

SUPPLEMENT TO "CURRENT SCIENCE"

Reviews.

An Examination of Examinations. By Sir Phillip Hartog and E. C. Rhodes, D.Sc. (Macmillan and Co., London, 1935.) Pp. 81. Price 1sh. net.

The publication of a book called '*An Examination of Examinations*' by Sir Phillip Hartog and Dr. E. C. Rhodes (Macmillan & Co.) has caused considerable commotion in the educational world. The history of the matter goes back to 1931, when, at the instance of the Carnegie Corporation, the Carnegie Foundation and the International Institute of Columbia University, Committees were set up in England, Scotland, Switzerland, France and Germany. These Committees were each financed with a grant for three years, and were requested to carry out investigations regarding examinations on whatever lines seemed best to them. The English Committee was presided over by Sir Michael Sadler, and consisted of educational experts of admitted authority. It determined to compare the marking of the same sets of examination answers by different examiners. The volume under review is an account of the main findings of the English Committee, and the reviews of the book already published in England are unanimous in describing the results of the enquiry as disquieting. Now that this investigation has been made, and its results published, the really surprising thing would seem to be the fact that such an investigation has been so long delayed. Those engaged in educational work have for long been aware that examinations were not a perfect test of the ability of candidates. Sir Phillip Hartog reminds us that at Oxford nearly fifty years ago, Professor Edgeworth conducted a small test concerned with the valuation of a piece of Latin prose by a number of different examiners. The results showed a variation of over fifty per cent. between the highest and the lowest marks awarded. In 1911 Sir Phillip Hartog himself in a lecture given before the Royal Society of Arts recommended that a Royal Commission should be set up to investigate the examination system in Great Britain. Until the work of the recent Committee of enquiry, however, nothing systematic appears to have been done.

In order to carry out their enquiry, the Committee enlisted the sympathy and services of various examining bodies in England. From them it received actual scripts written by candidates for different public examinations. After noting the numerical value assigned by the original examiners, every mark was removed from the scripts. The services of an independent body of expert valuers were then enlisted. These people were in every case persons accustomed for years to value examination papers of the type being investigated. Each of a number of examiners was then asked to value the selected scripts, and the volume under review is an account of the results obtained from this valuation. The Committee selected examinations of widely differing types and standards, in order to test valuation at different stages of the educational process. They selected—

1. *The Special Place Examinations.*

These examinations are held for candidates between the ages of 10 and 12, and on their results children in Elementary Schools gain admittance to Central Schools or Secondary Schools. The importance of this examination to children in England will be evident, when it is realised that the number of candidates every year is estimated to be nearly half-a-million.

2. *The School Certificate Examinations.*

These examinations are conducted by several different bodies in England, and are taken by nearly 70 thousand candidates every year. The average age of the candidates is about 16. Under certain conditions, the passing of this examination qualifies for entrance to the Universities. It may truthfully be said that a boy who is unable to pass this examination is in the vast majority of cases condemned to a poorly paid and subordinate post for the rest of his life.

3. *A College Scholarship Examination in English Essay at one of the Older Universities.*

4. *A University Honours Examination in Mathematics.*

5. *A University Honours Examination in History.*

From the foregoing, it will be seen that the Committee has tested the examination

system at many stages. In the space of a short review, it is not possible to give the detailed findings regarding each of these examinations, but no one engaged in educational work can afford to be ignorant of the information contained in *An Examination of Examinations*. As a sample of the findings of the Committee, we may select the School Certificate Examination in History, as the results in this case display, perhaps, the greatest disparities. Fifteen scripts were selected, all of which had been given the same "middling" mark by a certain English examining authority. The cleaned scripts were sent to fifteen examiners all of whom were in the habit of valuing papers for examinations of this standard. These fifteen examiners awarded no less than 43 different marks, the lowest mark assigned being 21% and the highest 70%. This result is sufficiently disturbing, but worse follows. After an interval of not less than a year, and not more than 19 months, the same scripts were cleaned again, and sent to the same examiners, who were not however, informed of the fact that they were being asked to value the same papers a second time. The result of the re-examination was that the total number of different marks assigned was 44 and the percentage varied from 16 to 71. It was found that nearly half the examiners give a different verdict on each candidate on the second occasion, and one examiner changed his opinion in regard to no less than 8 candidates out of the 15. The astonishing thing about this particular examiner was that he only varied his average mark per candidate by a unit, and that in each batch of 15 scripts, he awarded the identical number of failures. As Sir Phillip Hartog and Dr. E. C. Rhodes point out, such irregularity of judgment is not only formidable, but it is one which would never be detected by any ordinary analysis of valuation results. Statistically this examiner produced almost identical results on both occasions, but the fate he allotted to half the candidates was different. Of all the valuers engaged in this particular examination, only one was exceptionally steady, and his maximum variation between the two valuations was 7%.

Although the results in the other examinations showed smaller discrepancies than in the case quoted above, there was no examination which did not reveal disturbing differences of opinion. Every one will at

once ask the question: Should examinations be abolished? The Committee who conducted these investigations answer emphatically in the negative and are of the opinion that examinations as a test of efficiency are necessary, and that no satisfactory substitute can be found for them. Careful and systematic experiments, they point out, will be necessary in order to devise a system of examination valuation which will not be liable to the evident uncertainties of the present system. The President of the Board of Education in Great Britain in reply to a question on 9th December last in the House of Commons, stated that "the Report of the Committee raises questions of great importance that call for and will at once receive full investigation by my department."

During the last decade or more, there has been a marked increase in England in the *viva voce* (Interview) examination. It has been steadily maintained that this test (which is not a *viva voce* on any particular subject) affords a trustworthy opinion of the alertness, intelligence and general outlook of candidates. This interview examination (for which marks are allotted, for example, in the Indian Civil Service Examination, and in that for the Class I Administrative appointments in the British Civil Service) has become more and more popular for all kinds of appointments both public and private. There have, however, always been people, who refused to believe that the interview examination produced the results claimed for it by its enthusiastic advocates. The Committee whose work we are reviewing conducted an examination of this kind. It constituted two such Boards of Examiners. We are not told the names of those who made up the two separate Boards. We are, however, given the list of names of those from whom both Boards were made up. Their names command respect in England, and their competence to fulfil the functions assigned to them would be unquestioned by any one. Despite this fact, Board I examined 16 candidates and selected one as deserving of the first place. This candidate was placed 13th, however, by Board II, its first candidate being placed 11th by Board I.

We have not exaggerated in stating that the results of this enquiry into examinations are disquieting. It is well, however, to preserve a sense of balance, and a little

reflection will show that these results after all merely serve to prove a fact which should be self-evident, namely, the fallibility of all human judgment. Higher Law Courts are constantly reversing the judgments of Lower Courts on appeal. In medicine, the highly qualified specialist will not invariably diagnose a case in the same way as the general practitioner. There is, in fact, no walk of life in which different men will not give different judgments concerning matters on which all are theoretically competent. This being so, we need not be surprised that 'An Examination of Examinations' has revealed discrepancies in human judgment. The present writer has always felt that examiners should be more carefully selected. It should not be assumed that one who has a competent knowledge of his subject and is a successful teacher of it, is necessarily possessed of that calm balanced type of mind so necessary to enable an examiner to maintain a fair and even standard. It would, at the moment, be obviously a difficult and most delicate matter to subject prospective examiners to a test as to their fitness, but the time may come when such tests will be an accepted part of the machinery of the educational world. India will await with interest the consequences in England of the present enquiry. It seems clear that matters can no longer be left exactly where they are.

E. M.

Marine Zoogeography. *Tiergeographie des Meeres* (Akademische Verlagsgesellschaft, Leipzig, 1935). Pp. 542, 32 Marks.

Prof. Sven Ekman of the University of Uppsala, Sweden, has made a very valuable contribution to biological literature by the publication of his masterly work entitled *Tiergeographie des Meeres*.

The Zoogeography of earth's surface has been dealt with by various specialists, and there are available a large number of excellent publications which contain not only detailed and critical accounts of land faunas, their origins, relationships and distributions, but also deal with the conditions governing life, adaptations of different animals, animal communities, their ecology, etc. In reference to marine faunas, however, the earlier works of even such authorities as Schmarda, Agassiz, Dana, Woodward and Günther, unfortunately lack in some very essential points. In 1896 the masterly volume of

Ortmann—*Grundzüge der marinen Tiergeographie*—laid the foundations for detailed marine zoogeographical studies. In this book, Ortmann not only defined the zoogeographical regions into which the oceanic area can be divided, but also discussed the physical conditions governing life in the different regions, the various factors determining the conditions of life in different areas, the *Bionomie*, the peculiarities of the conditions of existence (Moseley) and the adaptations of the organisms for existence in the different *milieus*. In discussing the distribution of the sea animals he dealt with the factors which control and hinder distribution, as also the agencies which govern the distribution of the various organisms. The influence of the geological changes of the earth's surface on the distribution of animals in the different oceans and the changes in climatic, topographical and biological factors for the distribution of the animals were also discussed. Ortmann finally considered in detail the *Bionomie* and the present-day geographical distribution of the Decapod Crabs, and briefly reviewed the distribution of other marine organisms as determined by the various controlling agencies detailed above. Similar but more fragmentary accounts of the distribution of marine organisms are also to be found in oceanographical works such as *Science of the Sea* (Second edition, edited by E. J. Allen, 1928), but as Ekman points out, no work is available in which one can find a comprehensive account of our knowledge of marine zoogeography.

The first ten chapters of the work under review deal with the faunas of the different oceanic areas, their origins, relationships, compositions, etc. In view of the great importance of this part of the subject a somewhat detailed summary of these chapters is given below. The remaining six chapters deal with the "Meridiane Verbreitung" or the distributions of special genera or species along definite meridians of longitude or latitude, Bipolarity problem; Benthic Deep-sea Fauna, its composition, conditions governing its existence, regional distribution, and origin; and the Pelagic Fauna of the upper and deeper layers, its horizontal distribution, its relationships to salinity, etc. In the final chapter are discussed the adaptations of animals to deep-sea life, such as the development of special light organs, special enlargement, or reduction in the size of eyes culminating in the animals becoming absolutely

blind, uniform colouration and the enlargement of the mouth opening, special development of teeth, increase in the size of stomach, taste-organs, prolongation of antennae, fin-rays, etc. The horizontal distribution of the bathypelagic fauna and its origin are also discussed.

In conclusion the author remarks that the geographical distribution of the organic world seems to be determined by the physiological peculiarities of the animals as regulated by the chemico-physical reactions of the surrounding world. Evolution along divergent lines in widely separated localities is the essence of biogeographical distribution and its earlier manifestations are the discontinuity in the distribution of different classes of animals in adjacent areas.

In connection with the present-day disposition of the faunas of different areas modern work has clearly brought out the importance not only of studies regarding the influence of organic evolution but also of the changes in the earth's surface and climate during the past geological epochs. As a result it has become necessary to consider as intimately the geological and historical influences as the ecological and faunistic factors which determine the zoogeographical distribution in any area.

Ekman starts with a discussion of the Tropical Littoral Fauna which shows a marked general homogeneity in the circum-tropical region. The tropical fauna is very rich, much richer than that of the colder regions, and is probably the source from which the faunas of the colder seas originated. The detailed treatment of this fauna is prefaced by a general account of the life and the animal associations which are found on coral reefs, and a short discussion of the theories of their origin and distribution. The other important faunistic association of the littorals of the tropics, the Mangrove fauna, is similarly discussed and its characteristics briefly outlined.

The littoral fauna of the tropics is treated under three main heads: (a) the Fauna of the Indo-Pacific, (b) the Fauna of Tropical West Africa, and (c) the Fauna of Tropical America. Of these the fauna of the Indo-Pacific, which is the richest and most diverse, is sub-divided into Malayan, southern central Pacific, Hawaiian, Southern Japanese, Australian, tropic and sub-tropic, and finally that inhabiting the north and western areas of the Indian Ocean. The extent and boundaries

of the different areas are discussed and their faunal characteristics enumerated. The littoral fauna of Tropical America which is distributed along the two coasts of Central America in the Atlantic and Pacific Oceans, shows marked similarities, as a result of which in spite of the Panama Land bridge the fauna of this area constitutes a single entity; this is to be explained by an open connection between the Atlantic and Pacific Oceans throughout the Palaeozoic and the Mesozoic times and possibly also in the early Tertiaries. The endemic elements and the relationships of this fauna with that of the Indo-West Pacific Fauna are discussed in detail and this is followed by a description of the fauna of the Tropical West Africa on similar lines. Finally it is suggested that the boundaries of the Tropical Littoral Fauna are determined by climatic factors, of which, according to the author, "the temperature is one of the most important zoogeographic factors for the development of the marine fauna".

The past history of this Fauna and its origin are discussed and in this connection reference is made to the Tethys Sea which encircled the globe during the Cambrium and was present with slight changes in its extent and course up to the Middle Tertiaries. As a result of detailed geological studies the conclusions arrived at are as follows:—

- (1) During the Cretaceous and early Tertiaries a very rich littoral fauna of the tropical-type was widely distributed in the European Seas. Most of it has become extinct in these parts, to a great extent in the Atlantic Ocean and to some extent all over the world.
- (2) The Atlantic Fauna of the early Tertiaries was markedly of the Indo-West Pacific type; this was particularly the case with the Mediterranean Fauna.
- (3) The West Indian Fauna during the Eocene and Oligocene periods showed much closer conformity with that of the Indo-West Pacific area than is the case at the present day.
- (4) There was in the earlier geological periods a much greater conformity between the faunas of the eastern and western Atlantic. This disappeared to a great extent as a result of the extinction of the majority of the tropical types in the eastern Atlantic Ocean.

The changes in the fauna of this vast area are intimately connected with climatic changes during the Tertiaries. The elevation

of large masses of land in Central America and West Asia coinciding with the adverse climatic changes during Miocene and Pliocene was the determining factor for the later changes in the Tropical Littoral Fauna. From then on was gradually evolved the present-day distribution of the zoogeographical elements resulting in the great contrasts between the Indo-West Pacific fauna and the Atlantic-East Pacific fauna. The development of the faunas took place along new lines from the Middle Tertiaries onwards.

The present-day fauna of the Mediterranean extends into part of the mid-Atlantic along the Moroccan and Mauretanian areas and the Macronesian Islands such as the Canary Islands, Cape Verde, Medeira and Azores, and Ekman designates this region as the Mediterranean-Atlantic. The Mediterranean is evidently a section of the Atlantic, but this does not mean that all its faunistic elements are to be derived from the recent Atlantic fauna. On the other hand, several of its components are the remnants or relics of the Old Tethys Fauna. In addition, since 1869 when the Suez Canal formed an open communication between the Mediterranean and the Red Sea, a large number of erythrean forms have wandered into and established themselves in the Mediterranean.

The Sarmatic fauna which is rightly treated separately by Ekman, deals with the remnants of the inland Sarmatic Sea of the Upper Miocene and later times. Its present-day representatives are the Black Sea, the Sea of Azov and the Caspian Sea. The recent faunistic elements of the Black Sea are, in the main, of Mediterranean origin, but the Sea of Azov and the Caspian have retained more of the older elements. The Tethys fauna, however, does not consist of purely marine forms, but of brackish-water organisms or at least of very euryhaline animals.

The influence of the central Atlantic barrier does not seem to have been very marked in determining the North-Atlantic Littoral Fauna, and the author is, therefore, justified in considering the littoral fauna north of the Bay of Biscay in European waters and the Cape of Hatteras in American waters as a single unit. On practical grounds, however, he deals with the European and American faunas of the areas separately.

The European North Atlantic Fauna is treated under two distinct sub-heads:—

(1) The Atlantic Fauna proper, and (2) The Fauna of the Baltic Sea and other brackish-water areas. In either case the hydrographic influences such as temperature, salinity and other factors are discussed and the composition of the fauna from the point of view of its elements such as endemic, northern Mediterranean and northern Arctic, etc., elucidated. In the case of the deeper waters the fauna differs with the substratum, that of the hard sea-bottom being different from that inhabiting a soft muddy bottom. The effects of temperature of the sea waters on reproduction and development resulting in the wider distribution of the animals are also discussed, and according to their reaction to this factor the animals are classed into eurythermic, stenothermic and warm stenothermic forms. The salinity of the waters also plays an important rôle in the reproductive activities of these animals. As examples may be cited the fishes of the family Gadidæ investigated by Damas. The widely distributed north Atlantic forms such as *Gadus morrhua*, *G. aeglefinus*, etc., prefer temperatures of 4-6° C., a salinity of 34-35.2 per mille and a depth of 40-200 metres for depositing their eggs. The southern boreal species *G. esmarkii* breeds in 6° C., salinity of 35-35.2 per mille and at depths of 60-200 metres. The Mediterranean-Atlantic and boreal species such as *G. minutus*, *G. luscus* and *G. pollachius*, on the other hand, breed in a temperature of over 10° C., salinity of 32-35.35 per mille and a depth of less than 100 metres. In the Baltic Sea and other brackish-water areas there are, in addition to the pure marine types, a great variety of true estuarine species and several essentially fresh-water animals in the inner regions. The history of the changes in the extent of this area during the past geological ages is discussed, and the influence of periodic glaciations in determining the fauna elucidated. The main relics of the glacial periods are the brackish and fresh-water organisms, the extreme euryhaline species and certain marine and brackish-water animals occurring in isolated brackish-water areas, fjords, etc.

The American North Atlantic Fauna is treated on similar lines, but the information about this area is less complete. The general conclusion arrived at, however, is that the faunas on both sides of the Atlantic Ocean show greater affinity with those of the Arctic and sub-Arctic regions than with that of the intermediate northern and southern areas.

The North Pacific Fauna of the Temperate Zone is found north of Central Japan and along the middle of the southern part of the Californian Peninsula; these form the northern boundary of the Tropic-subtropic Littoral Zone. This Fauna, though it exhibits a certain admixture of tropic-subtropic forms in the southern zone, is entirely different. One finds here a very rich and distinct endemic temperate element with a number of forms of the temperate-Arctic type. The dominance of this Temperate Zone element, which is much more marked on the west coast, is to be explained by the convergence of the isotherms along the western coast, where, as a result, a very marked endemic element of a well-characterised Temperate Fauna predominates. Qualitative and quantitative comparisons of the North Pacific and North Atlantic Fauna bring out the fact that North Pacific Littoral is 6-8 times richer in endemic species than the North Atlantic; the same is the case with endemic genera. The North Pacific is, further, characterized by having endemic families. Reference may also be made here to the discontinuity in distribution of several types in the two areas. The common cod of the Atlantic *Gadus morrhua*, is represented in the Pacific by a nearly allied species *G. macrocephalus*; some ichthyologists, however, consider the Pacific species to be identical with the Atlantic. Similarly the halibut of the Atlantic, *Hippoglossus hippoglossus* is represented in the North Pacific by *H. stenolepis*. Invertebrates show similar discontinuous distributions, and these forms are designated as circumboreal or amphiboreal animals. Their present-day distribution is to be traced to the past times when the species or genera had a continuous distribution throughout the whole regions, but later as a result of climatic changes, the chain was broken and the distribution became discontinuous. Here also glaciation was a very important factor in determining the present-day distribution.

The Arctic fauna is dealt with in great detail and the conclusion arrived at is that the northern hemisphere has mainly two types of faunas, *viz.*, a tropical and a northern, and the northern fauna is sub-divided into that of the Temperate Zone and the Arctic region. The faunas of these two sub-zones show very close relationships; in some cases the Arctic appears to be the ancestral type, while in others the Temperate Zone

forms must be considered as the parental forms. As a result, Ekman is also of the opinion that both these faunas may have originated from a common ancestor. Two important peculiarities of the Arctic Fauna to which attention may be directed are: (i) along the coasts up to a depth of 4-5 metres the waters, as a result of the very low temperatures, due to the floating ice, harbour remarkably few, if any, animals, and (ii) the correctness of Thienemann's Rule—that whereas the animal communities (Biozonose) of an area (Biotope) become poorer in the species represented with the greater specialization in reference to the conditions determining life in the area, the number of individuals of such species, however, becomes comparatively very much richer, is proved beyond any doubt.

In discussing the fauna of the southern hemisphere below the tropics, Ekman deals with the fauna of the southern Temperate Zone—which is sub-divided into that of (i) South and West African; (ii) South Australian and New Zealand; and (iii) Peru and Southern Chili—separately from that of the colder southern hemisphere. In the latter are included the Kerguelan Archipelago, the Antiboreal South American area and the Antarctic Zone.

The fauna of South and West Africa shows very distinct affinities with that of the Indo-West Pacific; but here also there are indications of relationships with the fauna of the Atlantic. The fauna of New Zealand is very closely allied to that of South Australia, and both these show very close relationships with the Indo-West Pacific fauna. The relationships of the fauna of Peru and Southern Chili are not clear, but its relationships with the faunas of the northern area are indicated by the molluscs and crustacea, which have been studied in some detail.

The fauna of the Kerguelan Archipelago corresponds to that of the sub-Arctic area of the northern hemisphere, and may, therefore, be designated as the sub-Antarctic fauna. In addition to endemic elements there are types which show distinct affinities with the South American and others with the Antarctic types. The Antiboreal South American fauna shows close relationships with that of the adjacent northern area, but the influence of glaciation makes it rather difficult to elucidate its exact relationships. The Antarctic fauna is, as a result of the isolation of the Antarctic area, particularly rich in

endemic types; the number of such genera, however, is much smaller than that of the species. The isolation of the area, it may be remarked, is not only geographic but climatic as well, and these factors naturally have greatly contributed to the development of endemic types. The relationships of this fauna with that of the Kerguelan and the Antiboreal South America are indicated by the sea-urchins and Ascidians which have been studied by Mortensen and Hartmeyer respectively. A comparison of the Antarctic fauna with that of the Arctic is included in the discussion of the Bipolaritat problem and no further reference to it is necessary here.

The work under review is beautifully produced, with a very large number of excellent illustrations, charts and drawings, and will be indispensable as an authoritative source of reference for marine zoogeographic work. The bibliography at the end of the work is fairly extensive, and the only criticism that may be offered here is that it does not include the very extensive work of the R. I. M. S. "*Investigator*" in the Indian seas mainly published by the Trustees of the Indian Museum and the Zoological Survey of India in a large series of monographs and serial publications.

B. P.

A History of Science and its Relations with Philosophy and Religion. By William Cecil Dampier-Whetham, M.A., F.R.S. (Cambridge University Press, 1935.) Second Edition. Pp. xxi+514. Price 8s. 6d. net.

This is a great and scholarly work which it is both a pleasure and a privilege to read. The component parts of the imposing structure of modern science have an evolutionary history, the narration of whose orderly progress amounts practically to recording the struggles of the human mind in its quest of truth. Long before man began to investigate the facts and phenomena of the objective world, he had formulated definite theories and doctrines of his subjective experiences, and for a short time, not long ago, it looked as though they would crumble under the achievements and conclusions of the investigations of the physical and biological sciences. We have in modern times practically returned to the ideas of the old Greeks to whom philosophy and science were one.

Science adopts analytical methods of

investigation and mathematical forms of expression of the physical concepts, and these fundamental concepts whether they belong to the realms of the physical or biological science, are now tending to abstractions. The scientific method of approach to the ultimate reality can only reveal certain aspects of it, and philosophers are now recognising that their metaphysical concepts of nature must lack validity when not founded on the evidence of the experimental sciences. The interactions of the different modes of thought naturally reduce the complexities of phenomena to order and simplicity, leading to the discovery of a new realism built up by their means.

We know that civilisation first appeared in the valleys of the great rivers, the Euphrates and the Tigris, the Indus, and the Nile, and knowledge, which must have been crude and empirical at the dawn of history, associated the physical phenomena with the works of beings as capricious as man, but higher in order; and the desire to reproduce those phenomena naturally expressed itself in the practice of strange rites, magic and animistic beliefs. Magic, religion and astrology thus formed the foundations of science. The first attempts to introduce order and rules of measurement were made by the Greek nature-philosophers of Ionia as is evidenced by their efforts to convert the empirical rules for land surveying derived from Egypt into the deductive science of Geometry, the beginnings of which are assigned to Thales of Miletus and Pythagorus of Samos. The nature-philosophers sought reality in matter, and developed the theory of primary element, culminating in the atomism of Leucippus and Democritus. On the other hand the Pythagoreans saw reality in form and numbers, and, later when the Athenian school of Socrates and Plato developed metaphysics, the study of nature was replaced by the study of self, culminating in the development of the theory that ideas alone possessed reality which was denied to the objects of sense. Aristotle returned to observation and experiment at least in biology, but in physics and astronomy he followed the metaphysical doctrines of his master Plato.

During the Roman Empire science ceased to advance, but the Early Fathers of the Church produced a sort of Christian synthesis from their doctrines and those of

Neo-Platonic philosophy and the elements derived from the Oriental Mystery Religions. During the Dark Ages, learning, mainly Greek learning, was confined to the monks, though an Arab school arose, which made contributions to natural knowledge.

In the thirteenth century the scholasticism of St. Thomas Aquinas produced alternative synthesis which, based on the Aristotelian philosophy, gave a new rational scheme of knowledge in which Christian doctrines were blended with Aristotelian science. Scholasticism through the Middle Ages upheld the supremacy of reason, teaching that God and the Universe can be comprehended by the human mind. The way was thus paved for science, which holds that nature is intelligible. The scholastics were the forerunners of modern scientists whose appeal is only to verifiable facts. Scientists do not accept authority as the Scholastics did, but rely on observation and experiment as the ultimate sources of knowledge or as the means of approaching reality. In accepting a system of philosophy on authority, scholastics made full use of reason, examined the logical basis of premises and the validity of deductions in their relation to Christian theology and Aristotelian science. To the scientist observation and experiment are the starting points and final arbiters, and their methods are somewhat like those employed in fitting together pieces or words of a puzzle. To Aquinas and his contemporaries the real world was that disclosed by the senses, and they were unaware of the perplexities of the theory of knowledge and the difficulties underlying the concept of matter in motion by a non-material and non-extended mind which appeared for the first time under the analysis of Galileo.

The work of Galileo was consummated by Newton whose science was converted by his enthusiastic followers into a mechanical philosophy under which man became a machine. The first step to escape from this mechanism was taken by Kant and Hegel who in German idealism derived from Plato, succeeded in separating science from philosophy. This mechanical outlook first promoted by the physical sciences, seemed to extend to the biological sciences when in the second half of the nineteenth century Darwin formulated his Special Theory of Evolution. Man was reduced to a link in the chain of organic development. It became easy for most men of science to hold

that physical science revealed the reality of nature and they had little regard for idealist philosophy.

"Physical science represents one analytical aspect of reality; it draws a chart which, as experience shows, enables us to predict and sometimes to control the workings of nature. From time to time great syntheses of knowledge are made. Suddenly bits of the puzzle fit together, different and isolated concepts are brought into harmony by some master mind and mighty visions flash into sight—Newton's Cosmogony, Maxwell's Co-ordination of Light and Electricity or Einstein's reduction of gravity to a common property of space and time. All the signs point to another synthesis, in which relativity, quantum theory and wave-mechanics may fall into the all-embracing unity of some one fundamental concept."

"At such historic moments physical science seems supreme. But the clear insight into its meaning which is given by modern scientific philosophy shows that by its inherent nature and fundamental definitions it is but an abstraction, and that, with all its great and ever-growing power, it can never represent the whole of existence. Science may transcend its own natural sphere and usefully criticise some other modes of contemporary thought and some of the dogmas in which theologians have expressed their beliefs. But to see life steadily and see it whole, we need not only science, but ethics, art and philosophy; we need the apprehension of a sacred mystery, the sense of communion with a Divine Power, that constitute the ultimate basis of religion."

This high note sums up the outlook of this great book, to read which is a liberal and intense education in science and philosophy, and as the reader progresses in his study, his experience and knowledge are exalted into the higher planes of idealism. This is a great book worthy of a great mind.

An Introduction to Astronomy. By Robert H. Baker. (Macmillan & Co., London, 1935.) Pp. 522. Price 15 sh.

The book is written to serve as an introduction to Astronomy. The reader is expected to possess very little equipment in the way of previous study intelligently to read the book. The book is written in an attractive style so as to create an interest in the reader for the fascinating subject of Astronomy. Hardly any mathematics is used in the treatment. But this is not always an advantage, for the author in the absence of even simple mathematics cannot but make his account here and there carry little meaning to the reader. An instance in point is the treatment of "Doppler Effect". A short section covering less than half a page is devoted to it. The beginner

cannot appreciate the significance of the following sentence without further elucidation.

"The Doppler effect permits the astronomer to determine how the stars are moving towards or away from the earth, to observe their rotations, pulsations and explosions and to detect closely revolving pairs of stars which the telescope cannot separate."

On the whole we think the author has done well in omitting mathematical treatment in a work intended to be an introduction to Astronomy. The whole book is eminently readable and provides genuine enjoyment. In this connection one is inclined to draw particular attention to Chapter XIII "Within the Milky Way". We have no hesitation in recommending the book to beginners in Astronomy and to all those who wish to have an intelligent understanding of the fundamentals of a subject which no one claiming to be cultured can afford to ignore.

Industrial Electronics. By F. H. Gulliksen and E. H. Vedder, Members A.I.E.E. (John Wiley and Sons, Inc. New York, Chapman & Hall, Ltd., London, 1935.) Pp. xiv + 245. Price 17*sh.* 6*d.*

Many important types of industrial applications in which electronic devices are used, are now being extensively employed. A knowledge of the electronic apparatus and its working is therefore essential to an applied physicist or a practical engineer. The book by F. H. Gulliksen and E. H. Vedder supplies us with such a knowledge. Most of the important electronic devices in industrial technology are very ably and carefully described with an expert knowledge on the subject. Different kinds of tubes, their characteristics and some fundamental circuits are also briefly given before describing the elaborate and sometimes complicated circuits employed in commercial electronic instruments and control equipments and their applications which form the subject-matter of this very useful book. The type of equipments primarily used for wireless communication purposes, *viz.*, modulation, detection and amplification of high-frequency signals, is, however, left outside the scope of the book. A very brief outline of the methods generally employed for such wireless communication purposes would have been very useful.

The book is divided into four parts. The first two parts are of an elementary nature

and give more or less up-to-date information about the different kinds of electronic tubes and some fundamental circuits associated with them. In Part I the authors have classified the electronic tubes into three general classes. The first class is light-sensitive, the second high-vacuum and the third gaseous. A brief description of the three classes of tubes is given with the specific object of illustrating their working in different applications. The chapter on gas-filled tubes is comprehensive. Besides the rectifying tubes, it deals with some representative grid-controlled and ignite-actuated tubes. In Part II some fundamental circuits for high-vacuum amplifiers (low-frequency) and for grid-controlled gas-filled tubes and ignitrons are shown. With regard to high-vacuum amplifiers, the different methods of multi-stage low-frequency amplification are briefly given. The triode as an oscillator is very inadequately dealt with—although the circuits given for ordinary oscillating tubes and the multi-vibrator will be of practical value. The control circuits for grid-controlled gaseous discharge tubes and for the ignitrons will also be found very useful. While setting out the circuit diagrams, it appears the authors have assumed a knowledge of the fundamental physical principles on the part of the readers. A brief exposition of these principles in the first two parts, however, would have greatly facilitated the understanding of the last two parts—especially for the beginners who want to gain a working knowledge on the subject. The lack of proper emphasis on the physical principles is, in fact, a criticism which applies more or less to the whole of the book. It is needless to say that the fundamental principles clearly set out, not only help the understanding of the practical working but also give a broad and comprehensive view of the subject. It is hoped the authors will include in the next edition a short and clear exposition of the Physics of the subject, especially in Parts I and II which are regarded as a prelude to the remaining two parts.

Part III is devoted to commercial electronic instruments and control equipments and their applications. Among the light-sensitive control devices, photo-electric relays and their applications, elevator floor levelling, elevator door safety control, automatic control for artificial lighting, Louvre controller, door controller, sorting, grading and

matching will be found very interesting and useful. Only such details are given as are necessary for the understanding of the actual working of the appliances. Among the Indicating and Recording devices, the most important instrument described is the cathode-ray oscillograph which covers a wider field of applications than the mechanical oscillographs, for it can be used for the study of electric phenomena at radio-frequency, whereas the mechanical oscillographs are limited to about 10,000 cycles. The description of the working of the cathode-ray oscillograph, however, is not complete, since the authors have kept the subject of radio-frequency outside the scope of their book. Some useful and practical circuit-diagrams are given for the oscillograph work. Such useful recording devices as Smoke Indicator, Transmittency Instrument, Colour Matcher, Telemetering, etc., are explained with diagrams. The chapter on Rectification and frequency conversion deserves special commendation. It deals with rectifiers for low power and low voltage, mercury-arc rectifiers, ignitron-rectifiers and electronic inverters. The diagrams of circuits and of wave shapes of rectifier voltages and currents are shown. The fundamental relations between transformer voltage and output voltage for single-phase, three-phase and double three-phase circuits for ideal conditions with a resistance load have been clearly indicated so as to give a conception of the factors involved in the circuits. Circuit diagrams for electronic inverters have been clearly set out. Industrial applications of these electronic inverters, there will be many in future when there will be a considerable reduction in the price of the tubes. The chapters on the Control of Resistance Welders and Theatre and Mobile Lighting control will be of interest and help to those electrical technicians who work along these lines. Under miscellaneous applications, Oil Burner control, Train control and Cab Signalling, Resistance and Contact control devices in many industrial concerns are discussed. Precipitation rectifiers and Industrial X-ray equipment are also dealt with.

The chapter on Electronic Relays will be very much appreciated. We find in it the most modern applications of the Electronic relay equipments. Electromagnetic types of relays will soon be replaced by these electronic relays which are characterised by low

consumption of control energy, quick response action, absence of contacts and moving parts and flexibility in circuit design and adjustments. All the sections in this chapter, *viz.* Automatic synchronisers, Time-Relays, Cycle-Splitters and protective relays, show evidence of first-hand knowledge of the modern electronic equipments.

Part IV deals with Electronic Regulators. The automatic regulators are generally of the electromagnetic type. The introduction of the electronic regulators has extended the possibility of regulator applications especially in the industrial field. After setting out the fundamental principles of automatic regulator design, the authors describe the following chapter by chapter:

Voltage Regulators,
Speed Regulators,
Photo-electric Register Regulators,
Calorimetric Regulators,
Temperature Regulators.

All the chapters are full of useful, up-to-date and practical informations based on expert technical knowledge of the subjects.

Recent developments in Industrial Electronics are to be found scattered in different scientific and technical journals. Gulliksen and Vedder's book will be a very useful compendium of all the important modern developments. References to original papers appended at the end of each chapter add considerably to the value of the book. Insufficiency of details or vagueness at times due to the brevity of treatment has been amply compensated by these references.

To the applied physicists and electrical engineers the book will be of immense practical value.

S. R. KHAISTGIR.

Experimental and Theoretical Electrochemistry. By M. Dole. (McGraw-Hill, London, 1935.) Pp. 549. Price 30s. net.

In its widest sense Electrochemistry includes all chemical phenomena, since there is probably no form of chemical energy which is not essentially electrical in origin and no chemical phenomena of which the origin cannot be traced to an electrical effect. Dr. Dole, however, limits electrochemistry to chemical knowledge which has been obtained by experiments involving the application of electric or magnetic fields. This definition emphasises the experimental side of electrochemistry and indeed this book has definitely an experimental bias.

Some of the subjects included in older books such as the theories of indicators, of neutralisation, and of buffer solutions have been omitted; from the author's point of view they are outside the domain of electrochemistry. But their place is well taken by discussions of such interesting and important subjects as dipole moments, molecular rays, high frequency and high voltage conductance, electrokinetic and electrocapillary phenomena, and phase boundary and semipermeable membrane potentials. A good deal of space, as is natural, is devoted to conductance of electrolytes. The discussion on concentration cells is adequate and, from the student's point of view, is greatly improved by the inclusion of a chapter in which the fundamentals of thermodynamics are clearly outlined. The chapter on the glass electrode is a valuable addition, as this new type of hydrogen electrode has not been adequately treated in older text-books.

The book is well and clearly written, there are a sufficient number of references to the original literature to guide the student in the extension of his reading, the diagrams are clear and illustrative and the proof reading has been carefully done. The author is to be congratulated on having produced a text suitable in every way for use by Honours degree students.

T. S. W.

Probability and Random Errors. By W. N. Bond, M.A., D.Sc., F.Inst.P. (Messrs. Edward Arnold & Co., London, 1935.) Pp. 141. Price 10s. 6d. net.

One of the most useful and potent tools of laboratory practice, to-day, is a knowledge of Probability and Random Errors. Experiments may be planned and carried out, results may be obtained and interpreted, and conclusions arrived at; but unless the reliability of the results is ascertained, the conclusions may remain in a state of doubt. Attempts to confirm the results, by repetition of the experiments may be made, where they are really not required, and no such attempts made at all, where they are required to be made. In such cases, and in many others, in social, biological and physical sciences, the application of Probability and Random Errors is very essential.

As the author himself points out in his introduction to the book, it is as important

to state the probable degree of accuracy of results as it is to state what is measured and the units in which the results are measured. A knowledge of this branch of mathematics is therefore very useful to the student of any branch of science. A number of books on the subject, which require a considerable knowledge of mathematics on the part of the student, are available. But, for a student specialising in any particular branch of science, a book like the present one with a non-mathematical treatment of the subject-matter is very welcome indeed. The author has done great service to science by providing this useful book for the use of research workers. Though the book is mainly meant for the use of students of physics and chemistry, students of other branches of science could also use the book with great advantage. The subject is dealt with in a simple and understandable manner; with a working knowledge of mathematics, the matter dealt with in the book can be followed and understood. The large number of worked examples given in the book add to its usefulness to the student.

Analytical Chemistry. Vol. II. Quantitative Analysis. By F. P. Treadwell and William T. Hall. (Chapman & Hall, London, 1935.) Pp. 858. Price 30s.

So familiar and so useful is Treadwell and Hall's *Analytical Chemistry* (both qualitative and quantitative) to the student that it is hardly necessary to dwell on its merits. This brief review will serve no more than as an announcement to the appearance of the eighth edition of the second volume,—quantitative analysis. The book has been entirely reset and brought up-to-date. New and well tested methods have been described for the estimation of columbium, tantalum and certain other metals and much useful recasting has been done to improve the work.

It is difficult to review a book of this type. The best test of the excellence of a book is its popularity and judged by this standard, there is no doubt that the book occupies a pre-eminent place in the analysts' library. It would be ungrateful to try to point out any errors in a book of this importance but one is tempted, however, to mention that on page 78 under Cunning's method for determining nitrogen, it is mentioned that potassium sulphate is used as a catalyst

in the place of mercuric oxide originally recommended by Kjeldahl. This is not so; potassium sulphate serves to raise the boiling point of sulphuric acid and the digestion proceeds much faster than when sulphuric acid alone is used: a catalyser is still necessary and a small quantity of CuSO_4 or mercury or manganese dioxide is generally added. On page 77 under the procedure for Kjeldahl's method for determining nitrogen, it is mentioned that "2-30 ml. of concentrated sulphuric acid" should be added to a weighed quantity of the substance in the digestion flask. This is obviously a printer's error for 20-30 ml. No one will recommend the addition of 2 ml. to 0.7-3.5 gm. of substance in a 500-600 ml. Kjeldahl flask!! These errors are very minor indeed.

The binding and general get-up of this enlarged and revised edition are in the familiar style and are of the usual excellence.

Die Forstbenutzung (Forest Utilisation).

A Text-Book and Hand-Book founded by Dr. Karl Gayer, Professor in the University of Munich. Thirteenth Edition (in the German Language) rewritten by Dr. Ludwig Fabricius, Professor of Sylviculture and Forest Utilisation in the University of Munich. (Berlin, Paul Parey.) Pp. 758. 8 vo., with 418 illustrations in Text and two colour plates. Price in India 25.50 Gold Marks.

The fact that Dr. Gayer's *Die Forstbenutzung* was first published in 1863 and now appears in its thirteenth edition is eloquent testimony to its continued usefulness. During the period of nearly three-quarters of a century since its first publication, the practice of Forest Utilisation has undergone many and occasionally revolutionary changes. "Minor Forest Produce" have assumed increasing importance. The different editions of Dr. Gayer's work have faithfully covered all these changes. The book has been fortunate in its Editors who have kept up the high standard of the original in being at once thorough and up-to-date. In a very special sense, therefore, these editions mark definite steps in the theory and practice of German Forest Utilisation. The book under review, appearing after an interval of 15 years (the twelfth edition appeared in 1921) is a worthy successor to a very distinguished heritage.

Prof. Fabricius has not altered the general plan of the book. "Wood" being by far the most important Forest Produce has occupied the Part I of the volume. The requirements of the Wood Cutter and the wood working implements have been clearly described, after which are given the methods of felling and storage of wood. This is followed by detailed accounts of the conversion of wood into finished and semi-finished products in saw-mills, workshops, cellulose-, paper- and artificial silk factories, in wood-gas plants and what is perhaps most interesting, in wood sugar plants.

Part II of the book, is devoted to Minor Forest Produce and deals with such varied products as Bark and Vegetable tannins, resins, fruits, fodder, litter, peat and other forest produce. The author has throughout kept before his reader the fundamental maxim that in Forest Utilisation—as in any other sound commercial enterprise—the capital must never be allowed to depreciate.

It is characteristic of German thoroughness that forest utilisation is also considered in relation to national economy. When times are so unsettled politically and when the desire, for national self-sufficiency is degenerating to an insane craze, the intelligent utilisation of forests may prove vital to the very national existence. This is the justification for the inclusion in the book of such modes of utilisation as Wood carbonisation, Resin tapping, etc., which although obsolete in Germany at present, may leap into prominence during an emergent period of stress.

The exposition in the book is very clear. No one who has had the privilege of hearing the Professor's lectures would expect anything else. The gift of the true teacher—that of putting himself in the student's place—is manifest throughout the book. This enhances the value of the volume as a "Text-Book." The carefully analysed description of contents at the beginning and the elaborate index (there are some 2000 guide words) at the end of the volume justify its sub-title—A Text-Book and Hand-Book.

Prof. Fabricius' *Forstbenutzung* is a fine example of German Scholarship at its best. It would be sad if the language difficulty should render it inaccessible to Indian foresters. Such books make one sigh for an Esperanto that would sweep away the clumsy barriers of mere language.

EMMENNAR.