several chapters of the book are devoted to the investigations which have been or can be carried out by these ultramicroscopes, of high interest to many. As examples, we may cite the distribution of silver, gold, and other metal particles in the coloured glasses containing them, and in the hydrosols of such metals; the Brownian movements of ultramicroscopic bodies in colloids, and the translation of such bodies by electric current. Especially interesting is the description given of the motions of silver particles in the hydrosol of that metal prepared by the Bredig process of forming a submerged electric arc between silver wires. The particles, below certain dimensions, remain in stable suspension. They are quite ultramicroscopic, but still are capable of diffracting light. When an electric current is passed through the liquid contained in a layer, not too thin, between top and bottom planes of glass, quartz, mica, &c., the microscope being focussed at the middle of the layer, at a point about equally removed from either electrode, the points of light seen move equably in a direction from the kathode to the anode, the speed being proportional to the potential gradient. For one volt per centimetre the speed is about 3.78μ per second. Above and below this central region, *i.e.* in beds adjoining the top and bottom boundaries, the motion is in the opposite direction, somewhat slower and less equable, and variable with the size of the particles.

If the boundary surfaces are of glass, these inverse beds are each about 25μ in depth, and if the thickness of the whole layer is diminished until it is only 50μ , it is these inverse beds which survive, the central one being gradually extinguished. The motion will then be entirely from anode to kathode.

The material of the boundaries affects the depth of the inverse beds, which with quartz is rather less than 2.5μ , and seems to disappear with gypsum. Mica has much the same effect as glass in this particular.

The particles have such exceedingly small mass that their ultimate velocities in the central region are acquired instantaneously, and if the electrodes are connected with an alternating source of electromotive force, the points of light move backwards and forwards in harmony with the stress through a distance proportional to its mean value and to the period, the constant being sensibly consistent with the speed under uniform stress quoted above. If a three-phase machine is connected with three electrodes, the particles describe closed curves.

THOMAS H. BLAKESLEY.

ANCIENT AND MODERN SHIPS.

Ancient and Modern Ships. By Sir George C. V. Holmes, K.C.V.O. Part i., *Wooden Sailing-ships*. Pp. xv+168. Part ii., *The Era of Steam, Iron, and Steel*. Pp. xii+219. (London: Printed for His Majesty's Stationery Office by Wyman and Sons, 1906.) Two vols, cloth-bound, price 2s. 3d. each.

THESE volumes belong to the series of science handbooks issued by the authorities of the Victoria and Albert Museum at South Kensington. The author was for a long period secretary of the Institution of Naval Architects; he is well qualified for the task he has undertaken. Within extremely narrow limits of space (about 400 pages) he has produced a readable account of ancient and modern ships, in which a large amount of trustworthy information has been summarised and admirably illustrated. Although the original intention of these handbooks may have been the assistance and instruction of visitors to the collection of naval models in the museum, they will undoubtedly prove of interest as books of reference to all who are interested in the history of shipbuilding. Their moderate price ought to secure a large circulation.

In the first volume wooden sailing-ships are described. This part of the work was published in 1900, but has been revised and re-issued in company with the larger second part, in which the history of the era of steam, iron, and steel is traced, so far as mercantile ships are concerned. War-ships, considered as fighting machines, are not dealt with, but the influence of peculiarities in their construction upon the development of mercantile shipbuilding is illustrated. Formerly, the naval models at South Kensington included those of war-ships; when the Royal School of Naval Architecture was transferred to Greenwich (more than thirty years ago) the Admiralty also concentrated there its collection of war-ship models. South Kensington retained the mercantile models, and the present collection includes loans from private firms, as well as models which are national property. It is much to be desired that the collection should be made complete and should illustrate adequately the development of the British mercantile marine. If Sir George Holmes's handbooks should increase public interest in the collection and lead to its proper development, a good purpose will have been served. At all events, he has produced a work which will enable laymen to reach an intelligent understanding of the history of shipbuilding and the principles governing the structural arrangements of ships.

Beginning with an admirable account of ancient Egyptian vessels, the author describes boats still existing and to be seen in the Cairo Museum, although they were built nearly 5000 years ago. Ships of the Mediterranean and Red Seas—Phœnician, Greek, Roman, and Venetian—are next dealt with. Another chapter is devoted to the ancient ships of northern Europe, of which specimens have been discovered in Scandinavia in recent years.

Mediæval ships are briefly described and excellently illustrated, this section ending with an account of the famous *Sovereign of the Seas*, built about the middle of the seventeenth century. A long chapter on modern wooden sailing-ships concludes this volume, and brings the history up to the construction of the great sailing three-deckers in the Royal Navy, which formed our most powerful war-ships until the middle of the nineteenth century. On the mercantile side the gradual development of sailing-ships is traced, and the famous "clippers" are described.

In the second volume steam navigation and the use of iron and steel for shipbuilding form the main topics. An interesting account is given of early wooden steamers. It is worth note in passing that this year is the centenary of the completion of the *Clermont* by Robert Fulton, and her trials on the Hudson River. The development of types of mercantile steamers is described, and numerous examples are included, amongst them being the *Great Eastern* and many vessels now employed on ocean or cross-channel service. Tables of dimensions and particulars for Transatlantic steamers are given in an appendix. On the structural side the book is valuable; it traces the influence of the use of iron and steel on dimensions and strengths of ships, and the differences between mercantile and Admiralty methods of construction. A brief discussion of the external forces acting upon a ship at sea, and the resultant stresses on the structure, is given in one appendix; in another the puzzling subject of tonnage measurement is made as clear as it can be made to general readers. This necessarily brief notice leaves many points unmentioned; the volumes should be read by all interested in the history of shipbuilding.

W. H. W.

FREQUENCY CURVES AND CORRELATION.

Frequency-curves and Correlation. By W. Palin Elderton. Pp. xiii+172. (London: Published for the Institute of Actuaries by C. and E. Layton, n.d.) Price 7s. 6d.

AS stated in a short preface by the president of the Institute of Actuaries, the object of this little volume is "to give a detailed description of the basis and practical application of those modern statistical methods that are associated with the name of Prof. Karl Pearson." The work was undertaken, we understand, by Mr. Elderton, at the invitation of the council of the institute, and we not only concur with the president in his commendation of the "public-spirited manner" in which Mr. Elderton acceded to their request, but think that the action of the council of a professional society in thus endeavouring to place the results of recent research before the members in a convenient form for consideration is well worthy of note.

In view of its purpose, the illustrations introduced are, of course, mainly of an actuarial character, but we have no hesitation in saying that the volume

will be of great service to statisticians in other fields. Much of Prof. Pearson's work has been given in the *Philosophical Transactions of the Royal Society*, the *Philosophical Magazine*, and other publications which are not readily accessible to the ordinary statistician, and Mr. Elderton's work will be most useful to the student by providing a short and handy summary of some of the more important results.

After a brief introductory chapter, the author passes at once to the subject of frequency distributions, and the mean and standard deviation are defined (chapter ii.). The method of moments is then treated in some detail, including the calculation of moments by the direct and the summation methods (iii.). The deduction of Prof. Pearson's curves from the hypergeometrical series is then given (iv.), and their fitting by moments (v.).

The subject of correlation is introduced in chapter vi.; this is treated mainly from the standpoint of the normal distribution, but it is also shown that the formulæ may be regarded as obtained by the fitting of straight lines to the points in a "dot diagram," using the method of moments. In chapter vii. Prof. Pearson's method of calculating the coefficient of correlation from any fourfold table, for measured or unmeasured characters, is described, and there follow two short chapters on probable errors (viii.), and on Pearson's test for goodness of fit (ix.) respectively. The concluding chapter gives briefly the theory of the coefficient of contingency. A few appendices deal with frequency curves other than Pearson's, with the integrals of the normal function and other matters.

The exposition is careful and lucid, but some of the actuarial illustrations will prove rather a stumbling block to the non-actuarial reader. Proofs are given which assume a fair mathematical knowledge, necessarily including the integral calculus, but the more lengthy and difficult proofs are omitted. In some respects the work strikes one as a little limited in scope, but this arises naturally enough from the fact of its being addressed to a special public.

There are only one or two points we have noted in reading that seem to call for mention. In connection with the summation method of calculating moments, we would direct attention to the work of G. F. Lipps (*Wundt's Phil. Studien*, xvii., 538 *et seq.*, 1901), and to the chapters on "die Summenmethode" in the *Wahrscheinlichkeitsrechnung* of Bruns (1906). Even if the name "method of least squares" be avoided, we would submit that this is no reason for omitting the short and simple proof that $\Sigma(x-by)^2$ is a minimum if $b=r\sigma_1/\sigma_2$. Without this proof the meaning of the coefficients of regression remains, in the general case, vague and indefinite. In the chapter dealing with the coefficient of contingency, it might be as well to point out that the coefficient cannot attain the value unity unless the number of classes be indefinitely great; it cannot, in fact, exceed $\sqrt{(t-1)/t}$ for a $t \times t$ -fold classification, at the best.

We cordially commend the volume to the attention of all students of statistics. G. U. Y.