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SCIENTIFIC WORTHIES.

XXXVII.—Sir William Ramsay, K.C.B., F.R.S.

If we endeavour to build up to its highest pinnacle Auguste Comte's pyramid of sciences, in which natural science follows upon mathematics, and is succeeded by physiology, and finally by sociology, we reach as the highest of imaginable sciences the science of Geniology, the science of genius, of the excelling man. That such a science is possible has been known for half a century. The investigations of Sir Francis Galton in England, of de Candolle in Geneva, and of some recent workers in Germany, have proved to demonstration that even this rare and shining phenomenon is subject to definite natural laws, discoverable by a careful scrutiny of available facts, laws the significance of which is very great, since the position of any nation among the nations of the world is determined by the qualities and the efficiency of its men of genius.

On surveying the life of Sir William Ramsay in the light of this the youngest of the sciences, one is struck by the extraordinary consistency to be found in it, a consistency by virtue of which the rapid succession of astonishing discoveries filling the latter portion of his life appears as the necessary consequence of a natural and regular process, and almost resembles the working of a machine. Here we find nothing of the irregular curves with distinct maxima occurring in other types of genius, and usually in the most marked degree in youth, as in the case of Sir Humphry Davy, Sir William Ramsay's fellow-countryman, who resembles him in many respects. Ramsay recalls Davy by the brilliancy and the striking originality of his discoveries, which had no relation with any school or predecessor. In Davy's case these discoveries appear more as disconnected peaks suddenly arising from an average level. In Ramsay's case, on the other hand, we can observe how one discovery follows another, how comparatively modest and unobtrusive investigations, which have been accepted in their due place in the great register of the sciences, appear as the necessary foundations for truths of such novelty that their possibility was not even conceived before they were scientifically communicated.

This natural-law consistency is seen in the first instance in William Ramsay's descent. He has himself explained that his male ancestors for seven generations were dyers, thus handing down to him as a long inheritance a familiarity with chemical processes and a facility in chemical ways of thinking. On the mother's side, again, a series of physicians have provided the inherited capacity of the great scientific discoverer. But of all these men, none even remotely resembles Sir William in his eminence among his contemporaries, and, in this case, as in all similar cases, the question arises, how it is possible that such a genius arises from people of good average capacity.

It has, indeed, been established by Galton that an efficiency exceeding the average, but not amounting to genius, is in some families inherited through a whole series of generations. But here we have to deal with one of those extraordinary cases where an average efficiency was well evidenced through a number of generations, but suddenly made way for an incomparably higher personality, in which indeed the characteristic qualities of previous generations can be recognised, but which far surpasses its progenitors in efficiency.

If we bear in mind the well-known laws of heredity discovered by Mendel and de Vries, we know that every descendant is a mosaic of those qualities which have been transmitted to him partly by the father and partly by the mother. In the face of this fact the problem arises how such an unusual personality can be descended from parents of average ability, since it is just from these laws of heredity that we should conclude that another average equipment would result.

The answer which I tentatively should venture as regards this problem is this: The portions of the inheritance constituting a new being probably only on rare occasions fit together or harmonise with each other. The adolescent man then applies the greatest portion of his energy in the task of organising these accidental inheritances for the purpose of common work and harmonious cooperation, and this task uses up the greater part of the available energy, and withdraws it from productive work. It is only in rare cases that the inheritances are so constituted that they fit each other from the beginning, so that the young man has not to expend any energy on the mutual harmonising of his elements, but can immediately set about his creative work. Such a case seems to be that of Sir William Ramsay. On one occasion he described himself as a precocious, dreamy youth, of somewhat unconventional education. The precociousness is a practically universal phenomenon of incipient genius, and the dreamy quality indicates that original production of thought which lies at the basis of all creative activity.

His father, being a man of practical pursuits, who, however, in his free time zealously cultivated scientific works, such as quaternions and geology, introduced young William to the great passion of his life, chemistry, and, as is often the case, an accident was the immediate cause of the new departure. Young William had broken a leg at football, and to ease the tedium of convalescence, his father had given him Graham's "Chemistry" to study, and also brought him small quantities of many chemicals with which he could carry out the experiments described in the text-book. Sir William himself says that it was chiefly the question how fireworks could be prepared which induced him to study Graham's "Chemistry." But very soon the general scientific interest gained the upper hand, and this can very characteristically be gathered from the fact that he persuaded his people to take a practical part in the pursuits which interested him. In his fourteenth year William matriculated at Glasgow University, and there commenced his studies. The greatest influence was exerted upon him by William Thomson, whose curious and impressive method of teaching has been graphically and amusingly described by his great pupil. He gave him as a first problem a large heap of old copper wire in the laboratory, and instructed him to take out the kinks from it, and from the way in which the young student accomplished the task Thomson seems to have derived a favourable judgment as to his capacity for solving larger problems. For he soon made him acquainted with the quadrant electrometer, an instrument which at that time only existed in Glasgow, and instructed him to determine the potential difference between all kinds of objects found in the laboratory, or imported into it, such as a children's toy balloon. We can imagine that if such an originally constituted spirit could be at all affected by teaching, he must have been profoundly affected by this teacher. For William Thomson belonged to the same type of "romantic" or rapidly producing investigators as did Ramsay himself, and hence he made a particularly strong and permanent impression on that plastic developing genius.

The regular study of chemistry which followed upon this irregular course was made under Tatlock in Glasgow, and in this case also Ramsay appears to have distinguished himself so decidedly that his teacher after a short time made him an occasional deputy in the class.

At eighteen years of age the young student in Glasgow had learned whatever was to be learned there, and he had now to pursue his further study of chemistry. For this only Germany was at that time to be considered. But the Franco-German War had just broken out, and it therefore appeared somewhat risky to follow the original idea of continuing his studies in Heidelberg under Bunsen. However, the scene of war moved away so rapidly from the Franco-German frontier, that the German project could be undertaken. Ramsay passed one term with Bunsen, without, however, seeming to carry away a very strong impression, for in the following term he moved on to Tübingen, where he met a number of equally disposed fellow-workers in Fittig's laboratory, and under the guidance of this extremely conscientious teacher and able experimenter he was introduced to the usual problems and methods of organic chemistry. There Ramsay made one of the usual dissertations (on toluyl acids), which does not enable us to recognise the kind of man we have to deal with. After his return Ramsay was for some years assistant in the Glasgow course of study, and there he acquired a very extensive and profound knowledge of the whole field, especially of inorganic chemistry, at the same time laying the foundations of that mastery which he subsequently displayed as teacher in a great laboratory. Nor shall we err in supposing that the method of working a laboratory, as developed under the inspiring guidance of Liebig in Germany, and spread over the laboratories of the whole world as common property of chemical science, has exerted a very profound influence on Ramsay's talents and ideals as a teacher. In any case, we can state that he has approached the great example of Liebig as closely as any distinguished teacher of chemistry since that great time. Particularly in England his extraordinary facility of organising work in a great laboratory, with a diversity of the most varied talents, must be regarded as very rare, considering that they spread over many different regions of science, and thus make results possible which turn out afterwards to be of fundamental importance.

It is very interesting to observe from Ramsay's own communications how he gradually found his way out of organic chemistry, at that time the object of chief interest, into that other region which has since found an independent place as physical, or rather general chemistry. It was first certain practical problems, such as the determination of vapour densities, which introduced him to the more physical problems of chemistry. Here we find the first marks of the growing genius, in the extraordinary independence in the choice of means of solving the problem. Thus he used the pitches of pipes of fixed dimensions for the determination of vapour densities, and thus utilised his own musical talents.

This process was successful (although it has never been published), but he was less fortunate in his attempts to measure the electric conductivity of solutions by means of the telephone. Here we are involuntarily brought to a pause and have to ask ourselves how the geographical distribution of discoveries in electrochemistry, such as have reformed chemistry in the last twenty years, would have arranged itself if the young investigator had at that time been more fortunate in the execution of his experimental ideas.

We also know of physiological investigations concerning anæsthetics, dating from this period, executed in company with some medical colleagues. In these he himself was the experimental subject, as he suffered less under them than his companions. But here also no considerable results were obtained.

The first independent position was obtained by William Ramsay in the year 1880, when the professorship at the University College, Bristol, was entrusted to him. The choice fell upon him in preference to a competitor because, as he himself narrates, he understood Dutch. For he had to make visits to the various members of the council of the College, and was fortunate enough to be of assistance to one of them, an old minister, in the translation of a Dutch text, so that this member gave him his vote, and the choice was made with a majority of one. But soon it turned out to be an exceptionally happy one. A year after that Ramsay was chosen as the principal of the College. In this short time he had not only proved himself to be an excellent teacher, but also an excellent organiser.

The problem of vapour densities, which had first introduced him to physical chemistry, gave rise to further investigation, in the course of which the habit of expressing experimental results by mathematical formulæ, learned from Sir William Thomson, turned out to be extraordinarily valuable. In this connection originated the fundamental works on evaporation and dissociation, carried out in great part with his assistant, Sydney Young, which first drew the attention of the larger circles of the scientific world upon him. Here also it is suggestive to note how one followed on the other. His intervention in a controversy which was at that time raging in the columns of NATURE concerning "hot ice" suggested to him the possibility of determining the relation between vapour pressure and temperature by introducing into a space under the pressure in question a thermometer the bulb of which was covered with the body under investigation, in this case ice. The resulting temperature corresponding to the pressure turned out to be so precise that the process was soon developed as a general method of determining vapour pressure.

These investigations, which have been published in a number of large essays in the Philosophical Transactions, gave the impetus which led to the appointment of the still youthful professor to the highly esteemed chair at the University College, London, which Sir William Ramsay still adorns. It is true that at that time the great value of these works was imperfectly recognised, and I remember having an opportunity of pointing out to the authorities of the University College with great emphasis that we had here to do with investigations carrying us considerably further than the determinations of the great physicist Regnault, who was then regarded as the first authority on the whole subject.

At this point began the rapid succession of works which brought Ramsay to the scientific eminence which he still occupies. The measurements of surface tensions up to the critical temperature led to the well-known law which allows us to determine molecular weights in liquids. An occasional lecture experiment, during which magnesium nitride was produced, suggested to him to cooperate with Lord Rayleigh in the solution of the problem proposed by the latter concerning the difference in density between nitrogen derived from the air and artificial nitrogen.

By heating nitrogen from the air repeatedly with metallic magnesium, he succeeded in producing a gas that became ever denser, and turned out to be decidedly different from nitrogen itself. At the same time, Lord Rayleigh solved the problem of separating nitrogen from a possible other gas by the repetition of an experiment devised by Cavendish a hundred years earlier. Both these excellent investigators combined for joint continuation of this work, which led to the discovery of argon, the first type of a new class of elements.

But when an element of a new type had been found, the periodic law immediately suggested the existence of a number of other elements of the same type. Thus Ramsay succeeded in a short time in discovering the element helium, belonging to the same group, in certain rare minerals. An incidental occupation with a litre of liquid air, then first made in London by Hampson, led shortly afterwards to the discovery of three further elements of the same type—neon, krypton, and xenon—which were separated from each other and described, using in many cases quite novel methods of determining their properties. Thus while other discoverers were satisfied with single new elements, Ramsay discovered a whole class of elementary substances.

Then when in 1896 Becquerel demonstrated during his stay in Paris his newly discovered dark rays of uranium from which later the discovery of radium resulted, Ramsay showed the keenest interest, and undertook in his own laboratory an investigation of these phenomena.

This work led up to the greatest discovery made by our great investigator, the discovery of the real transmutation of one element into another. The gaseous emanation of radium, which at first had behaved as an entirely new body, showed after some time the lines of helium, and, finally, it was definitely proved that radium in its spontaneous decomposition produced helium in a perfectly regular way. If Ramsay had not come to know helium beforehand as his own child, so to speak, and if he had not, in the course of his work on rare gases, acquired the skill of working with almost immeasurably small quantities of such substances, he would probably not have succeeded in this capital discovery, which placed him among the very first chemical discoverers.

Following upon this work, Sir William Ramsay originated a series of other investigations, some of which are not yet finished, and cannot therefore be dealt with in this place, more especially as he is still at an age at which we may expect great and manifold achievements from him which preclude a final judgment upon his work.

But it may be possible to describe the general type to which Sir William Ramsay belongs as a discoverer. It has already been said that he undoubtedly belongs to the "romantic" type, working with an unusual speed of reaction, and marked by rapid and various productions. The marked peculiarity of this type of investigators, which enables them to train a great number of budding talents and to spur them to extraordinary efforts, has been brilliantly brought out. We may regard the physico-chemical school of Sir William Ramsay as the most important chemical school of his country for a large number of years. He has not been spared the fate of the "romantic" school, inasmuch as he has on occasion made an error in his discoveries. When the unheard-of number of new elements derived from the air rattled down upon the astonished world of chemists, one of these elements, which had been given the name metargon, on account of its similarity with argon, turned out to be carbon monoxide, which had entered the gases by an impurity in the phosphorus. This error did not do much damage, especially since, as Sir William Ramsay remarks himself, there is always in such a case a large number of good friends who hasten to point out and correct such inaccuracy.

Here we have a life in which merit and good fortune have combined as they rarely do. No external difficulties have stood in the way of the straight-line development of the growing spirit, and the acknowledgments of his contemporaries have crowned his great merits soon enough to give his life the benefit of such stimulus. Thus he has come to be one of the great *international* investigators, known wherever science is cultivated. If we add that Sir William personally belongs to those unassuming and agreeable figures such as can only be found in the small circle of the front-rank men of science, and that his domestic fate, though not free from occasional cares, has given him a more than average degree of contentment, we have stated the conditions which lead us to expect that his sixtieth year of life, which he will shortly complete, will not by any means mark the close of an unusually rich and fruitful life's work.

WILHELM OSTWALD.

ARCHÆOLOGY IN THE "ENCYCLOPÆDIA BRITANNICA."

Collection of Articles (loose sheets) dealing with Ancient History and Archaeology, from the New (11th) Edition of the Encyclopaedia Britannica. (Cambridge University Press, n.d.)

IN no department of knowledge has greater progress been made during the last twenty years than in the realms of archæology and ancient history. A glance at almost any volume of the new edition of the "Encyclopædia Britannica" will bring this fact forcibly home to anyone. By means of the supplementary volumes, which were issued as an appendix to the tenth edition, it was attempted to summarise the course of such progress, and the result was certainly a series of interesting monographs by specialists, whose efforts were, however, largely controlled and cramped by the existence of articles on the same subjects in the earlier volumes, which were admittedly out of date. No such disadvantage characterises the eleventh edition. In fact, this new edition establishes a record of its own by the simultaneous issue of the whole of its twenty-eight volumes. Thus the purchaser has not to wait for years for the work to be completed. On the contrary, he obtains at once a marvellous summary of knowledge, every part of which has been subjected to a final revision by its author at the time of going to press. The amount of labour and organisation which must have been required to bring such a plan to a successful issue is little short of marvellous, and the editor has certainly reason to congratulate himself on the achievement.

His task must have been particularly arduous in keeping the archæological articles abreast of the most recent research. Yet in this section of the work, wherever we have tested it, he has not failed. Take, for instance, such an article as that on Ægean civilisation in the first volume. Here we have an admirable summary by Mr. D. G. Hogarth of the gradual discovery of the remains and their distribution, and a discussion of the general features of Ægean civilisation based upon them; yet even in such a moot section as that on the chronology, we find he has been enabled to make use of data quite recently acquired. The same remark applies to the series of careful monographs on ancient Egypt which have been contributed by several specialists, and to that on Babylonia and Assyria, the greater part of which is from the pen of Prof. Sayce. We have mentioned these three articles in particular as dealing with departments of archæology in which additions to our material and information are being constantly made. Yet, though they all occur within the earlier volumes, they represent the present state of our knowledge equally with those in the final volumes of the work.

With such a wealth of material to choose from, it is difficult to do more than indicate some of the more important and striking features of the present edition. In the arrangement of the material we have noted what appears to us an admirable innovation, the greater weight and prominence given to the general article. On one hand this enables a writer to lend additional interest to his subject by treating it from a more personal and less encyclopædic point of view. Such an article is Mr. C. H. Read's, on archæology, in which he has space, not only to summarise the headings of his subject, but also to discuss its value as a branch of science and the progress that has been made in its organised study. Thus, when dealing with the primitive epochs in the history of man, we note Mr. Read's timely warning to students of prehistoric archæology to use caution in their treatment of that much-debated problem as to whether traces of man have actually been found in deposits of the Tertiary period. As Mr. Read points out, there is no valid reason against the existence of Tertiary man, but the evidence in favour of the belief is not very convincing. For, on one hand, there is considerable doubt as to whether the deposits containing the remains are without doubt of Tertiary times; and, on the other, it is not certain whether the objects found show undoubted signs of human workmanship. On the latter point, a recurrent difficulty, and one which can never be entirely removed, is our ignorance of the precise methods of nature's working. It is certain that natural forces, such as glacial action, earthquake, landslips, and the like, must crush and chip flints and break up animal remains, grinding them and scratching them in masses of gravel or sand. It is almost impossible to separate the markings or crushing of flint and bone due to such natural agencies from others which may have been purposely made by man to serve some useful end. Even the one feature which is commonly held to determine human agency, the "bulb of percussion" (the lump or bulb on the face of a flint weapon at the end where the blow was delivered to detach it from the mass), is not conclusive evidence; for recent investigations have shown that natural forces frequently produce a similar result. Mr. Read's advice in deciding knotty points of this character may be summarised: use caution, and, where possible, obtain collateral evidence of some kind.

Another much-debated question, which is also discussed in the general article on archæology, concerns the apparent break of continuity in man's history which occurs in Europe at the end of the old Stone age, or Palæolithic period. Attempts have indeed been made to bridge this gap by means of a "Mesolithic" period; but the missing links do not occur, at any rate so far north as Britain. Here the last glimpse we get of Palæolithic man shows him living in a cold climate, hunting his prey and scratching his rude drawings on bone and rock, but with only a dawning knowledge of pottery; he sometimes shelters in caves, but generally camps in the open. His successor of the later Stone age is a very different person, living in a Britain which is practically the same as we see it to-day. The severe arctic conditions, with their appropriate fauna, consisting of mammoth, reindeer, &c., have entirely disappeared, and man himself has been changed by the introduction of new arts. Now Neolithic man probably immigrated into northern and central Europe long after Palæolithic man and his characteristic fauna had disappeared. Where then did the earlier race go, and has it any modern representatives? It would be tempting to accept Mr. Boyd Dawkins's theory that Palæolithic man followed the reindeer in its journey northward after the retreating glaciers, and that his modern representative is the Eskimo. But, as Mr. Read points out, the similarities in their culture may well be due to similar conditions of life, and are not convincing evidence of direct descent. Moreover, the skulls of the Eskimo do not resemble any of those of Palæolithic man hitherto found in the caves. In fact, we cannot yet answer this question, though if, as appears possible from recent discoveries in the south of France and in the Pyrenees, the reindeer was there in existence, along with man, at a later period than that of the caves, it is possible that Palæolithic man retreated southwards, and may have left no modern representative of a racial character sufficiently marked for recognition.

These two problems we have referred to, which are among those discussed under the heading of archæology, will serve to illustrate the use made of the general article in this new edition of the "Encyclopædia," in order to collect and discuss under one heading the more important aspects of a subject. Separate articles are, of course, still devoted to special points of interest, such as that on Hallstatt, to mention only one in this connection. In it Prof. Ridgeway gives a valuable account of the celebrated Celtic burial ground near Hallstatt, in Upper Austria, where it has been assumed that the use of iron was first developed, and afterwards spread thence southwards into Italy, Greece, the Ægean, Egypt, and Asia, and northwards and westwards in Europe. It is true that, while elsewhere in Europe and the Ægean the change from bronze weapons to iron is apparently sudden, at Hallstatt iron is seen gradually superseding bronze, first for ornament, then replacing fully the old bronze types of weapon, and finally taking new forms of its own. We may here note that, with regard to the earlier transition from stone to copper; a similarly gradual development has been noted by Prof. Reisner in Egypt at Naga-ed-Dêr and other prehistoric Egyptian cemeteries. On the strength of these results Prof. Elliot Smith a few months ago advanced the theory that Egypt was the original home of metal, and that its use spread thence eastwards into Asia and northwards into Europe and the Ægean area. But there is no need to regard the "Encyclopædia," which naturally can take no account of theories produced after its publication, as already out of date upon this point. For, while Prof. Reisner appears to have made out his case for the independent development of copper in Egypt, it appears to the present writer that there is no need to assume that no other race hit upon the same idea. In fact, it may be that M. de Morgan and his colleagues will some day find in Persia a proto-Elamite equivalent of Naga-ed-Dêr; and should this prove to be within easy reach of the tin supplies of Central Asia, it might also throw light upon disputed questions with regard to the transition from copper to bronze.

We have laid some stress upon the two last-named articles, as they are among the very few that have been sent us which have any bearing, direct or indirect, upon British archæology. We should have liked to refer to articles on Dolmens, Stone-circles, and their possible connection with astronomical ceremonies, and other subjects particularly connected with early British archæology, but the selection of articles sent us deals mostly with classical and Oriental subjects; and these will serve very well to illustrate other aspects of the work. We have already noted some characteristics of the general article in the new edition; another advantage, to which we may also direct attention, is that, where a wide survey is to be taken of material extending over various periods, it makes a far more detailed treatment possible. This is especially the case in the general articles of composite authorship. The treatment of ceramics is an instance in point. Here we are first presented with a general study of the art of pottery, which, both in its treatment and illustration, is such as we should look for in an encyclopædia. It is lucid and informing, and serves as an admirable introduction to anyone desirous of beginning a study of the subject. Such is all that could reasonably be expected of any encyclopædia. But the "Encyclopædia Britannica" now gives us more. The reader, when he comes to the bibliography at the end of this introductory section, is now no longer obliged to go to some library for further information. The "Encyclopædia" itself supplies it; for the introductory section is amplified by a series of articles by specialists on the pottery of ancient Egypt and Western Asia, Greek, Etruscan, and Roman wares, and further sections on Persian, Syrian, Egyptian, and Turkish pottery. This article on ceramics is certainly one of the fullest archæological articles in the work, but it is quite typical of the rest. We clearly have here a deliberate policy on the part of the editor and his assistants to furnish the reader not only with the dry bones of a skeleton, but with plenty of material to fill them out at will.

Another feature that has struck us during a careful study of the articles dealing with ancient history and archæology is the system of cross-references which has been adopted throughout. One obvious gain has naturally been to avoid repetition and inconsistency; but a further advantage consists in the fact that the reader is enabled to follow up various subsidiary lines of study in cognate articles treating the subject in greater detail or from a different aspect. We have already referred to the article on Ægean civilisation; the reader, if he so desires, may find further information in other important articles on Crete, Mycenæ, and the Troad; while the products of Ægean art are treated under the more technical articles. By such a system of cross-reference the value of the "Encyclopædia," not only as a work of reference, but also as a subject for detailed study, is vastly increased.

There is one point on which we have not touched, but which perhaps distinguishes more than any other this edition of the "Encyclopædia" from its predecessors—the number and beauty of the illustrations. Many of the old line blocks and wood engravings have naturally still great value, and where they have not been rendered obsolete or out of date, they have been retained; but they are supplemented by a wonderful series of half-tone plates, arranged clearly on both sides of the paper in order to save space, and containing, in some cases, as many as twelve or sixteen separate blocks to the page. For beauty of half-tone illustration it would be hard to beat the series of plates to the article on Greek art, while those to the article on gems, with their admirably clear classification, show what modern scientific illustration can achieve.

In the short account we have given of a single aspect of this great work, we have not attempted to criticise any article in detail, though in the course of our reading we have noted one or two slips. To select them for special mention from a work of such magnitude would be unfair, as it would tend to create a wrong impression. That so high a standard of accuracy should have been achieved is an eloquent testimony to the devotion of the editor, and of the distinguished band of specialists whom he numbers among his contributors. L. W. K.

THE DATA OF PHYSICAL CHEMISTRY.

Physico-Chemical Tables, for the Use of Analysts, Physicists, Chemical Manufacturers, and Scientific Chemists. By John Castell-Evans. Vol ii., Physical and Analytical Chemistry. Pp. xiv+549–1235. (London: C. Griffin and Co., Ltd., 1911.) Price 36*s*. net.

THE second and concluding volume of Mr. Castell-Evans's work on physico-chemical constants is a veritable monument to the industry and perseverance of the author, who unhappily has not lived to reap the reward of his labours. The user of the tables may well be appalled at the magnitude of the task undertaken by a single compiler to bring out two volumes covering in detail the whole domain of physical chemistry and running in all to more than twelve hundred pages.

To review such a work adequately is almost impossible without keeping the book in hand for a longer time than is desirable. The reviewer's criticisms must therefore be taken as indicative of the directions in which a future edition might be improved, rather than as the results of a detailed examination; it should also be noted that in the circumstances the reviewer has refrained from raising debatable questions.

The distinguishing feature of the book is undoubtedly the very large amount of labour put into the calculation of the numerous tables, a great number of which are quite new and contain data only obtainable elsewhere from many scattered sources. For example, the collection of data on viscosities and on densities of liquids and their variation with temperature are most useful and complete. To the analytical chemist and assayer the two hundred pages of tables for shortening analytical computations, for the comparison of volume and weight percentages, and for the conversion of the various systems of units employed in such estimations, will be very valuable.

In the compilation of this second volume of tables even to a greater extent than in the first, the author seems to have allowed his extraordinary desire for high numerical accuracy to lead him to give the values of constant in many cases to far more figures than can possibly have any significance.[1]

As a sample physical measurement of the highest class under the best possible conditions may be considered the comparison of two similar platinum-iridium kilograms with all the refinements of a transposition balance, a "complete" set of weighings, and the utmost precautions. Under these conditions the thousandths of a milligram may be said to have some significance. Similarly in length measurements the difference in length between two similar standard metres of the highest class may be determined to a few hundredths of a micron, and the height of a metre column of mercury to a few thousandths of a millimetre. The last significant figure in the three cases is $1/10^9$, $1/10^8$, and $1/10^6$ of the whole respectively. These are the most favourable cases, but it seems unlikely that even with the best of methods an interval of temperature can be measured with greater precision than about one part in a hundred thousand. Besides, if instead of the mass or length chosen in the examples an odd multiple of a fundamental standard be taken, the precision attainable may be only one-tenth of that given or even less.

But Mr. Castell-Evans gives many instances of eleven and some even of fourteen significant figures among his constants and conversion factors, whereas for the purpose of avoiding mere errors of computation the retention of one, or at most two, additional places beyond the usual limits would have been amply sufficient.

While dealing with this question, it may be remarked that a physicist familiar with the modern precision measurements of physics, but whose mental estimate of the kind of accuracy now attainable in chemical work was obtained only from Mr. Castell-

[1] The writer is informed that this retention of an unusually large number of figures was not due, as might have been supposed, to the use of a calculating machine whereby the extra digits were obtained without any very serious increase of labour, but that the numerical work was performed by the author without the aid of any machine.

Evans's volume, would be very much astonished to be told that probably no single atomic weight is known to 0·01 per cent., and that comparatively few are certain to one part in a thousand. Indeed, it may almost be asserted that there is just as much a prevailing "fashion" in atomic weights as in that of wearing apparel. In view of the fact that laboratory chemistry may be said to have had a start of nearly a century upon laboratory physics, this great discrepancy in the precision attainable in the two sciences is not easy to explain, the difference being the more remarkable when the relative numbers of workers in the two fields are taken into account.

Possibly after all the theorising to the contrary the true cause may be found to be that all the atoms of a so-called elementary substance have not exactly the same weight. J. A. HARKER.

PRACTICAL ASTRONOMY.

Text-book on Practical Astronomy. By Prof. G. L. Hosmer. Pp. ix+205. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd.; 1910.) Price 8*s*. 6*d*. net.

THOSE who have used Prof. Hosmer's previous work, "Azimuth," will remember that one of its most pleasing features is the unconscious display of the author's intimate acquaintance with the practical side of surveying and of teaching. The same pleasing feature is just as much a characteristic of the present work. One feels that there is but little of the subject that the author has not practised until the operations are almost part of a second nature, yet in this work he does not lose sight of the fact that the student is a beginner and needs telling that the sun-glass is not usually placed over the object-glass.

The order of treatment is the conventional one; the method of treating the subject is Prof. Hosmer's. In the early chapters he explains, with numerous simple diagrams, the real and apparent motions of the celestial sphere, gives a number of definitions, and then describes the common systems of coordinates, their interrelations, and the methods of converting quantities from one to the other.

The anomalies of our unscientific mixture of "times" are elucidated in the next chapter, and the student is shown by example how to obtain any one, knowing either of the others. In chapter vi. the American ephemeris is explained, but much of the matter would apply equally to the contents of our Nautical Almanac; the method of interpolation to get intermediate ephemeris values is simple, but Prof. Hosmer recognises that it is not so simple—to the student—as to need no explanation. After considering the figure of the earth and the corrections it renders necessary, the author proceeds to a chapter on instruments, where, after dealing with the engineer's transit, the sextant and the chronometer, he gives a brief and simple account of the zenith telescope and concludes with a characteristic paragraph (58) of hints and suggestions on observing; the hint as to the making of a permanent mark showing the focus on a frequently used surveyor's transit telescope illustrates how simple the author has made it for a beginner to "go right."

In the subsequent main chapters on the determination of latitude, time, longitude, and azimuth, we do not detect any novel methods, but we do recognise the simple conciseness of the instructions. By the use of smaller print the matter for a longer (advanced) course is differentiated from the simpler matter which would form a good first, or short, course—a hint that is valuable from such an experienced instructor. The formulæ employed are all numbered, so that in the case of transformations, or derivations, the student can readily refer back to his primary form.

The concluding chapter, on nautical astronomy, is chiefly notable for its excellently clear statement of Sumner's method illustrated by one or two useful diagrams. In an appendix the general question of tides is discussed briefly from the point of view of "level," and a number of useful tables of various astronomical quantities are given. The diagrams throughout are numerous, clear, and readily comprehensible.

THE MENACE OF THE HOUSE-FLY.

The House-fly—Disease Carrier: an Account of its Dangerous Activities and of the Means of Destroying it. By Dr. L. O. Howard. Pp. xix+312. (New York: Frederick A. Stokes Co., 1911.) Price 1.60 dollars net.

ALTHOUGH house-flies are universally admitted to be a nuisance of a peculiarly exasperating kind, it was not until almost within the last decade that even physicians, with a few isolated exceptions, began to realise the possible dangers lurking in the presence of the most familiar and probably most widely distributed of all insects. The Spanish-American war of thirteen odd years ago did something to direct attention to the importance of the house-fly as a carrier of enteric fever in military standing camps, and the lesson then borne in upon the medical officers of the United States Army was enforced only too well a few years later by our own experiences in South Africa. It is now agreed by those best qualified to judge that the house-fly can convey the causative agents of cholera and enteric fever, and in outbreaks of these diseases often plays no inconsiderable part as a disseminator. Whether or not it acts as a carrier of infantile diarrhœa, which during the summer months frequently causes great mortality among young children, is not yet conclusively established; but that it is capable of carrying tubercle bacilli is certain, and tuberculosis and the other diseases mentioned do not exhaust the list of what are at least *potential* dangers connected with the house-fly.

In the so-called "residential" quarters of cities, in countries such as our own, the house-fly has nowadays not much opportunity of becoming contaminated with disease-causing organisms, but, as has been shown by Prof. Newstead in Liverpool, and in Washington by the author of the volume before us, it is unfortunately otherwise in the dwellings of the poor. In villages and old-fashioned farmhouses, where sanitary arrangements are too often painfully primitive, given a single case of enteric fever, the habits of the house-fly may easily cause an outbreak of the disease, which may have far-reaching consequences. As a potential disease-disseminator, at any rate, no other British insect is of anything like the same importance as the common house-fly; yet by the British public its potentialities are but dimly realised, if at all.

In the volume under review, which "is not intended to be a scientific monograph," Dr. L. O. Howard, a well-known authority, provides a convenient and altogether admirable summary of existing knowledge concerning the subjects mentioned in the title. The book is well arranged, simply yet forcibly written, excellently illustrated, and provided with a very complete "bibliographical list," while the results obtained by other workers down to the date of publication are duly noted in the text. With regard to the range of flight of house-flies—a subject of great practical importance—it may be mentioned that the observations of Copeman, Howlett, and Merriman, showing that the insects are capable of flying to a distance of more than 1400 yards, were published too late for inclusion. Only two comments seem necessary by way of criticism; in a subsequent edition, which we hope will be called for, Dr. Howard should correct the unfortunate slip on p. 18, where it is stated that the house-fly's eggs vary in length "from one-sixth of an inch to a little longer" (the real length being one millimetre or a little less), and should on no account omit to provide an index. If a hackneyed phrase may be pardoned, "The House-fly—Disease Carrier" "supplies a want," and a copy of it should not only find a place on the shelves of every medical officer of health and borough surveyor in the British Islands, but should also be included in every public library.

E. E. A.

MAN AND BEAST IN EASTERN AFRICA.

Man and Beast in Eastern Ethiopia: from Observations made in British East Africa, Uganda, and the Sudan. By J. Bland-Sutton. Pp. xii+419, with 204 engravings on wood. (London: Macmillan and Co., Ltd., 1911.) Price 12s. net.

THIS work has been prepared with considerable care, and the reviewer has no desire to be captious; but he feels bound to say that there is little in it which strikes him as being due to really original observations on the part of the author; nor are the illustrations (all of them woodcuts) particularly novel, or, in the case of beasts and birds, invariably accurate. They do not possess the truth of photographs taken direct from nature. Moreover, in regard to these illustrations, many are from photographs or drawings in other books; and even when the source of the original is mentioned (this is not always done), one asks oneself why they should be reproduced, since the original work is easily accessible in libraries.

In like manner, the text of the book is almost entirely made up by extracts or paraphrases from the published books or reports of H. M. Stanley, Joseph Thomson, F. Elton, Speke, F. C. Selous, H. H. Johnston, Newton Parker, J. F. Cunningham, various members of the Church Missionary Society, C. W. Hobley, R. J. Stordy, Mr. and Mrs. Hinde, W. S. Routledge, L. von Höhnel, A. H. Neumann, F. J. Jackson, Drake-Brockman, J. E. S. Moore, Donaldson Smith, and others, whom it would be tedious to enumerate. As an example of inappositeness the author has put in a drawing of *Cobus ellipsiprymnus*, the South African waterbuck; but he is obliged to explain that it is absent from the districts he is describing, where the form of waterbuck is *Cobus defassa*. The African lung-fish (Protopterus) is described as the Lepidosiren (the Lepidosiren being the representative of this order which is found in the waters of the Amazon and its tributaries in South America; the figures in the text, of course, are those of Protopterus).

These criticisms do not imply that the book is not an exceedingly interesting one for persons who are unacquainted with the natives, beasts, birds, and reptiles of eastern equatorial Africa. To those who desire a superficial acquaintance with this remarkable fauna it will certainly be of use, but to be perfectly fair, it must be taken as the summary of other people's work and other people's observations, and cannot be described, as it is on the title-page, as being based on observations made by the author, though undoubtedly the author's own journeys have taught him to appreciate the interest and the accuracy of the works published by his many predecessors.

H. H. JOHNSTON.

OUR BOOK SHELF.

(1) *A Compendium of Aviation and Aërostation: Balloons, Dirigibles, and Flying-machines.* By Lieut.-Colonel H. Hoernes. With a preface by J. H. Ledeboer. Pp. xi+179. (London: Charles Griffin and Co., Ltd., 1911.) Price 2s. 6d. net.

(2) *The Helicopter Flying-machine: an Account of Previous Experiments, including an Analysis of the Author's Turbine Machine.* By J. Robertson Porter. Pp. viii+80. (London: *Aëronautics* Office, 1911.) Price 3s. 6d. net.

(1) LIEUT.-COLONEL H. HOERNES has, under the title given above, produced a very readable popular handbook, and its low price and handy size should find it a ready market. Its chief value is as an historical record, the section dealing with dirigibles being particularly useful and giving a mass of important information in a small space. As may be expected from one whose name is well known as an authority on lifting-screws, the author declares emphatically for the helicopter as the machine of the future, and says: "In my opinion at least, the lifting-screw machine, or helicopter, forms an advance on every other type of flying-machine." The reasons for this statement are given as its capabilities for vertical rise, its lightness, strength, and ease in landing, its safety, trustworthiness, and ease in control.

(2) On the other hand, in "The Helicopter Flying-machine," Mr. J. R. Porter, who has devoted many years to the study of the subject, rejects the helicopter proper for what he terms a "turbine machine." The propellers in this apparatus are designed to produce a horizontal and radial current of air, which is diverted downwards by means of curved annular surfaces, with the result that an upward reaction is produced. It is his opinion that a helicopter proper "has less stability than the aëroplane, that the matter

of control brings a greater responsiblity on the pilot, and in case of the engine stopping the machine has no means of gliding safely to earth." Mr. Porter deserves great credit for the clear and concise way he has analysed the most important experiments with lifting-screws, and his book, which at present stands as the only English work on the subject, should find a place in every student's library.

Secrets of the Hills, and How Ronald Read Them. By Sterling Craig. Pp. 320. (London: George G. Harrap and Co., n.d.) Price 3*s.* 6*d.* net.

VERY early in the nineteenth century, the Rev. Isaac Taylor showed how a certain James and his father, Mr. Thompson, visited a series of British mines and compared them sagaciously with those of other lands. The little book, called "The Mine," in which the didactic Thompson and the preternaturally patient James were made to record their impressions, ran through three editions by 1831. At that date the Wicklow nugget of 22 ounces was the largest mass of native gold on record, while the mineral zircon was regarded as beyond the reach of an ambitious collector. Mr. Craig now comes forward with a similar book, published bravely in the twentieth-century manner in a very excellent type, and beautifully illustrated by photographs in place of the romantic old copper plates. Of course, when we were boys we loved Taylor's "Train of Mules bearing Copper Ore" in Cornwall, and the tufted Indians "Diamond washing at Golconda"; and our successors may equally delight in the realistic pictures of "Holing the Coal" (p. 202) and of the fossil bones at Pikermi (p. 306), which are so well provided by Mr. Craig. Mr. Craig's boy, Ronald, goes to stay with a well-informed doctor in the Leadhills, and receives even more instruction, in return for his judicious questions, than did the late lamented James.

Dr. Thomson—the name is, of course, a pure coincidence—keeps himself well abreast of geological literature, though we may not agree with him about the entirely mythical crystallised sea-sand so neatly figured on p. 30. His lucid but lengthy manner of discourse has proved contagious in the district, and is successfully imitated by Jim, a working miner, and by Mr. Holloway, of Dollar. But boy readers, to whom all this is new, will probably not regard such friends as tiresome. It is quite incorrect to think that young minds have no thirst for information, and even the adventurous will enjoy the graphic account of Ronald's work in a lead-mine underground. Mountain-building and river-erosion are described with the aid of sections, and the line-drawings in the book are for the most part as effective as the photographs. There are a few misprints, as "Unita" for "Uinta," and "Cornish" for "Coruisk," and some rather definite statements on matters that are a good deal in dispute. But the 320 pages contain a large range of information, and it is interesting to find that the Thompsonian (or Thomsonian) manner is still so much in favour.

G. A. J. C.

A Laboratory Text-book of Embryology. By Prof. C. S. Minot. Second edition, revised. Pp. xii+402. (London: J. and A. Churchill, 1911.) Price 16*s.* net.

LABORATORY text-books are apt to be limited in their use, due, no doubt, to the fact that the teaching in two different laboratories is never identical. Their use will be the more extensive as the illustrations and text are made general in application.

The illustrations in this work are well executed, and in the new edition their number has been increased from 218 to 262. They are mainly taken from special sections and figures, but the sections and figures have been well selected as typical. Their value is much enhanced by the fact that they are faithfully drawn, and give, as much as is possible in black and white, the appearance of sections as seen under the microscope; too diagrammatic a section is apt to mislead a student. The reconstructions illustrated are valuable aids in giving a student a general idea of the anatomy of the embryo; they also help by showing where the sections illustrated are cut.

Besides additions to the illustrations, Prof. Minot has in this second edition entirely recast several chapters so as to make the study of development chronological throughout. The text is chiefly descriptive of the sections and figures, but short comparisons are drawn between the various stages. The introductory chapter deals with too much in too short a space to be of any real use. Heredity, for instance, when treated in a page leads one to believe that Darwin's theory of "Pangenesis" is the only theory worthy of consideration. Again, Prof. Minot's classification of glands, when proposed so shortly, is liable to confuse.

As in the old edition, the pig is the basis of study, since in America pig embryos above the length of 6 mm. can readily be obtained from abattoirs. For the early stages the rabbit is used. Human embryology is treated at some length, well-known figures being used for the purposes of illustration. The chicken is only allowed forty-four pages out of a total of 402, so that the work treats almost entirely of mammalian anatomy.

The practical directions at the end of the book supply the details of formulæ and give methods for staining and reconstruction.

Photograms of the Year 1911–1912. Edited by H. Snowden Ward. Pp. 154. (London: George Routledge and Sons, Ltd.; Dawbarn and Ward, Ltd.; New York: Tennant and Ward; Melbourne: Kodak (Australasia), Ltd.; Toronto: The Musson Book Co., Ltd., n.d.) Price 2*s.* 6*d.* net.

THIS annual deals chiefly with descriptions and criticisms of the "pictorial" photographs exhibited in the various exhibitions, and brief summaries of the state of pictorial photography in other countries. Mr. Robert Demachy speaks for France, and concludes that there is sounder work going on there. South African progress is recorded by Mr. George E. Whiting, and he deplores the ending of the *Journal of Photography* published there, but rejoices at the formation of two new societies. The work in Germany is taken in hand by Mr. F. Matthies-Masuren, while Mr. Walter Burke's remarks are devoted to Australia. The main portion of the book is, however, from the pen of the editor, who, as was announced in NATURE of December 14, died early in that month in New York. Mr. Snowden Ward's contribution consists in the main in describing the special features of the very large collection of the works exhibited at various places during the past year, and this will be found very useful to those who take up this, the pictorial, side of photography.

The book, as usual, is profusely illustrated, and the fact that many of the pictures have not been seen in this country before adds a special feature to them. There is no doubt that pains have not been spared to reproduce well the pictures contained in the volume, but there are some, notably that entitled "When all the snowy hill and the bare trees are still," which seemed scarcely worth the trouble taken. Many readers will find in the book much that is both amusing and useful.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Weather of 1911.

I HAVE received the subjoined letters from Dr. Schmauss at Munich, which may be of interest to your readers. In England in December, 1911, the temperatures up to 8 km. were decidedly below the mean. This is nearly always the case in stormy weather.

In the following table the correlation between the general drift of the atmosphere and the temperature is shown.

N denotes the north component of the drift of the balloon, the positive direction being the north.

E, the drift to the east.

T_0, the surface temperature.

T_4, the temperature at a height of 4 km.

T_8, the temperature at a height of 8 km.

H_c the height of the commencement of the isothermal column.

The observations in England were taken during the four years 1908 to 1911 on some eighty different days. Owing to the practice of the International Commission of nearly always fixing the week for daily ascents in the summer, the preponderance of the observations lies in the summer. Since observations made at neighbouring stations on the same day cannot be considered independent, and since large groups of observations are concentrated into particular weeks, during some of which unusual conditions prevailed, the probable errors are really far larger than the number of observations would indicate.

Correlation Coefficients.

	English. Four years			Continental One year
	Winter	Summer	Combined	
E and T_0	0·18	0·07	0·13	−0·12
E ,, T_4	−0·17	0·12	0·07	−0·28
E ,, T_8	−0·08	0·17	0·16	−0·26
E ,, H_c	−0·31	0·08	−0·09	−0·08
N ,, T_0	−0·16	−0·01	0·18	0·26
N ,, T_4	−0·13	−0·16	0·10	0·18
N ,, T_8	−0·17	0·00	0·06	0·21
N ,, H_c	−0·26	−0·11	−0·06	0·04
H_c ,, T_0	0·22	0·42	0·43	0·49
H_c ,, T_4	0·60	0·57	0·67	0·75
H_c ,, T_8	0·75	0·72	0·71	0·76
No. of obs.	(46)	(93)	(139)	(80)

It will be seen that the only correlation coefficients large enough to be significant are those showing the connection between the height of the isothermal and the temperatures.

Dr. Shaw's hope, expressed in your issue of December 21, 1911, seems to be fulfilled, for were there any close and systematic connection between the temperatures and the direction of the air currents, or between the latter and the height of the isothermal, it could scarcely fail to appear in the figures. The small values of the coefficients (0·31, with a probable error of 0·1, even if we treat all the observations as independent, is the largest) and the want of agreement between the different groups both lead to the conclusion that there is no connection, or at the best a very slight one.

The connection between the height of the isothermal and the temperature of the air below down to 4 km., and perhaps even to the surface, is very plainly shown, and makes me regret my somewhat rash statement that the surface temperature was more dependent upon the direction of the wind than upon anything else.

The negative value of −0·16 between T_0 and N is certainly curious, and the sign would probably be reversed if there were some hundreds of observations instead of forty-six; but the drift of the balloon is not necessarily the same as the direction of the surface wind, although, as a general rule, especially when the wind is strong, the two agree fairly well. The negative sign indicates that a south wind is colder than a north, and must be taken as a warning not to ascribe any significance to small correlation coefficients. W. H. DINES.

December 30, 1911.

Kgl. bayer. meteorologische Centralstation, München, den 11 *Dezember,* 1911.

Es wird Sie im Anschlusse an Ihre Mitteilung in NATURE 88 S. 175 interessieren zu hören, dass unsere September-fahrten über München nahezu die gleichen Verhältnisse aufweisen wie Ihre britischen Aufstiege.

Es war die Temperaturabweichung vom Mittel:—

516	1	2	3	4	5	6	7	8	9	10	11	12	13 km.
+2·9	+4·3	+**5·7**	+4·4	+4·3	+3·4	+2·3	+2·3	+2·2	+2·4	+1·0	−3·4	−**7·4**	−6·9

München, den 27 Dezember, 1911.

Auch noch die Dezemberaufstiege haben eine ähnliche Abweichung über München ergeben. Es wurden die Werte der drei Dezemberaufstiege gemittelt und die Abweichungen vom Mittel gebildet.

Es war dieselbe:—

In 1	2	3	4	5	6	7	8	9	10	11 km.
+3·7	+**6·3**	+5·5	+5·0	+4·0	+4·0	+**5·8**	+5·7	+3·1	−0·1	−3·3

Der grosse Wärmevorrat der Atmosphäre in diesem Herbste ist darin deutlich ausgesprochen.

A. SCHMAUSS.

SIR EDWARD FRY has asked (NATURE, December 21, 1911, p. 244) whether the unusually warm weather that prevailed in Western Europe last summer extended over the whole earth. It is possible to answer in the negative so far as Egypt is concerned, for the temperature here was below average from June to September. Indeed, on some days London had a higher maximum than Cairo, *e.g.* August 9, Greenwich 100°, Cairo 93°. The result was a retardation of the cotton harvest by some twenty days at the first picking.

As regards the cause of the cooler weather, there is a certain amount of evidence that the amount of solar radiation reaching the lowest stratum of the atmosphere here was less than usual, if any faith is to be placed in the indications of the black-bulb thermometer *in vacuo*. This phenomenon, of course, may be due either to diminished solar activity or to locally increased absorption in the upper strata, or to a combination of both. In any case, Sir Edward Fry's original query brings us face to face with what is probably the ultimate question in meteorology—given unit increase of solar radiation, calculate the effects at the earth's surface. The solution will not be identical for all parts of the earth, and so a small and temporary diminution of radiation may at one place cause increase of temperature, while at another the reverse is the case.

J. I. CRAIG.

Giza, Egypt, December 31, 1911.

English *v.* Continental Microscope Stands.

REFERRING to the interesting article on the merits of English *versus* Continental Microscope Stands in NATURE of December 21, 1911, I notice that whilst reasons are given on both sides for the distinctive peculiarities of the respective models, and a general suggestion is made as to how the present well-recognised types have come about, curiously enough, no reference has been made to what seems to me to be the real origin of the most important differences between the two types—I refer, of course, to the substage arrangements as a whole. Why is it that the English model provides for the exact centring, and frequently for fine adjustment focussing of the substage optical system, whilst the Continental model does not? Why is it that the Continental models, on the other hand, provide rackwork mechanism for moving the iris diaphragm of the condenser out of centre, with means for rotating this whole arrangement—a feature absent in the English model?

These things are clearly the outcome of the different theories which prevailed at one time in England and Germany on the question of microscope illumination. On the Continent, it must be remembered, the general recognition of the utility of substage condensers dates from the time when Abbe worked out his epoch-making theory of the microscope image. But, fruitful as that theory immediately was in so many respects, it led Abbe in the first instance, as we now know, to undervalue the importance of the substage illumination in certain aspects, for which statement the fact that only a chromatic form of condenser was originally supplied is sufficient evidence. Further, as is well known from the controversies at the time, it led Abbe at first to favour a narrow cone of light from the substage condenser. Thus the latter became merely a tool by which the object might be studied by means of a beam or pencil of light impinging on it at various degrees of obliquity and in different azimuths.

The Continental substage was designed for this purpose; indeed, it has been explicitly stated by Prof. H. Ambronn[1] (*Zeitschrift für Wissenschaftliche Mikroskopie*, January, 1905) that the construction of the illuminating apparatus named after Abbe, and of which the arrangements connected with the diaphragm carrier constitute the chief novelty, was really only designed by its originator for the testing of objectives and for experiments on the effects of diffraction.

Strange to say, although it is a long time since the utility of achromatic condensers and wide illuminating cones for general microscopic observations has been recognised on the Continent, most Continental makers still cling to the old form of substage construction, preferring to modify other arrangements to adapt them to this construction rather than change their model.

In England, substage illuminators were in general use long before this was the case on the Continent; originally they were looked upon—as the name "condenser" implies—simply as a means of concentrating light on the object; but at the time when Abbe brought out his theory of microscopic images, the value of precise centring arrangements for the condenser and the use of wide-angled cones of light had been so well recognised by Nelson and others that the new theory did not induce English microscopists to recede from their previous experience in these respects. On the contrary, it led in this country to a campaign on behalf of the wide-angled cone of light from the condenser, and the mechanically moveable iris diaphragm was not adopted by English makers. The simpler method of the shallow carrier above the iris diaphragm, into which stops for dark-ground illumination, for oblique illumination, or various stops for experimental purposes could be dropped, was found to render all the service necessary. Hence the general lines on which the construction of the present-day English substage arrangements have developed.

Those who have worked with both forms will be in little doubt as to which is the more convenient.

JULIUS RHEINBERG.

London, December 30, 1911.

[1] *Vide* also Journal of the Quekett Microscopical Club, 1905, pp. 157-8.

The Photography of Hα during Solar Eclipses.

WITH regard to Mr. Butler's letter on this subject (NATURE, vol. lxxxviii., No. 2199, p. 244), I may say that I was unaware that Hα had been photographed in the "flash" spectrum in former total solar eclipses. As I have also been, so far, unsuccessful in my search in the preliminary reports of the eclipse observers of 1893 and 1898, in the Proceedings and in the Philosophical Transactions of the Royal Society, in finding any specific mention of Hα, would Mr. Butler kindly supply the needed references? I may add that in the photograph taken by Father Pigot under my direction in the last eclipse, Hα does not appear as an isolated arc, such as might be recorded on an isochromatic plate, but as the strongest impression crossing a continuous band which extends from Hα well into the ultra-violet. A modification of my original statement in this sense might meet Mr. Butler's criticism.

A. L. CORTIE.

IN reply to Father Cortie's note, I give the detailed references he requires, abstracted from the papers mentioned in my previous letter:—

(1) *Total Eclipse of the Sun*, April 16, 1893.
Phil. Trans., A, 187, pp. 551–618, 1896.

P. 574.—On negative 17 the image of Hα was obtained even at mid-eclipse, although the plates were not specially sensitive to red.

P. 617.—The line Hα is indexed in the table of chromospheric lines as having been recorded on three photographs, Nos. 17, 18, 19. On No. 19 it is given as intensity (3) on a scale of 10, which is quite remarkable considering that the plate employed was not specially red-sensitive.

(2) *Total Eclipse of the Sun*, January 22, 1898.
Phil. Trans., A, 197, pp. 151–227, 1901.

P. 199.—The line was so prominent that it was utilised for wave-length determinations.

"For the purposes of reduction the spectrum has been divided into two parts, one extending from Hα in the red to λ 3900 in the violet. . . ."

P. 226.—In the table of chromospheric lines determined from photographs, the line Hα is given as intensity (5) on a scale of 10. The plates on this occasion were isochromatic, but still not specially red-sensitive, and the greater relative intensity of the image of Hα compared with that on the 1893 plate is probably due to this.

Plate 6, spectrum strips *a* and *b*.—Inspection of these two strips will at once show the presence of Hα as a strong line; in fact, the best description of it is exactly similar to that given by Father Cortie for the impression on Father Pigot's plate. It is the strongest impression (in that region) crossing a continuous band which extends from (beyond) Hα well into the ultra-violet.

One of the other results to which I referred is that given in the report by J. Evershed, "Wave-length Determinations, &c., at the Solar Eclipse, January 22, 1898."
Phil. Trans., A, 197, pp. 381–413, 1901.

P. 410.—Hα strong on No. 7 plate.

P. 413.—Spectrum No. 7 (Hα).

Plate 11, Fig. 5, Spectrum No. 7.—Hα shown and lettered as a strong line.

CHARLES P. BUTLER.

Meteor-showers.

THE following meteor-showers become due during the remaining part of January:—

Epoch January 11, 20h. 30m., twentieth order of magnitude. Principal maximum, January 13, 21h. 20m.; secondary maximum, January 12, 1h. 45m.

Epoch January 15, 9h. 30m., second order of magnitude. Principal maximum, January 14, 21h. 50m.; secondary maximum, January 14, 3h. 30m.

Epoch January 15, 4h. 30m., approximately fourth order of magnitude. Principal maximum, January 15, 12h.; secondary maxima, January 16, 16h. 10m., and January 17, 7h. 25m.

Epoch January 21, 18h., approximately eleventh order of magnitude. Principal maximum, January 20, 19h. 30m.; secondary maxima, January 19, 0h. 5m., and January 21, 3h. 35m.

Epoch January 22, 8h., thirteenth order of magnitude. Principal maximum, January 23, 14h.; secondary maxima, January 23, 2h. 50m., and January 24, 3h. 50m.

Epoch January 26, 11h., approximately eleventh order of magnitude. Principal maximum, January 27, 13h. 15m.; secondary maxima, January 24, 14h. 20m., and January 27, 10h. 30m.

Epoch January 26, 19h. 30m., thirteenth order of magnitude. Principal maximum, January 28, 1h. 5m.; secondary maximum, January 28, 8h. 40m.

Epoch January 30, 0h., approximately twenty-eighth order of magnitude. Principal maximum, January 30, 8h. 40m.; secondary maximum, January 31, 11h. 20m.

There is a considerable degree of meteoric activity in the latter half of January. The most important days during the period January 9–31 are January 14–15, January 16–17, January 20–22, January 24–28, and January 30–31. The most noteworthy epoch of this period is that of January 26, 19h. 30m., as it resembles in type that of November 17, 1911, 3h. 30m., to which attention has previously been directed. The epoch January 15, 9h. 30m., comes next in importance as a slight variant of the same type, though its intensity is apparently much greater.

Dublin, January 8.

JOHN R. HENRY.

Explosive Hail.

On the afternoon of November 11, 1911, there was a brief storm of explosive hail at this place.

The morning had been unseasonably warm; about noon there were the usual signs of a coming thunderstorm—heavy cumulo-nimbus clouds with a gusty wind—which began about 2.30 p.m. with a slight shower of heavy rain-drops; shortly afterwards there were two or three flashes of lightning and thunder, followed by a fall of large hail-stones, which on coming in contact with the windows or walls or pavement in many instances exploded with a sharp report, so loud as to be mistaken for breaking window panes or a pistol shot. As the hail fell, the fragments sprang up from the ground and flew in all directions, looking like a mass of "popping corn" on a large scale.

The fall lasted two or three minutes, about half the hailstones being shattered, the ground in some places being nearly covered white with the stones and fragments.

Of the unbroken stones, seventy were gathered. They weighed, roughly, 225 grams. A few were ellipsoidal, the longest axis about 25 mm. in length; most of them, however, were nearly spherical, and somewhat smaller, from 15 to 20 mm. in diameter.

Practically all of them contained a nucleus. In a few of the stones the nucleus was porcelain-like, raspberry-shaped, surrounded by almost colourless spherical layers of ice, for about five-sevenths of the diameter, and then a shell of porcelain-like, snowy ice.

A fair proportion of the stones showed, in addition to the spherical, a radiate structure, which was very apparent as the stones melted in a flat dish, showing the cross-section with great distinctness.

The writer noticed a similar fall of explosive hail about eighteen years ago at Lexington, Virginia. The stones in this fall were much smaller, and attention was directed to the stones by the peculiar way in which they seemed to rebound on striking the ground, which was also due on that occasion to their breaking into fragments, without, however, any noticeable explosion.

W. G. Brown.

University of Missouri, Columbia, Mo.,
December 27, 1911.

THE BEGINNING OF ARCTIC EXPLORATION.[1]

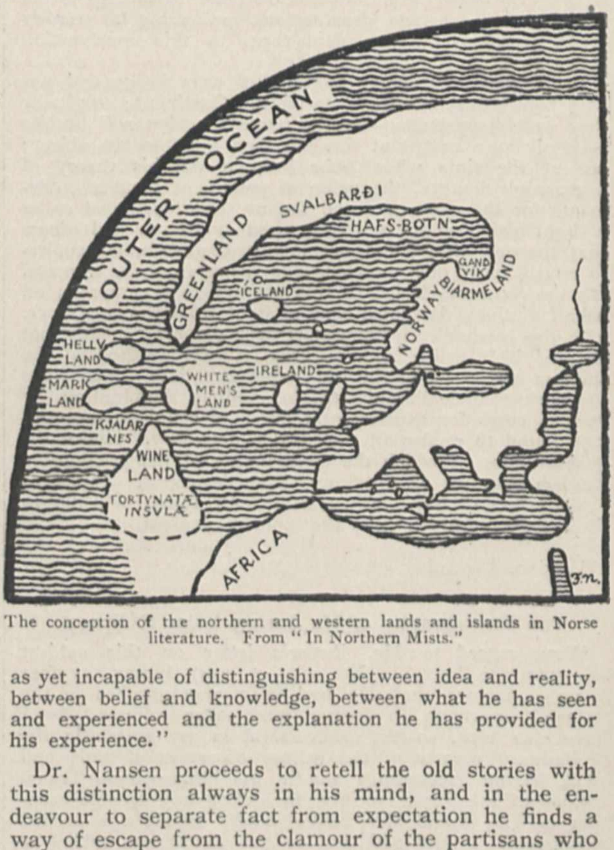
These two great volumes take up the knowledge of the northern regions from the dawn of history, and starting from Homer they have only reached the voyage to Newfoundland of Gaspar Corte-Real in 1503. The reason for this is thus explained, not in the preface, but in the "Conclusion":—

"If we would discover how a watercourse is formed, from the very first bog-streams up in the mountain, we must follow a multitude of tiny rills, receiving one fresh stream after another from every side, running together into burns, which grow and grow and form little rivers till we come to the end of the wooded hillside and are suddenly face to face with the great river in the valley below.

"A similar task confronts him who endeavours to explore the first trickling rivulets of human knowledge; he must trace all the minute, uncertain, often elusive beginnings, follow the diversity of tributaries from all parts of the earth, and show how the mass of knowledge increases constantly from age to age, sometimes reposing in long stretches of dead water, half-choked with peat and rushes, at other times plunging onward in foaming rapids. And then he too is rewarded; the stream grows broader and broader, until he stands beside the navigable river."

Dr. Nansen takes us with him as he traces the head streams of the earliest knowledge of the north in the misty uplands of the past, and leaves us just where the historian can advance with some assurance. He points out how the early peoples had vague ideas of shadowy regions on the edge of the habitable world-disc, and how, though now and again a voyager placed solid facts on record, such details as were current regarding the northern lands were for the most part a mixture of legend and myth. The writers who have dealt with the history of Arctic exploration hitherto have usually commenced with the search for the north-west and the north-east passages which supplied a powerful and intelligible motive for centuries of struggle. This record concludes before that motive came into play; but a book on the history of exploration without some clue of continuous human interest would be a weary chaos of random incidents, which no reader would willingly face, and Dr. Nansen finds a unifying clue in the persistent, romantic, and ever-hopeful search for the Fortunate Isles, which lay or drifted throughout the mistiest periods of history just on the verge of the known world. The guiding principle for the elucidation of the beginnings of exploration seems to be implied in this piece of psychology.

"For one thing, man's power of grasping reality varies greatly; in primitive man it is clouded to a degree which we modern human beings can hardly understand. He is as yet incapable of distinguishing between idea and reality, between belief and knowledge, between what he has seen and experienced and the explanation he has provided for his experience."



The conception of the northern and western lands and islands in Norse literature. From "In Northern Mists."

Dr. Nansen proceeds to retell the old stories with this distinction always in his mind, and in the endeavour to separate fact from expectation he finds a way of escape from the clamour of the partisans who have so frequently made out the dim heroes of early voyages and their first chroniclers to be either paragons of veracity and precision or shameless and aimless liars. There is an appeal to the most authentic versions of the early narratives, many of which are given in these pages more completely than ever before in translation, and there is a minimum—we had almost said an absence—of controversial statements directed against the holders of contrary views.

It should be explained that the quotations from early authorities are all in translation, and the very interesting maps or portions of maps which are reproduced are translations also in so far as they are not facsimiles, but representations of the meaning of the maps, in many cases without the conventional repre-

[1] "In Northern Mists: Arctic Exploration in Early Times." By Prof. F. Nansen, G.C.V.O. Translated by A. G. Chater. Vol. i., pp. xii+384; Vol. ii., pp. iv+416. (London: Wm. Heinemann, 1911.) Two volumes, 30s. net.

sentations or the networks of compass lines which make the originals often both indistinct and confusing. Thus Dr. Nansen does not invite criticism of his interpretation of documents except from the very few who have made a special study of one or other of the many lines of literary or cartographic investigation with which he deals. Our knowledge of Dr. Nansen's character and of the fact that he went into the enormous labour of this work without prejudice or prepossession gives us confidence in the soundness of his conclusions.

The early history of the north, apart from vague poetical allusions, rests upon only a few definite authorities. The first is Pytheas, the Phocean colonist in Massalia, who first ventured northwards in the Atlantic, about 330 B.C., circumnavigated the British Isles, and reached Thule; he was also the first navigator to fix positions by astronomical determinations of latitude by means of a gnomon or by ascertaining the length of the longest day. Dr. Nansen goes fully into the question of the position of Thule, and satisfies himself that it was not Shetland or Faroe or Iceland but Norway. The next definite information was the description given to King Alfred about 890 A.D. (by the Norwegian walrus-hunter Ottar) of the rounding of the North Cape, the entry into the White Sea, and the phenomenon of the midnight sun. This was obviously a truthful narrative of personal experience. Then came Adam of Bremen about 1070, who collected a great deal of authentic information regarding Scandinavia, and mentions Iceland, Greenland, and Wineland, the two last-named for the first time in literature; but there is also much of the fabulous in his writings derived from classical legends. Contemporaneously with the chroniclers, and in the centuries between them, there were two vague currents of northern exploration regarding which such knowledge as has emerged is of the mistiest. They were those of the Irish monks, who founded a chain of settlements from the Hebrides to Iceland and carried with them legends of Hy Breasail—the Isle of the Blessed or the Fortunate Isles of the Greeks—of which many adventurous souls went in search; the finding of which was often rumoured but never confirmed. The second current was that of the Norsemen, who sailed westward to Iceland, where they found Irish monks residing, and whence, pushing westward still, they reached and colonised southern Greenland.

The old Icelandic sagas speak, as is well known, of a voyage of Leif Ericsson, when he missed Greenland and sailed westward until he met a coast, parts of which were named Helluland, Markland, and Wineland the Good, where self-sown wheat and wild vines were found, and various remarkable encounters took place. Hitherto the sagas have been accepted as faithful tradition enshrining facts of observation, but the outcome of a prolonged examination of all possible data is to convince Dr. Nansen that the wheat, the vines, and many other features were mere products of expectation on the part of the saga-tellers. He allows that Norsemen did reach the American coast (though we must say that his iconoclastic logic, if carried further, seems to us capable of throwing doubt on the authenticity of this part of the narrative too), but he believes that they thought they had reached the Fortunate Isles spoken of by the Irish monks and the Roman legends, and so attributed all that the Fortunate Isles were supposed to be to the lands of their discovery.

The idea that Wineland, though reached from Greenland, lay so far along the rim of the world-disc that it was close to Africa brings it in line with the Mediterranean legend, and presented no difficulty to the mediæval geographers before the revival of the spherical form of the earth and the invention of portable instruments for the astronomical determination of latitude. The growth of knowledge of cosmography and of precision in cartography is traced down to the time of the Cabots and the Corte-Reals, and the period of commercial whaling on the small scale which led the northern seafarers to the edge of the arctic ice is touched upon; and then, when the globe had been swept clear of myth and the Fortunate Isles had gone to Davy Jones with the Sunken Land of Busse, Dr. Nansen leaves us with the stage free for modern exploration. What he said of the explorers of that sixteenth-century stage we may say of those of our twentieth-century stage, when the passages have been found and the pole itself reached—

"To riches men have seldom attained, to the Fortunate Isles never; but through all we have won knowledge."

H. R. M.

MICROSCOPE STANDS.[1]

II.

THE CHANGES NOW GOING ON.

IN discussing the relative merits of Continental *versus* English pattern microscopes, the ground is at once cleared if we discard the labels Continental and English, and seek a more accurate definition for each type than merely the place of origin.

As a matter of fact, the old labels will soon cease to have any real meaning, for the Continental makers are adding to their patterns new instruments, rivalling in complexity of adjustments the so-called English type, and English makers are in many instances producing almost exact replicas of the Continental type. That the foot still remains of a more or less horseshoe form, with inclination axis below the stage, in the one, and is generally of the tripod form with inclination axis above the stage in the other, is a detail which does not affect the real difference between the two types, viz. relative complexity, although it renders the former more suitable for use in the vertical, and the latter more comfortable for use in an inclined position.

The English type of microscope, owing to the fostering care of a small body of dilettanti, came into general notice, when the need of a microscope was felt by the professions, already a complex instrument; from this simpler types have been slowly evolved, too slowly unfortunately for the demand, which has in consequence swung over to the Continental type, which, having no past to speak of, was able to adapt itself the more readily to the wants of those who did not care so much how they saw, so long as they could see.

The two types, starting from opposite poles, have lately reached common ground as regards the majority of the instruments produced, and there is little to choose between them for mere demonstration of known structure; but to get the finest results out of any optical system centration along the axis, and in the case of a microscopical system interchangeability of parts not only above but below the stage is essential, and few Continental microscopes possess the means of doing this, while every English stand of the first class is so provided.

Therefore the conclusion of any unbiassed observer must be that the English type is the better in the hands of the expert, who wishes not merely to demonstrate the known, but to reach out maybe into the unknown; but what is best for the master of his instrument and subject is not always good for the average man, and

[1] The first article appeared in NATURE of December 21, 1911.

there are minor details, such as the method of fixing the mirror, &c., in the Continental pattern which make them easier of use by those who merely look on the microscope as a tool; and this, combined with the greater handiness in the vertical position when wet preparations are under examination, makes the Continental type more acceptable to the laboratory worker.

Such, in the writer's opinion, are the differences between the two types considered from a general point of view. We can now draw nearer, as it were, and examine each type in detail; and, curiously enough, although the conclusion drawn above was that, for the laboratory worker at any rate, the Continental is the better type, on account of greater simplicity, &c., yet the Continentals, in their more costly instruments, are greater offenders as regards redundances than the English, the differences in the two types being not so much that one is practically perfect, while the other is not, but that the errors and superfluities in the Continental type are passive—that is to say, they are there, but need not be used, and if used unknowingly make very little difference; while the defects in the English type, if fewer, are more vital, in that the efficient working of the instrument is interfered with if they are not mastered.

Taking first the Continental type, most of the better instruments are fitted with a circular rotating and centring stage, the use of which for anything but petrology it is difficult to guess; the iris diaphragm, below the Abbe condenser, is also fitted with an excentric rotating movement, which will, of course, give oblique light in any azimuth, but as oblique light is altogether discredited, except for certain experimental and lens-testing purposes, it can scarcely be considered a useful adjunct to the average microscope. So much for redundances. The instruments with this type of substage usually possess a mirror which is fixed as to its centre, but which can be inclined in any position about that centre. This is as it should be, as when mounted in this way it is easier for the average worker to illuminate properly; but such mirrors are usually fixed, not on the tailpiece, but on the part that slides in the tailpiece groove, thus altering the position of the mirror when focussing the condenser, which, when using a small source of illumination, such as a lamp, is a disadvantage, but a very minor one, compared with the swing tailpiece on which the mirror is mounted in most of the cheaper forms of the Continental type, and practically all patterns of the English type. The one advantage of the swing tailpiece is, of course, that oblique light can be obtained by its aid, a very doubtful advantage, as indicated above, and far too dearly bought by adding an adjustment that invariably puzzles the average man, and leads to more bad microscopy than all the other faults of either type put together.

In the writer's opinion, it is the combination of the altogether undesirable swing tailpiece with the desirable (if understood) centring substage, that has caused the prejudice (for such it amounts to) in certain quarters against the English type.

The first should be done away with entirely; the second, except for instruments used for amateurs, with almost as many condensers as objectives, should also be conspicuous by its absence, the centring nosepiece, or objective changer, such as made by Zeiss or Leitz, being a much more practical method of centring for the laboratory worker, who almost invariably uses only one condenser.

A BIRD-BOOK FOR YOUNG PEOPLE.[1]

WITH the assistance of Mr. A. R. Horwood, of the Leicester Museum, who has written the first seventy-eight pages dealing with bird photography, collecting eggs and skins, mounting the latter, and nature-study generally, Mr. Westell has succeeded in producing a very readable little volume. It is also rendered more attractive by the photographic illustrations, many of which appear to be from nature, although others are obviously "faked." The author treats his subject from the point of view of environment, discussing in turn the birds of the garden, the lane, the field and meadow, the air, the woodland, the heath, moor and mountain, the riverside, and the coast. That such an arrangement has a certain advantage from the point of view of the collector is sufficiently obvious, and in the opinion of the author it does not apparently outweigh difficulties that arise from the systematic point of view.

As regards systematics, the author, with the aid of Mr. A. R. Thompson, gives, in the form of an appendix, a list of British birds brought, so far as possible, up to date, with their scientific names. This is based on one recently compiled by Mr. Ogilvie Grant, but with some modifications in the sequence of the orders, which, in our opinion, are no improvement, since, whatever may be popular views on the subject, British orders of birds ought undoubtedly to commence with the passerines and end with the game-birds. In the matter of generic and specific names it is satisfactory to find that the author takes a conservative course.

Wheatear and Nesting-hole under Rock. From "The Young Ornithologist."

It has, however, to be mentioned that the systematic list does not in all cases tally with the text. For instance, we find on p. 165 of the latter reference to one species of coal-tit, whereas two, the British and the Continental, are mentioned in the former, and it is accordingly a difficult matter for the young collector to identify which is described. That they are not really two species is immaterial. It may also be mentioned that no mention is made in either place of the Irish coal-tit, recently described by Mr. Grant. A word must also be said in regard to the index.

[1] "The Young Ornithologist: a Guide to the Haunts, Homes, and Habits of British Birds." By W. P. Westell. Pp. xv+311. (London: Methuen and Co., Ltd., 1911.) Price 5s.

We happened to want to see what the author had to say about the partridge, and naturally turned to the letter P, where no such name occurs. At last we find the bird, together with several other species, under the entry "Common," which, to say the least, is absurd. In fact, the prefix of "common" to *the* partridge is not required at all. R. L.

ADMIRALTY REORGANISATION.

THE official memoranda published by the First Lord of the Admiralty on January 8 are of great interest, but that relating to the Naval War Staff is of much greater importance than the other two. Mr. Churchill discusses at considerable, if not unnecessary, length the distinctions which he believes to exist between "naval and military problems," apparently considering it necessary to justify differences of organisation which will be found at the Admiralty and at the War Office when the new scheme has been developed. The First Lord is an able and forcible writer, who might be expected to state his case well, but it may be questioned if it would not have served his purpose better and have given a clearer understanding of the subject to the public if his memorandum on the Naval War Staff had been less diffuse. The fact is admitted by him that "during the course of years all or nearly all the elements of a War Staff at the Admiralty have been successively evolved in the working of everyday affairs." The edifice is now to be completed and crowned by combining "these elements into an harmonious and effective organisation." It is proposed "to invest the new body with a significance and influence which it has not hitherto possessed, and to place it in its proper relation to existing powers." This is obviously both wise and necessary action; but it is scarcely to be described as such a radical change as some persons have asserted.

In the current Navy Estimates provision is made for a Naval Intelligence Department and a Naval Mobilisation Department, each under a naval director (rear-admiral or captain), the former department including twenty-one naval officers and thirteen civilians, the latter six naval officers and four civilians. The total cost of these departments is about 22,000*l.* per annum. Both departments are placed under the First Sea Lord, and their duties are sufficiently indicated by their names. In the new scheme they will continue in existence, and a third section is to be added, to be known as the "Operations Division," and to be placed under a director. All three sections are to be combined together under a chief of the staff, who is to be "a flag officer, primarily responsible to the First Sea Lord, and working under him as his principal assistant and agent." "Constant, free, and informal intercourse between [the three sections] is indispensable"; and it is laid down that each of the directors is "to be kept fully acquainted with the work of their two colleagues."

All this is admirable, but the principles involved are in no sense novelties at the Admiralty; nor is it conceivable that the consideration of "war plans"—which is stated to be the special business of the new section—has not been practised at the Admiralty hitherto. Long-continued peace has tended to drive somewhat into the background the primary importance of a scientific study of operations and preparation of "plans of campaign," but it is well known that the great shipbuilding programmes which have been carried out during the last twenty-five years have been based—as they ought to have been—on strategical plans prepared by the Admiralty for the naval defence of the British Empire, its commerce and communications. While this is true, it is equally true that the enormous increase of the Royal Navy, the growth of rival war fleets, and the present complex conditions of naval warfare, have all emphasised the need for greater attention and closer study of the subject by competent persons. Consequently there can only be universal and hearty welcome of the endeavour now made to meet the pressing necessity by the development of an advisory War Staff at the Admiralty.

NOTES.

M. LIPPMANN has been elected president of the Paris Academy of Sciences for the present year, and Prof. Guyon vice-president.

THE Academy of Sciences of the Royal Institute of Bologna has awarded the Élie de Cyon prize of 3000 lire for 1911 to Prof. E. A. Schäfer, F.R.S., of Edinburgh, for his work on the ductless glands, and especially for his recent work on the pituitary body.

IT is proposed to establish in Dartmouth a permanent memorial to Thomas Newcomen, known for his work in connection with the steam engine, who was born in that town in 1663. A meeting of persons interested in the matter was held yesterday in the Dartmouth Guildhall. The Mayor of Dartmouth, Mr. Charles Peek, and Mr. T. F. Caston, the honorary secretary to the Newcomen Memorial Committee, will welcome suggestions as to the best manner of perpetuating the memory of the inventor and his invention, and be glad to receive contributions.

THE council of the Royal Sanitary Institute offers the Henry Saxon Snell prize for competition this year. The prize was founded to encourage improvements in the construction or adaptation of sanitary appliances, and is to be awarded by the council at intervals of three years, the funds being provided by the legacy left by the late Henry Saxon Snell. The prize will consist of fifty guineas and the silver medal of the institute, and is offered for an essay on "Suggestions for Improvements in the Ventilating, Lighting, Heating, and Water Supply Appliances and Fittings for an Operating Room and its Accessory Rooms for a General Hospital of 400 Beds (no Students)."

AN influential body of gentlemen interested in the preservation of our local antiquities has presented a memorial to the committee now engaged in considering schemes for the future utilisation of the Crystal Palace and its grounds, suggesting the establishment of a National Folk Museum. The nearest parallel to the proposed institution is the Northern Museum at Stockholm, with its offshoot the Open Air Museum at Skansen. The scheme suggests the erection in the Palace grounds of a series of typical ancient houses, each provided with appropriate gardens and furniture, and an open-air amphitheatre for pageants, folk-songs, and dances. Part of the main building of the Palace might, the memorialists suggest, be devoted to exhibits of domestic art products, toys and games, a folk-lore room, a museum relating to the Royal House, and other exhibits illustrating the origin and evolution of the various departments of national culture. Something of the kind has been attempted in the Pitt Rivers Museum at Oxford, and the educational value of the culture series arranged by Mr. H. Balfour supplies good evidence in support of the present proposals. The domestic appliances of past times are now disappearing so rapidly that unless active steps are taken at once it will soon be impossible to supply the exhibits needed for a folk museum such as that now suggested.

By the death of M. Radau on December 22, 1911, as already announced in these columns, France has lost a mathematical astronomer of real distinction. Born on January 22, 1835, at Angerburg, in Prussia, he was a student at Königsberg between 1854 and 1857. The following year he went to Paris, where he became naturalised, and passed the remainder of his life. For many years he acted as secretary to M. Brunetière on the staff of the *Revue des Deux Mondes*. At no time does he seem to have held an official post as a practical astronomer or as a teacher of astronomy. Yet he contributed a very large number of valuable memoirs, for the most part having a direct bearing on theoretical astronomy. Perhaps, as a result of his unofficial position, the greater number of these contributions are not of great length, but in spite of his early training all of them show a freshness of thought and an elegance characteristically French. Among them may be specially mentioned an essay on astronomical refraction, in which the effect of the humidity of the atmosphere is for the first time considered; a very important memoir on the planetary inequalities of the moon, the results of which have been confirmed by Dr. Cowell's analysis of the Greenwich observations (Annals of the Paris Observatory, 1889 and 1893); and memoirs on theoretical dynamics and on interpolation in the Annals of the École Normale and in Liouville's Journal. M. Radau was an editor of the *Bulletin Astronomique* from its inception in 1884, and contributed many elegant notes to its pages. He was also a prolific writer of popular articles, for which he had a marked gift. M. Radau succeeded Tisserand as a member of the Institute in 1897; he was a member of the Bureau des Longitudes, and he was elected an associate of the Royal Astronomical Society so lately as 1905.

Dr. Sophia Jex-Blake, one of the pioneers of the medical education of women, has just died, in her seventy-second year, at her home in Sussex. Dr. Jex-Blake was the youngest daughter of Thomas Jex-Blake, Proctor of Doctors Commons, and was born at Hastings in 1840, where her childhood was passed. As a girl she desired to spend her life in educational work, and at the age of eighteen filled the post of mathematical tutor at Queen's College, London, a post she held for three years. At this time she decided to travel in order to study different methods of education. Whilst in America for this purpose she met Dr. Elizabeth Blackwell, and being impressed with the interest of medicine as a career for women, and the need for medical women to attend those women who desired treatment by one of their own sex, she began to study medicine in Boston, U.S.A. Miss Jex-Blake returned to England in 1868, and finding it impossible to get teaching in London, she and four other women who had joined her went to Edinburgh, where, after some difficulty, certain classes were opened to them for study, but they were debarred from presenting themselves for any qualifying examinations. After much time had been spent and money lost in litigation, though many warm friends had been made, Dr. Jex-Blake came to London, where she soon gathered together a band of sympathisers, among whom were Mr. Garrett Anderson, the late Sir William Broadbent, Prof. Burdon Sanderson, and others, and the London School of Medicine for Women was formed. The school was opened in 1874 with fourteen students, but it was not until 1877 that a qualification could be obtained, when, thanks to the Kings and Queens College of Physicians, now the Royal College of Physicians, Ireland, their examinations were thrown open to women, and qualification and registration were at last able to be obtained. Dr. Jex-Blake subsequently returned to Edinburgh, where she practised for twenty-one years. During that time she opened a dispensary for women and children and a cottage hospital, and in 1886 founded a School of Medicine for Women, which in 1894 was recognised by the University of Edinburgh for the purposes of graduation. For the past twelve years Dr. Jex-Blake lived at her country home in Sussex, where she took great interest in her fruit and flowers. She will always be remembered by those who knew her personally for her charm of voice and her powers of organisation.

Dr. W. B. Kemshead, who died at the Charterhouse on January 3, at eighty years of age, was for a number of years science master at Dulwich College. He devoted much of his time to scientific research, and for some years endeavoured to produce a metal which would resist corrosion, for use in the manufacture of miners' lamps.

On Tuesday next, January 16, Prof. W. Bateson will begin a course of six lectures at the Royal Institution on "The Study of Genetics"; on Thursday, January 18, Prof. A. W. Bickerton will begin a course of two lectures on "The New Astronomy"; and on Saturday, January 20, the Rev. John Roscoe will commence a course of two lectures on "The Banyoro: a Pastoral People of Uganda" —(1) "The Milk Customs"; (2) "Birth and Death Customs." The Friday evening discourse on January 19 will be delivered by Sir James Dewar on "Heat Problems," and on January 26 by Prof. Bertram Hopkinson on "The Pressure of a Blow."

The following awards of medals and premiums, December, 1911, have been made by the Institution of Mining and Metallurgy, and will be presented at the annual meeting in March:—Gold medal of the institution (two awards): (*a*) to Mr. E. P. Mathewson, Arizona, U.S.A., in recognition of his eminent services in the advancement of metallurgy generally, and especially in regard to copper; (*b*) to Mr. Walter McDermott, in recognition of his special services in the equipment of the Bessemer Laboratory of the Royal School of Mines, and as the representative of the institution on the board of governors of the Imperial College of Science and Technology during the period of its establishment and organisation, and to signalise his services in the advancement of metallurgical practice. "The Consolidated Gold Fields of South Africa, Ltd.," gold medal to Mr. Walford R. Dowling, for his paper on the amalgamation of gold in banket ore. "The Consolidated Gold Fields of South Africa, Ltd.," premium of forty guineas to Mr. A. M. Finlayson, for his paper on secondary enrichment in the copper deposits of Huelva, Spain. "William Frecheville" students' prize of ten guineas to Mr. F. Percy Rolfe, for his paper on shrinkage stoping in Western Australia. "Arthur Claudet" students' prize of ten guineas to Mr. Arthur C. Hoare, for his paper on the roasting of complex ores in gold assaying.

The seventeenth International Medical Congress is to be held in London from August 6 to August 12, 1913, inclusive. We learn from *The Lancet* that the King has given his patronage, and it is expected that a detailed programme will be issued not later than September 30 next. The officers of the congress are as follows:—*President*, Sir Thomas Barlow, F.R.S.; *vice-presidents*, Sir W. S. Church, Bt., K.C.B., Sir Jonathan Hutchinson, F.R.S., Lord Lister, O.M., F.R.S., Prof. James Little, Sir R. Douglas Powell, Bt., K.C.V.O., Sir Frederick Treves, Bt., G.C.V.O., Sir William Turner, K.C.B., F.R.S., and Sir Hermann Weber; *treasurers*, Sir Dyce Duckworth, Bt., and Mr. G. H. Makins, C.B.; *chairman* *of executive committee*, Sir Alfred Pearce Gould, K.C.V.O.; *honorary general secretary*, Dr. W. P. Herringham. The presidents of sections are as follows:—(i) Anatomy and embryology, Prof. Arthur Thomson. (ii) Physiology, Prof. E. A. Schäfer, F.R.S. (iii) General pathology and pathological anatomy, Mr. S. G. Shattock; Subsection, chemical pathology, Dr. F. Gowland Hopkins, F.R.S. (iv) Bacteriology and immunity, Prof. G. Sims Woodhead. (v) Therapeutics (pharmacology, physiotherapy, balneology), Sir Lauder Brunton, Bt., F.R.S. (vi) Medicine, Sir William Osler, Bt., F.R.S. (vii) Surgery, Sir William Watson Cheyne, Bt., C.B., F.R.S.; Subsection A, orthopædics, Mr. Robert Jones; Subsection B, anæsthesia, general and local, Dr. Dudley W. Buxton. (viii) Obstetrics and gynæcology, Sir Francis H. Champneys, Bt. (ix) Ophthalmology, Sir Henry Swanzy. (x) Diseases of children, Dr. Eustace Smith. (xi) Neuropathology, Sir David Ferrier, F.R.S. (xii) Psychiatry, Sir James Crichton-Browne, F.R.S. (xiii) Dermatology and syphilography, Sir Malcolm Morris, K.C.V.O. (xiv) Urology, Prof. E. Hurry Fenwick. (xv) Rhinology and laryngology, Prof. St. Clair Thomson. (xvi) Otology, Mr. Arthur Cheatle. (xvii) Stomatology, Mr. Morton A. Smale. (xviii) Hygiene and preventive medicine, Dr. Arthur Newsholme. (xix) Forensic medicine, Prof. Harvey Littlejohn. (xx) Naval and military medicine, Sir James Porter, Bt., K.C.B. (xxi) Tropical medicine, Sir David Bruce, C.B., F.R.S. (xxii) Radiology, Sir J. Mackenzie Davidson.

To the current issue of *The Popular Science Monthly* Prof. W. E. Ritter, scientific director of the San Diego Marine Biological Station, contributes an article dealing with the duties to the public of research institutes in pure science. He urges that an institution of pure science should be one the primary aim of which is to extend the bounds of man's knowledge of nature in a specified field, and to show something of the significance of the new knowledge for the higher life of mankind. Not only, he insists, must research institutes add to knowledge, but they must show "in language comprehensible to the generally but non-technically educated members of the community something of the meaning of this knowledge for human beings in both the physical and the spiritual aspects of their natures." Prof. Ritter's view is that research institutions, as institutions, ought to hold themselves obliged, from time to time, to give out in a form readily accessible to and comprehensible by the rank and file the results of their most significant achievements. So far as work accomplished in biology is concerned, this popular instruction, it is urged, should be given by professed biologists constantly occupied with the first-hand gathering of data, with the making and testing of hypotheses, and with the submitting of results to fellow-workers for criticism and verification.

IN "A First Study of Inheritance in Epilepsy" (Eugenics Record Office, Bulletin No. 4, Cold Spring Harbor, N.Y., November, 1911) Prof. Davenport and Dr. David Weeks discuss an important collection of material bearing on this point. The data consist of the pedigrees of inmates of the New Jersey State Village for Epileptics at Skillman, N.J., obtained at the cost of much care and labour by visiting the homes of the patients and interviewing their parents or other relatives and physicians. The authors conclude that epilepsy and feeble-mindedness behave as Mendelian recessive characters, and state: "it appears, consequently, that when both parents are epileptic, both feeble-minded, or one epileptic and the other feeble-minded, all the offspring will be either epileptic or feeble-minded." We note, however, that in a table facing the page on which this statement is made a mating is recorded in which the two children of a feeble-minded father and an epileptic mother are both normal. Another conclusion is worthy of special reference, namely, that "provided marriage matings continue as at present and no additional restraint is imposed, the proportion of epileptics in New Jersey would double every thirty years."

To the Journal of the Ipswich Field Club for October, 1911, Mr. Alfred Bell contributes an article on the zones of the East Anglian Crags, in the course of which a number of the molluscs are described as new. The Coralline Crag is divided into a Gedgravian and a Boytonian zone, of which the latter forms a transition into the overlying Waltonian of the Red Crag. Lists of the faunas of the Boytonian zone and of the so-called box-stones are given. The author disputes the opinion that the majority of the mammalian remains are older than the Crag itself, but considers that the cetacean remains, more especially those of beaked whales, form an exception in this respect. It is difficult to see the force of this, as all the Crag cetaceans are essentially of a modern type.

WHEN the modern type of shorthorn cattle was produced by careful crossing and selection, no attention was paid to the superficial character of colour, so that in this respect the breed is mongrel, and in consequence it is a general belief that the colour of the progeny of any particular pair cannot be predicted with anything approaching certainty. Consequently, the inheritance of coat-colour among shorthorns forms a problem of great difficulty. It has, however, been taken up by Mr. H. H. Laughlin, of the Carnegie Experimental Evolution Station at Cold Spring Harbour, and the results of his investigations are published in *The American Naturalist* for December, 1911 (vol. xlv., p. 405). These are so complex that it is impossible to give a summary within the limits of our space, although it may be noted that when white shorthorns are crossed with white park-cattle the calves are invariably white. This indicates that the white of park-cattle—although by no means all white—is dominant, park-cattle having, it is believed, formed part of the stock from which the modern shorthorn was evolved.

THE extermination of the big-game fauna of German East Africa forms the leading theme in *Naturwissenschaftliche Wochenschrift* for December 17, 1911, Prof. Fritz Behn, who has recently returned from a journey in that province, devoting the whole of a long article to this subject, and Prof. C. G. Schillings supporting his arguments from his own experience. The subject is also touched upon in a third article, by Dr. F. Doflein, on sport and science in the German colonies, where emphasis is laid on the remarkable fact that the prolonged British occupation of India has not resulted in the extermination of a single indigenous species of animal. The rapidity with which the big-game fauna of German East Africa is being wiped out presents a marked contrast to the conditions obtaining in the adjacent British Protectorate, where the establishment of game-reserves, the restrictions in regard to the number of animals shot by sportsmen, and the prohibition of the export of undersized ivory, horns, and skins work wonders. In the German Protectorate the work of destruction is mainly carried on by Boers and professional hunters, and not by the casual sportsman. Unless steps are taken promptly to check the slaughter, there will ere long be no game to protect.

From the report of the Department of Agriculture for the Nyasaland Protectorate, it appears that the export of cotton, which in 1903 was valued at only 3*l*., rose in 1909–10 to 26,209*l*., and during the past season to 58,687*l*. The area under crop during the present season is 23,314 acres. This excellent result reflects great credit alike on the planters and on the Agricultural Department; but it is considered not to exhaust the possibilities, but only as an indication of what Nyasaland can do. Selection experiments with Nyasaland upland cotton have been carried out with good results, and some crossing has been done, although this method is now given up. The export of rubber also doubled and is likely to increase considerably in the near future, as the estate rubber is now approaching the age for tapping. Tobacco is proving a useful crop, while maize, coffee, and tea are grown to advantage. The velvet bean (*Mecuna Lyonii*) has been introduced by the department for green manuring purposes.

Although the botany of the Sikkim Himalayas is generally well known, since many botanists have added to the historic explorations of Sir Joseph Hooker, the remote Zemu and Llonakh valleys, in the north-west, are very inaccessible except by an expedition specially arranged at a favourable season, as described by Messrs. W. W. Smith and G. H. Cave, two officials of the Calcutta Botanic Gardens. Their account, published in the Records of the Botanical Survey of India (vol. iv., No. 5), furnishes some indication of the difficulties encountered, including the penetration of the Rhododendron jungle, composed of *R. Whitii*, *R. campanulatum*, and *R. Hodgsoni*, at an elevation of 10,000 feet. The Zemu valley presents a transition from the moist, prolific area in the south to the dry area of Tibetan Sikkim. It resembles the drier aspect of the Llonakh valley, which shows affinities in vegetation with Tibet, in the lack of epiphytic ferns and cryptogams. A survey of the alpine region points to the dominance of the genera Arenaria, Potentilla, Saxifraga, Saussurea, Rhododendron, Primula, and Pedicularis. Under Saxifraga thirty-four species are recognised, including a new crustaceous form resembling a Sedum.

A recent number of the *Bollettino* of the Italian Seismological Society contains an account of an interesting meeting of the society held at Rocca di Papa on August 30, 1910, to honour the memory of the late Prof. M. S. de Rossi, the pioneer of seismological studies in Italy. The memorial consists of a stone placed in the front of the Observatory of Rocca di Papa stating that in this his house Michele Stefano de Rossi first in Italy made systematic observations on terrestrial dynamism and published very valuable statistical data. The observations were carried on from 1874 until de Rossi's death in 1898, and are recorded in his well-known works the "Meteorologia Endogena" and the seventeen volumes of the *Bollettino del Vulcanismo Italiano*.

The history of the numerous attempts that have been made to predict the occurrence of earthquakes is summarised in an interesting paper by Mr. G. Martinelli (*Boll. Sismol. Soc. Ital.*, vol. xv., 1911, pp. 154–90). An account is given of many phenomena which were generally supposed to precede earthquakes, such as various states of the weather, the physiological condition of observers, the position of the greater planets, and the occurrence of microseismic storms. Although we are still very far from the solution of the problem, Mr. Martinelli indicates two lines of research which may ultimately lead us in the right direction—the study of electromagnetic phenomena and of the gradual deformation of the earth's crust. Of the two methods, he considers, and no doubt rightly, that the latter is the more promising, for it is connected with the movements which are now known to be the chief cause of earthquakes.

We have received copies of the tide tables for the eastern coasts and for the Pacific Coast of Canada for the year 1912, which are published by the Tidal and Current Survey of the Dominion of Canada. Longer series of observations are available for the eastern coast, but it is estimated that for at least three ports on the Pacific Coast—Sand Heads, Vancouver, and Port Simpson—the tables are now superior to those for any other port on the Pacific coasts.

A scientific expedition left Trieste at the end of October, 1911, under Dr. L. Brühl, of the Institut für Meereskunde of Berlin, for the Dead Sea and the Jordan Valley, in order to study the chemical, physical, and biological problems which this region presents, so as to extend and complete the earlier work in these directions which was done by the expeditions of Lynch in 1848 and of the Duc de Luynes in 1864. According to *Petermann's Mitteilungen*, the expedition will probably return about the end of January.

In the October (1911) number of *La Géographie* Dr. H. Hubert discusses the thunderstorms which occur so frequently in the southern portions of the western Sudan, and furnish the larger part of its annual rainfall. He recognises two principal directions of air currents: one from the north-east, which blows persistently during the dry season, and even during the summer rainy season still prevails at an altitude of about 2000 metres; and another, the south-westerly monsoon current, which blows as a light, moist surface wind, ranging up to about 1000 metres in the summer months. A few observations are quoted to indicate the directions of the upper and lower air currents during the passage of a thunderstorm, and the general direction of their movement is given as being from east-south-east to west-north-west, with a velocity of translation of about 60 kilometres per hour. Rain due to such thunderstorms will be recorded by travellers as coming from the east, though the ordinary rains of the wet season accompany the southerly and south-westerly current of the monsoon.

We have recently received from the Australian Central Weather Bureau a report by Mr. F. A. Hunt of his visit to Europe, Asia, and North America, undertaken by direction of the Commonwealth Government for the purpose of "discussing with other meteorologists the most modern methods of organisation and equipment." Mr. Hunt left Australia in July, 1908, and returned in March, 1909; and although three years have elapsed since some of the places were visited, and changes (especially in this country) have taken place, the reports of the various services contain much useful information and are convenient for reference. Those relating to Canada and India are very full. We are glad to see that the various proposals made by Mr. Hunt and by the Melbourne conference (held in May, 1907) have been generally approved by the Commonwealth Department for Home Affairs.

The meteorological charts issued for the various oceans by the Weather Services of the United States, Germany, and this country for December, 1911, include interesting and useful data. The U.S. Bureau has issued separately a useful "Marine Calendar" summarising the monthly weather conditions in the North and South Atlantic Oceans. The interesting synoptic charts showing the weather in the North Atlantic for December 7–13, 1911, prepared by the Meteorological Office, explain the very unsettled weather over this country and western Europe. While on the American side of the Atlantic the distribution of pressure was anticyclonic, and the weather for the most part fair and quiet, the weather over the eastern half of the ocean remained in an exceedingly disturbed state. A summary given of the Arctic weather in the summer of 1911 from the log of the whaler *Diana* is of interest. The ship passed Cape Wrath outwards on April 24, and again homewards on November 1; she reached lat. 75° 28′, long. 75° 19′ W., on July 18. Fog was included in 25 per cent., and snow in about 20 per cent., of the weather observations. The lowest temperature recorded was 23°, on May 22. Gales were experienced in each month, especially in May and October. The north-west storm of October 30, in about 59° N., 10° W., was little short of a West India hurricane.

ACCORDING to the December (1911) number of *The Illuminating Engineer* of New York, the American illuminating engineer, after devoting his attention in the past mainly to mechanical efficiency, is now in a position to consider looks, and the question of attractive design will play a prominent part in his business in the near future. He appears to feel acutely the monopoly in electric lamps held by the National Electric Lamp Co. The relations between the gas and electric companies seem to be as strained in America as they are in this country. At the recent annual Convention of the National Commercial Gas Association there were papers read which, on the one hand, treated gas lighting as a decaying industry, and on the other claimed for it a position of recognised superiority. With such extreme statements possible, it does not appear that the question is any nearer settlement in America than it is here. The present tendency to use as the source of light a tungsten filament or an incandescent mantle, neither of which can with comfort be viewed directly, and to place them in situations in which they are not themselves visible, may lead to more trustworthy statements as to their relative merits.

IN the Proceedings of the Royal Academy of Sciences of Amsterdam (November 22, 1911, p. 370) Dr. Th. Weevers describes the isolation from the spadix of *Sauromatum venosum*, Schott., by pressing out and precipitating the press-juice with alcohol or acetone, an enzyme which decomposes dextrose with formation of carbonic and organic acids, but without any production of alcohol. The decomposition occurs equally well in an atmosphere of either air or hydrogen. The action of the enzyme is in some respects, especially as regards the formation of acids, reminiscent of that of certain fungi and of the nocturnal production of acids by Crassulaceæ. The acid formed is non-volatile with steam, and is therefore not formic, acetic, propionic, or a higher fatty acid; judging by microchemical tests, citric acid is formed, and in one instance malic acid was detected. Other acids may perhaps be present, but lactic and tartaric acids are apparently not formed. The same enzyme, but weaker in action, was isolated from the leaves of the same plant. It is noteworthy that, contrary to what appears to be the case with other respiratory enzymes, alcohol and acetone do not destroy its action, so that there is little, if any, loss of activity on precipitation of the aqueous extracts with these solvents.

The Scientific American for December 9, 1911, is a special naval number containing many articles by chief officials connected with the United States Navy. Dealing with the question of ammunition, we note that Rear-Admiral N. C. Twining, Chief of the Bureau of Ordnance, states that nitro-cellulose smokeless powder continues to be the standard propellant. He claims for this powder that it is extremely satisfactory in stability, ballistic characteristics, and keeping qualities, and that there is no better smokeless powder in the world. The powder consists essentially of cotton dissolved in nitric acid, then dried, colloided, and pressed into the desired form of grain. When not unfavourably affected by climatic and other adverse conditions, the powders retain their qualities for from twelve to fifteen years. In case deterioration occurs, due to such conditions, ample warning is given by the physical appearance of the powder, so that no spontaneous explosion or combustion is ever to be apprehended; it is, in fact, extremely doubtful whether spontaneous combustion is possible, unless the powder should be subjected to abnormally high temperatures. Powder which has changed in character to such an extent as to reduce its ballistic value is now reworked and made over into new powder.

DEALING with failure of buildings caused by the drought of last summer, an article in *The Builder* for January 5 says that it is impossible to estimate the enormous damage to buildings throughout the country produced by such weather conditions as have been experienced. Suburban London has suffered to a remarkable degree. In many districts where the foundations rest upon clay buildings by the hundred have needed underpinning. Clay retains a considerable amount of water in its structure, and even at the height of an ordinary summer is found to be quite moist at a depth of from 2·5 to 3 feet from the surface. Last year, however, the moisture evaporated to a much greater depth, and the clay was often found to be perfectly dry at depths of 5 and 6 feet. The consequent shrinkage in bulk led to settlements in the buildings above. Again, clay when dry tends to fall to powder, and the early autumn rain, instead of percolating gradually through the soil, finds its way into the fissures and washes the powdered clay out of its place. Sliding or lateral movement is likely to occur where a part only of the soil is wet, the remaining parts being still quite dry. The stability of a structure depends not so much upon whether the clay is moist or dry as upon the condition, whichever it be, remaining unaltered. The consideration of the action of the weather upon the clay emphasises the importance of obtaining a depth of foundation sufficient to reach below the point affected by sun and rain, and, further, of carrying all foundations to a uniform depth. The writer of the article, in dealing with more than seventy cases of failure last autumn, found only two or three cases of fractures occurring where the foundations were at a uniform depth. The explanation is that uniform depth of foundation is more likely to secure even settlement of the structure.

THE presidential address to the Dumfriesshire and Galloway Natural History and Antiquarian Society, delivered by Mr. Hugh S. Gladstone on October 20 last, consisted of addenda and corrigenda to his volume "The Birds of Dumfriesshire," which was reviewed in these columns on January 19 of last year (vol. lxxxv., p. 378). The council of the Dumfries society has published the address in pamphlet form, and this will prove a valuable adjunct to Mr. Gladstone's book.

MESSRS. J. AND A. CHURCHILL announce the following works for early publication:—"Diseases of the Stomach," by Prof. C. D. Aaron; "Who's Who in Science, 1912," edited by H. H. Stephenson; "Annual Tables of Constants and Numerical Data," issued under the authority of the International Congress of Applied Chemistry. The tables are intended to contain all the numerical data likely to be of interest in connection with chemistry, physics, and allied sciences, pure and applied, to be found in the literature published during the previous year.

OUR ASTRONOMICAL COLUMN.

OBSERVATIONS OF COMETS 1911*c*, 1911*e*, 1911*f*, AND 1911*g*.—In No. 4544 of the *Astronomische Nachrichten* Dr. Bemporad discusses at length the photometric observations of Brooks's comet (1911*c*), made at the Catania Observatory during the period August 14 to November 28, 1911. The greatest apparent brightness was recorded on October 23, when the comet was about as bright as a 3·5 magnitude star. On a chart accompanying the paper he plots the curves $i=k/r^2\Delta^2$ and $i=k/r^4\Delta^2$ with the curve of observed magnitudes, and this shows that the comet became brighter even than the value given by the latter formula. A fourth curve, on which the intensities reduced to $\Delta=1$ are shown, indicates that the rise of intensity near perihelion was very steep, the magnitude rising from 9·5 on October 12 to 4·8 at perihelion.

As an abstract from *Hemel en Dampkring* (October, 1911), Prof. Nijland sends us an account of the Utrecht observations of comets 1911*c*, 1911*f*, and 1911*g*. A drawing of Beljawsky's comet (1911*g*), made on October 1, 1911, shows the head quite near to ι Leonis, with the tail extending nearly to η Leonis, while an enlarged drawing of the head shows two dense streamers flowing as a parabolic envelope from the head.

The Algiers observations, made by MM. Rambaud and Villatte, of Borrelly's comet (1911*e*) are reported in No. 4544 of the *Astronomische Nachrichten*. On October 27, 1911, the comet was observed as a round nebulosity 45″ in diameter, with a brilliant nucleus of magnitude 10·5.

A BRILLIANT METEOR.—A meteor of extraordinary brilliancy was observed at South Kensington by Mr. W. Moss at 5h. 10m. on December 22, 1911. Starting from a point near ϵ Persei, the object moved very quickly, passing above Mars and Saturn to a point $\alpha=35°$, $\delta=+12°$. The latter part of the path was distinctly wavy, and the meteor was at least as bright as Mars, and left a slight trail.

NICKEL-ON-GLASS REFLECTORS.—As is well known to anyone who has done any photographic work in the ultraviolet, silver reflects scarcely any light in the neighbourhood of λ 3160, therefore, for this special region, a silver-on-glass mirror is practically useless as a reflector. To overcome this difficulty, primarily in his experiments on the ultra-violet photography of the moon, Prof. R. W. Wood carried out some trials, during his last summer vacation, in which he endeavoured to replace the silver film on a figured glass disc by some other metal capable of reflecting light throughout the whole range of the spectrum; the production of large mirrors of speculum is too difficult for ordinary work.

Consulting Rubens's tables, he found that nickel was probably the most suitable metal, and after numerous experiments he succeeded in depositing, electrolytically, a film of nickel on a previously silvered, figured disc. The method of doing this and the results obtained are described in an interesting paper which Prof. Wood publishes in No. 5, vol. xxxiv., of *The Astrophysical Journal*. To illustrate the various reflecting powers of glass, silver, nickel, and speculum, he photographed, through a quartz lens, a mirror partly covered by Ag, partly by Ni, and partly left bare, alongside a piece of polished speculum. With blue and violet rays passing through the lens the order (increasing) of reflecting power was glass, Ni, Ag, speculum, but when the quartz lens was heavily coated with silver, thus allowing only the ultra-violet rays to pass through it, the silver was found to reflect as little as the bare glass, and came out nearly black, while the nickel surface was almost as bright as the speculum surface on the resulting photograph. Incidentally, Prof. Wood points out that such ultra-violet photography as that which he has applied to the moon may prove exceedingly useful in other branches of science. For example, some white substances come out quite black (*e.g.* zinc oxide), and white flowers show very different reflecting powers; common phlox comes out quite black, while white geraniums are much lighter.

ALMANACS FOR 1912.—From the Observatory of Madrid we have received a copy of the official *Anuario* (525 pages) for 1912, which, in addition to the usual astronomical and meteorological tables, contains special articles dealing with the observations of comets, the solar eclipse of April 17, the spectroheliograph of the Madrid Observatory, and the solar and meteorological observations made in 1910. From the discussion of the various data, the writer of the article on the April eclipse suggests that possibly a totality of three or four seconds will occur in Spain and Portugal, and mentions three favourable stations, viz. Cacabelos, Barco de Valdeorras, and Verin.

The *Annuaire Astronomique* for 1912, published by M. Flammarion, is of the usual form, and, being published later than usual (December, 1911), contains in the annual *revue* of astronomy some very interesting notes and comments on recent solar, planetary, and cometary observations.

The "Companion to the Observatory" is too well known to need any description here, and should, of course, be in the observatory of every British astronomer. This year's issue resembles that of other years, and may be obtained from Messrs. Taylor and Francis at the price of 1*s*. 6*d*.

THE PALISA-WOLF STAR CHARTS.—The fifth series of the star charts prepared by Drs. Palisa and Wolf is now ready, and until April 1 a set may be obtained for 30 marks; after that date the price will be 40 marks.

WEATHER IN 1911.

FROM a meteorological point of view, the year which has just closed was of considerable interest. The feature which stands out beyond all others is the abnormal summer, during which both the temperature and sunshine have established a record, whilst the rainfall was also exceptional. After the heat and brilliancy of the summer, the exceptionally heavy rains of the late autumn and early winter are probably of next importance, although in many parts of England rain was sorely needed.

Taking the country as a whole, the mean temperature for the year was everywhere in excess of the average, and in England, where the excess was greatest, the difference amounted to fully 2°. The rainfall was deficient over the entire kingdom, except in the south-east of England and the Channel Islands, the deficiency in the English Midlands, where the summer drought was keenly felt, amounting to 4·20 inches, the aggregate rainfall being only 84 per cent. of the average. The duration of bright sunshine was everywhere largely in excess of the average, the excess amounting to 336 hours in the south-east of England, and the duration was 121 per cent. of the normal.

The Greenwich observations, which may fairly be taken to represent England, show that the mean temperature for the year was 52°, which is 2° above the average. The warmest month was August, with the mean temperature 69°, which is 6° above the average, and was the warmest August since 1841. The temperature was in excess of the average every day throughout the month, and on August 9 the sheltered thermometer registered 100°, which is the highest reading as yet recorded in any part of the British Isles. The mean temperature in July was 68°, which is 4·5° above the average, and there have only been two Julys warmer in the last seventy years. The first twelve days of September were also the warmest on record. The mean temperature was in excess of the average in every month, with the exception of January and April. The thermometer was continuously above the average for sixty days from July 11 to September 13, and there were in all 224 warm days during the year. The lowest temperature was 22°, in February, and frost occurred on thirty-three days. Two of the coldest days on record for April occurred on April 5 and 6, and on May 22 the radiation temperature fell to 25°.

The aggregate rainfall for the year was 23·67 inches, which is 0·46 inch less than the average. The rainfall was above the normal in six months and below in six months. The wettest month was December, with 3·99 inches, which is 2·16 inches more than the average, and in both October and November the rainfall exceeded 3 inches. The total for the three closing months of the year was 10·71 inches, which is 45 per cent. of the fall for the year. The driest month was July, when the total measurement was 0·26 inch, and rain only fell on three days during the month. The aggregate summer rainfall, for June, July, and

August, was 3·72 inches, which has only been smaller in three previous summers since 1841. There were during the summer two periods of absolute drought—twenty-three days from July 1 to 23, and seventeen days from August 2 to 18. Rain fell on 156 days during the year; December had twenty-three wet days and November twenty.

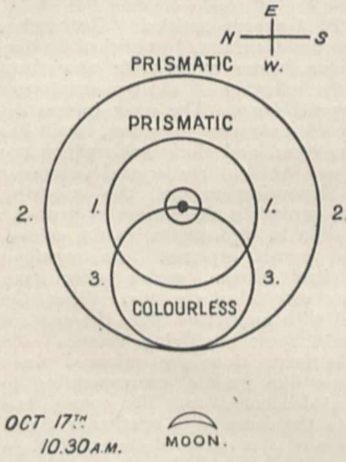
In the Ebbw Vale Sir Alexander Binnie measured 29·23 inches of rain from October 18 to December 31, and during the whole of this period there were only nine days without rain.

The duration of bright sunshine at Greenwich was 1780 hours, which is 425 hours in excess of the average of the past thirty years, and is the brightest year on record since 1881; the next brightest year was 1906, with 1735 hours. July had 335 hours' sunshine, which is the sunniest month since the establishment of sunshine records in 1881. The duration of sunshine was in excess of the average in each month, with the exception of January and March.

CHARLES HARDING.

OBSERVATION OF SOLAR HALOS IN AFRICA.

AN optical phenomenon is reported by a correspondent from Elobey Island, lat. 1° N., long. 9° 30′ E., in the Gulf of Guinea. On October 11, 1911, between 1 and 2 p.m., he observed "a large light, of different colours as the rainbow, encircling the sun, and at times only visible on the east side and sometimes only on the west of the sun, and at 2 p.m., our time, disappeared altogether." During this time the sky was covered with swiftly passing small clouds, and shortly after the disappearance of the phenomenon heavy rains began to fall. Without information as to the angular diameter of the ring or the order of the colours it is not possible to say with certainty whether it was a halo or a corona, but its appearance with low clouds makes it probable that the phenomenon was a corona. The corona sometimes appears round the sun when it shines through thin cloud or mist. It is coloured, red being outermost, and several successive sets of coloured rings are usually formed. They are due to the diffraction which the light undergoes in passing among drops of which the cloud is composed. The radius of the first ring of the corona varies from 1° to 3°, according to the size of the drops, and radii of the others are successive multiples of that of the first. As the drops of water in the mist or cloud become larger the rings grow smaller. Their diminution consequently implies approaching rain.



Six days after the observation at Elobey Island, on October 17, the combination of halos shown in the diagram was observed by Mr. J. G. Orchardson at Kericho, in British East Africa. The halos 1 and 2 are probably the two of most common occurrence, with radii of about 22° and 46° respectively. The altitude of the sun at the time of the occurrence was presumably about 65°–70°, and for this altitude the horizontal circle through the sun, on which mock suns are usually found, would just touch the larger halo and appear to have its centre on the smaller halo. This ring would be produced by reflection at the vertical faces of ice crystals in the higher atmosphere. It seems most likely that this is the origin of ring No. 3. If, however, the circle had been parallel with the horizon, it is probable that the fact would have been mentioned by the observer. The other possibility is that the circle was a secondary halo formed about a mock sun in the same way as the 22° halo is formed about the sun itself. Such secondary haloes are very rare. The position of the mock sun which could produce one in the present case would be at the point where the vertical through the sun met the halo of 22° either at the zenith or half way between the horizon and the zenith. In the former case the secondary halo and the mock sun ring would coincide.

PRIZES PROPOSED BY THE PARIS ACADEMY OF SCIENCES FOR 1913.

GEOMETRY.—The Francœur prize (1000 francs), for discoveries or works useful to the progress of pure or applied mathematics; the Bordin prize (3000 francs), for improving in some important point the arithmetical theory of non-quadratic forms.

Mechanics.—A Montyon prize (700 francs), for inventing or improving instruments useful in agriculture or the mechanical arts or sciences; the Poncelet prize (2000 francs), for a work on applied mathematics.

Navigation.—The extraordinary prize of 6000 francs, for a work increasing the efficiency of the French Navy; the Plumey prize (4000 francs), for improvements in steam engines or any other invention contributing to the progress of steam navigation.

Astronomy.—The Pierre Guzman prize (100,000 francs), for the discovery of a means of communicating with a star other than the planet Mars; the Lalande prize (540 francs), for the most interesting observation, memoir, or work contributing to the progress of astronomy; the Valz prize (460 francs), for the most interesting astronomical observation made during the year; the G. de Pontécoulant prize (700 francs).

Geography.—The Tchihatchef prize (3000 francs), for the encouragement of explorers of the lesser known parts of Asia; the Gay prize (1500 francs), for a study of the reptiles of warm countries, especially the reptiles of Mexico.

Physics.—The Hébert prize (1000 francs), for the best treatise or most useful discovery for the practical application of electricity; the Hughes prize (2500 francs), for discoveries or works contributing to the progress of physics; the Gaston Planté prize (3000 francs), for an important discovery or invention in the field of electricity; the Kastner-Boursault prize (2000 francs), to the author of the best work on the various applications of electricity in the arts, industry, and commerce.

Chemistry.—The Jecker prize (10,000 francs), for works contributing to the progress of organic chemistry; the Cahours prize (3000 francs), for interesting researches in chemistry; a Montyon prize (unhealthy trades; a prize of 2500 francs and a mention of 1500 francs), for the discovery of a means of ameliorating an unhealthy trade or occupation; the Vaillant prize (4000 francs), for the discovery of a photographic layer without visible grain and as sensitive as the gelatino-bromide now used.

Mineralogy and Geology.—The Victor Raulin prize (1500 francs), for assisting the publication of works relating to geology and palæontology; the Delesse prize (1400 francs), to the author, French or foreign, of a work on geological or mineralogical science; the Joseph Labbé prize (1000 francs), for geological works or researches putting in evidence the mineral riches of France, its colonies or protectorates.

Botany.—The Desmazières prize (1600 francs), for the best work published during the year on Cryptogams; the Montagne prize (1500 francs), for works on the anatomy, physiology, development, and description of the lower Cryptogams; the de Coincy prize (900 francs), for a work on Phanerogams; the grand prize of the physical sciences (3000 francs), for the geographical study of the flora of French western Africa; the Thore prize (200 francs), for the best work on the cellular Cryptogams of Europe; the de la Fons-Mélicocq prize (900 francs), for the best work on the botany of the north of France.

Rural Economy.—The Bigot de Morogues prize (1700 francs), for a work contributing to the progress of agriculture in France.

Anatomy and Zoology.—The Savigny prize (1500 francs), for the assistance of young travelling naturalists, not receiving Government assistance, who specially work on the invertebrates of Egypt and Syria; the Cuvier prize

(1500 francs), for a work on zoological palæontology, comparative anatomy, or zoology.

Medicine and Surgery.—Montyon prizes (prize of 2500 francs, mentions of 1500 francs), for work contributing to the progress of medicine; the Barbier prize (2000 francs), for a valuable discovery in surgical, medical, pharmaceutical science, or in botany in its relation to medicine; the Breant prize (100,000 francs), for a discovery eradicating Asiatic cholera; the Godard prize (1000 francs), for the best memoir on the anatomy, physiology, and pathology of the urino-genitary organs; the Baron Larrey prize (750 francs), to a physician or surgeon belonging to the Army or Navy for a work treating a subject of military medicine, surgery, or hygiene; the Bellion prize (1400 francs), for valuable discoveries in medicine or hygiene; the Mège prize (10,000 francs), to an author who will continue and complete the founder's essay on the causes which have retarded or favoured the progress of medicine; the Argut prize (1200 francs), for a discovery of a cure for a disease at present incapable of treatment by surgery.

Physiology.—A Montyon prize (750 francs), for work in experimental physiology; the Philipeaux prize (900 francs), as a recompense for researches in experimental physiology; the Lallemand prize (1800 francs), for works relating to the nervous system; the Pourat prize (1000 francs), for researches on the actions exerted by the X-rays and radium rays upon the development and nutrition of living cells.

Statistics.—A Montyon prize (one prize of 1000 francs and two mentions of 500 francs).

History of Science.—The Binoux prize (2000 francs).

General Prizes.—The Arago, Lavoisier, and Berthelot medals; the Henri Becquerel prize (3000 francs); the Gegner prize (3800 francs), for researches or work contributing to the progress of science; the Lannelongue prize (2000 francs), for the assistance of scientific workers or their relations in distress; the Gustave Roux prize (1000 francs); the Trémont prize (1100 francs); the Wilde prize (one of 4000 francs and two of 2000 francs), for discoveries in astronomy, physics, chemistry, mineralogy, geology, or experimental mechanics; the Lonchampt prize (4000 francs), for a memoir on the diseases of man, animals, or plants from the special point of view of the introduction of mineral substances in excess as the cause of these diseases; the Saintour prize (3000 francs), for work in mathematics; the Fanny Emden prize (3000 francs), for a work treating of hypnotism, suggestion, or physiological actions exerted at a distance on the animal organism; the Petit d'Ormoy prize (two prizes of 10,000 francs), for work in pure or applied mathematics or natural science; the Pierson-Perrin prize (5000 francs), for an important discovery in mechanics or physics; the Parkin prize (3400 francs), for work on the therapeutic effects of carbon dioxide or on the effects of volcanic action in the production of epidemic diseases; the Estrade-Delcros prize (8000 francs); the Danton prize (1500 francs), for researches relating to radiant phenomena; the prize founded by Mme. la Marquise de Laplace; the Félix Rivot prize (2500 francs).

FORESTRY IN NORWAY.

THE progress of scientific forestry in Norway forms the subject of an interesting article, by Mr. S. Burtt Meyer, in No. 5 of the Journal of the Board of Agriculture. No less than 21·4 per cent. of the total area of Norway is under forest, as against 3·9 per cent. in the United Kingdom. The most abundant forest tree is the Scots pine (*Pinus Sylvestris*), followed by the birch and the spruce (*P. excelsa*). The alder, aspen, and rowan are distributed pretty generally, while the oak, ash, elm, and beech are also found in favoured areas. The commercial timbers, however, are the Scots pine and the spruce, the latter being of great importance since the introduction of the wood-pulp trade. Spruce forms much the best material for wood pulp. A certain amount of pine can be added, but more than about 15 per cent. tends to spoil the colour. Spruce grows at a lower altitude than pine, and, generally speaking, in a more southern latitude. South of Trondhjem the pine usually ceases at about 2600 feet above sea-level, where it is replaced by the birch; above 3500 feet only dwarf birch and willow occur, while at some 4000 feet the snow-line stops all vegetation. The best forest land is that lying in the neighbourhood of Christiania extending north and north-east over the Glommen watershed. The management of the forest is on the whole good, and well adapted to the local conditions. The work of felling and removing the timber commences in autumn and continues throughout the winter, being greatly facilitated by the snow which covers the ground from November until March or April.

One common system consists in clearing a circle until its diameter equals the height of the surrounding trees. Labour is obtained largely from the small peasant proprietors, who preponderate so largely in the country. Much attention is devoted to afforestation, two societies, the Royal Society for the Welfare of Norway, and the Norwegian Forestry Society, interesting themselves considerably in this question. Afforestation has naturally received most attention in the coast provinces, but preparatory schemes for land drainage and improvement have also been made for districts in the interior, while planting has been widely carried on over the high-lying Crown lands of eastern Norway. On account of the snowfall, planting is only possible in early summer or early autumn.

Shifting sands on the coast are planted up in the same manner as on the northern shores of Jylland, in Denmark. Irregularities in the surface are filled in, the ground is then covered with moss, heather, or any kind of loose material, pegged down when necessary, seed of Elymus or *Arundo arenaria* is sown, and lastly broad strips are planted with *Pinus maritima*.

THE DEVELOPMENT OF CRYSTAL FACES.

IN a memoir by M. P. Gaubert entitled "Recherches récentes sur le Facies des Cristaux," published by the Société de Chimie physique, some remarkable new facts are described regarding the influence of foreign substances on the development of crystal faces. The most interesting relate to the influence of colouring matters, such as methylene blue, eosine, fuchsine, and picric acid, which are shown to be capable of passing into the crystal substance in two different ways. According to one, the colouring matter is deposited on the crystal in the course of growth; this occurs when the solution is saturated with the colouring matter, which thus deposit crystals. An excellent example is afforded by lead nitrate, which when pure usually deposits colourless octahedral crystals. When the mother liquor is saturated with methylene blue, the crystals first deposited exhibit cube faces modifying those of the octahedra, and these cube faces alone are coloured blue; they also exhibit striations like pyrites, corresponding to the faces of the pentagonal dodecahedron. The colour thus not only attaches itself to the faces of a particular form, but indicates the true class of symmetry of the system, in this case a class lower than the holohedral. Similar phenomena are described with gypsum, copper sulphate, thallium sulphate, and morphine, all of which develop specific unusual forms and faces, coloured by the dye, when the latter is methylene blue. Strong polychroism is also introduced in the case of copper sulphate.

The second mode of coloration occurs when a dye stains the crystals grown whatever be the state of dilution of the dye. Nitrate of urea is a good example. The ordinary crystals are monoclinic tables parallel to the basal plane {001}, bounded by the prism {110} and pinakoids {100} and {010}. But when methylene blue is present the two latter forms are suppressed, and the plates are coloured blue and elongated along the axis of the prism {110}. If, however, picric acid be used as the colouring matter, the facial disposition is entirely altered, the pinakoids being developed, but not the prism. More remarkable still, when both methylene blue and picric acid are present, the crystals of urea nitrate show all four forms, and the plate shows eight sectors, four coloured blue, corresponding to the prism faces, and four yellow opposite the pinakoid faces. Phthalic acid exhibits analogous phenomena with methylene blue, malachite green, and scarlet of Biebrich, specific forms staining with each dye, and the crystal showing differently coloured sectors when the dyes are simultaneously present. The reasons for these remarkable phenomena are not convincingly brought out in the memoir, and it is obvious that an interesting new field of work is opened up, in which much will have to be done before the solution of the problem is satisfactorily achieved.

MAYER'S PAPERS ON THE CONSERVATION OF ENERGY.

THE recent issue as one of the volumes of Ostwald's "Klassiker der exakten Wissenschaften" of Robert Mayer's two papers of 1842 and 1845, on the subject now known as the conservation of energy, will prove a great boon to those interested in the early history of that great generalisation. Traces of the idea may be found amongst the ancients, and Descartes held that it was a self-evident truth. But in the middle of the seventeenth century the term energy had but a vague significance, even in the simple case of a moving body, and the doctrine of conservation, when held, meant little or nothing for physical science. Towards the middle of the nineteenth century interest in the question appears to have been widespread. Séguin in France in 1839 calculated the mechanical equivalent of heat from the fall of temperature of steam when expanding against external pressure; Joule in England in 1840 showed that when a battery of cells drives a motor the consumption of zinc in the cells is proportional to the work done by the motor; and Mayer in Germany, after explaining how the term energy was to be understood, stated the generality of the law in his first paper in 1842, and with greater clearness in his pamphlet of 1845.

The titles of Mayer's publications were not such as to suggest the subjects treated in them, and they were so little known, even in Germany, that Helmholtz in 1847 published his paper on the subject without any reference to Mayer. In the meantime, Colding in Denmark had read a paper to the Royal Society of Copenhagen in 1843 in which he stated clearly the law of conservation of energy, and Joule read before the British Association in the same year the first of his papers on the measurement of the mechanical equivalent of heat. Before the middle of the century Joule's experimental work had placed thermodynamics on a firm basis. When the contributions of Séguin and of Colding, and possibly of others whose work has been overlooked, are republished in a form as accessible as are those of Mayer, Joule, and Helmholtz, it may be possible to apportion the credit for one of the greatest generalisations of the nineteenth century in a way to satisfy even the most captious critic.

NATURAL SELECTION IN MAN.

MR. E. C. SNOW, in his paper entitled "The Intensity of Natural Selection in Man" (Drapers' Company Research Memoirs, Studies in National Deterioration, No. vii. London: Dulau and Co., 1911), has set himself to answer the following question: Has heavy infantile mortality any selective value or tendency to eliminate the more sickly and to spare the hardier children? Of the data available for the investigation of this problem, the most satisfactory are derived from the annual volumes of Prussian statistics, and the most definite of the results were obtained from them. In order to indicate the method employed, one example will be described. Thirty rural districts in Prussia were taken, and all the children in them born in the year 1881 were considered. It was ascertained for each district how many of these children died in the first two years of life and how many in the next eight. Now it is obvious that if the infantile mortality tends to weed out the weaker children, then in those districts in which the mortality among the children born in 1881 was highest in the years 1881 and 1882 it should tend to be lowest in the years 1883–90, since stronger children less likely to succumb to the ailments of childhood would have survived their first two years. In other words, there will be a *negative* correlation between the number of deaths in the first two years of life and the number in the next eight, provided that allowance is made for the total number of births in each district for the year 1881 and for the effects of environment. After making these necessary allowances by means of the formula for partial correlation, a coefficient of $-0{\cdot}93$ was obtained in the case of males and of $-0{\cdot}85$ in the case of females.

These results, considered by themselves, would seem to show that the selective action of infantile mortality was very strongly marked; but it is perhaps unnecessary to say that the author, whose work bears every sign of the most painstaking care and thoroughness, has brought forward a considerable body of additional evidence derived from data of a similar nature collected both in England and Germany. The greater part of it corroborates the conclusion stated above, though the correlation coefficients were in no other cases found to be so high, and in some cases the sign was actually positive. Yet we are of opinion that, on the whole, the author is justified in saying: "Natural selection in the form of a selective death-rate is strongly operative in man in the earlier years of life." A word of praise must be added on the composition of the memoir: it is fair, clear, and interesting.

E. H. J. S.

THE KING ON EDUCATION IN INDIA.

DURING his visit to Calcutta the King-Emperor and Queen-Empress received in the Throne Room an address from the University of Calcutta. The address was read by the Vice-Chancellor of the University, Sir Asutosh Mukharji, and Lord Hardinge, the Governor-General, was present in his capacity of Chancellor of the University. In his reply to the address the King-Emperor said:—

"I recall with pleasure the occasion on which, six years ago, I received from the University of Calcutta the honorary degree of a Doctor of Law, and I am glad to have an opportunity to-day of showing my deep and earnest interest in the higher education of India. It is to the universities of India that I look to assist in that gradual union and fusion of the culture and aspiration of Europeans and Indians on which the future well-being of India so greatly depends. I have watched with sympathy the measures that from time to time have been taken by the universities of India to extend the scope and raise the standards of instruction. Much remains to be done. No university is nowadays complete unless it is equipped with teaching faculties in all the more important branches of the sciences and the arts, and unless it provides ample opportunities for research. You have to conserve the ancient learning and simultaneously to push forward Western science. You have also to build up character, without which learning is of little value. You say that you recognise your great responsibilities. I bid you God-speed in the work that is before you. Let your ideals be high and your efforts to pursue them unceasing, and, under Providence, you will succeed.

"Six years ago I sent from England to India a message of sympathy. To-day in India I give to India the watch-word of hope. On every side I trace the signs and stirrings of new life Education has given you hope; and through better and higher education you will build up higher and better hopes. The announcement was made at Delhi by my command that my Governor-General in Council will allot large sums for the expansion and improvement of education in India. It is my wish that there may be spread over the land a network of schools and colleges, from which will go forth loyal and manly and useful citizens, able to hold their own in industries and agriculture and all the vocations in life. And it is my wish, too, that the homes of my Indian subjects may be brightened and their labour sweetened by the spread of knowledge with all that follows in its train, a higher level of thought, of comfort, and of health. It is through education that my wish will be fulfilled, and the cause of education in India will ever be very close to my heart.

"It is gratifying to me to be assured of your devotion to myself and to my house, of your desire to strengthen the bonds of union between Great Britain and India, and of your appreciation of the advantages which you enjoy under British rule. I thank you for your loyal and dutiful address."

Since the new University Act was passed in 1904, considerable and satisfactory progress has been made in India in all branches of education, and the university standards, in particular, have been raised and made more real and effective. There are many signs of educational activity in India, and if the true purpose of education be kept well in mind the country will enter upon an era of increased prosperity based upon increase of knowledge.

RECENT PROGRESS IN SPECTROSCOPIC METHODS.[1]

AN observer who for the first time views the light of the sun through a prism cannot fail to express his wonder and delight at the gorgeous display of colours into which the white light is separated; and if the observation is made under the same conditions as in the celebrated experiment of Newton, 1666, there is, in truth, nothing else which he could observe. You will remember that he allowed a beam of sunlight to stream through a round opening in a shutter of his window, falling on a glass prism, which bent the sun-rays by different amounts depending on their colour, thus spreading out the white round sunlit spot on the opposite wall into a coloured band —the spectrum—which he rather arbitrarily divided into seven colours—red, orange, yellow, green, blue, indigo, and violet. (If the division were made to-day I doubt if indigo would be included.) There is, in fact, no definite demarcation between these, and they shade insensibly into each other, and if the solar spectrum were always produced under these conditions we should say it was continuous; indeed, if it were not the sun, but an argand burner or an incandescent lamp, which served as source, it would really be so.

But even if the source consisted of isolated (but sufficiently numerous) separate colours, the fact would be disguised by the overlapping of the successive images. In other words, the spectrum is not pure. In order to prevent this overlapping, two important modifications must be made in Newton's arrangement. First, the light must be allowed to pass through a very *narrow* aperture, and, secondly, a sharp *image* of this aperture must be formed by a lens or mirror.

The first improvement was introduced by Wollaston in 1802, who writes:—"If a beam of daylight be admitted into a dark room by a *crevice* one-twentieth of an inch broad, and received by the eye at a distance of 10 or 12 feet through a prism of flint glass held near the eye, the beam is seen to be separated into the four colours only—red, yellowish-green, blue, and violet. . . . The *line* that bounds the red side of the spectrum is somewhat confused. . . . The *line* between the red and green . . . is perfectly distinct; so also are the two limits of the violet. There are other distinct lines (in the green and blue . . .)."

The second improvement was effected by Fraunhofer, 1814, and by observing the light which fell from such a narrow aperture upon a prism by means of a *telescope* he discovered upwards of 750 *dark* lines in the solar spectrum, and mapped their position and general character.

In recognition of the enormous importance of this discovery, these lines are always known as the Fraunhofer lines.

A minor inconvenience in Fraunhofer's arrangement lay in the fact that the slit source had to be at a considerable distance from the telescope; and this was obviated in the apparatus of Bunsen and Kirchhoff, 1860, which is essentially the same as the modern spectroscope of to-day, consisting of a slit and collimator, prism, and observing (or photographic) telescope.

On this beautifully simple device rests practically the whole science of spectroscopy, with all its wonderful applications and all the astonishing revelations of the structure and motions of the sidereal universe and of the constitution of the atoms of matter of which it consists—nay, even of the electrons of which these atoms are built!

Without the telescope it is evident that the science of spectroscopy would be as limited in its field as was the science of astronomy without the telescope. It is interesting, indeed, to compare the progress of the two sciences as dependent on the successive improvements in the two instruments.

Without the telescope nothing could be discovered concerning the heavenly bodies (with the exception of a few of the more evident features of the sun, the moon, and the comets) except the brightness and places of the stars and the motion of the planets, and even these could, at best, be very roughly determined (say, to within one part in five thousand, or something over a half-minute of arc). Without the telescope spectroscopy would also have been limited to observations of general differences in character of radiations and absorptions, and a rough determination of the position of the spectral lines, with a probable error of this same order of magnitude.

In fact, the *resolving power* of the eye is measured by the number of light waves in its diameter, about 5000, and if a double star (or a double spectral line) presents a smaller angle than 1/5000 it is not "resolved." The resolving power of a telescope with a 1-inch objective would be about 100,000, so that details of the solar and lunar surfaces, and of planets, nebulæ, and of double stars and star groups can be distinguished the angular distance of which is of the order of 1/100,000. The discs of the planets, the rings of Saturn, the moons of Jupiter, and some star groups and clusters, begin to be distinguishable. Our largest telescopes have a resolving power as high as 2,000,000, corresponding to a limit of separation of one-tenth of a second.

But in order to realise the full benefit of the telescope when used with a prism, the latter must be so large that the light which falls upon it entirely fills the object glass. The efficiency of the prism then depends on its size and on its dispersive power.

In order to form an idea of the separating or resolving power in spectroscopic observations it will be convenient to consider the Fraunhofer line D of the solar spectrum or the brilliant yellow line corresponding to the radiation given out by a salted alcohol flame. This Fraunhofer recognised as a double line, and the length of the light-waves of the components are approximately 0·0005890 mm. and 0·0005896 mm. respectively. The difference is, then, 6/5893 of the whole, or about 1/1000, requiring a prism of resolving power of 1000 to separate them. If the prism were made of flint glass with a base of 25 mm. it would just suffice to show that the line was double.

Now we know of groups of spectral lines the components of which are much closer than those of sodium. For instance, the green radiation emitted by incandescent mercury vapour consists of at least six components, some of which are only a hundredth of this distance apart, and requiring, therefore, a resolving power of 100,000 to separate them. This means a glass prism of 100 inches, the construction of which would present formidable difficulties. These may be partially obviated by using twenty prisms of 5 inches each; but owing to optical imperfections of surfaces and of the glass, as well as the necessary loss of light by the twenty transmissions and forty reflections, such a high resolving power has not yet been realised.

The parallelism of the problems which are attacked in astronomy and in spectroscopy is illustrated in the following table. It is interesting to observe how intimately these are connected and how their solution depends on almost exactly the same kind of improvement in the observing instruments, particularly on their *resolving power*; so that not only are the older problems facilitated and their solution correspondingly accurate, but new problems, before thought to be utterly beyond reach, are now the subject of daily investigation.

Astronomical.	*Spectroscopic.*
(1) Discovery of new stars, nebulæ, and comets.	Discovery of new elements.
(2) Star positions.	Wave-length of spectral lines.
(3) Double stars and star clusters.	Double lines, groups, and bands.
(4) Shape and size of planets and nebulæ. (?) Star discs.	Distribution of light in spectral "lines."
(5) Star motions (normal to line of sight).	Star motions (parallel with line of sight).
Resolution of doubles.	Resolution of doubles.
Solar vortices.	Solar vortices.
Protuberances, &c.	Protuberances, &c.
(6)	Changes of character and position of lines with temperature, pressure, and magnetic field.
(7) Spectroheliograph. (Combination of telescope and spectroscope.)	

[1] Address of Dr. A. A. Michelson, retiring president of the American Association for the Advancement of Science, delivered at the Washington meeting of the Association on December 27, 1911.

We must especially note that the newer problems require an enormous resolving power. In the telescope this has been accomplished partly by the construction of giant refractors and partly by enormous reflectors: and, curiously enough, the same double path is open to spectroscopy; for we may employ the analogous dispersive power of refracting media or the diffractive power of reflecting media. The increasing cost and difficulty of producing large transparent and homogeneous blocks of glass have tended to limit the size and efficiency of lenses and of prisms, and these have been more or less successfully replaced, the former by mirrors and the latter by *diffraction gratings*.

These are made by ruling very fine lines very close together on a glass or a metal surface. The effect on the incident light is to alter its direction by an amount which varies with the wave-length—that is, with the colour; and a spectrum is produced which may be observed to best advantage by precisely the same form of spectrometer, with a substitution of a grating for the prism.

The dispersion of a diffraction grating depends upon the closeness of the rulings; but the resolving power is measured by the total number of lines. It is important, therefore, to make this number as large as possible.

The first gratings made by Fraunhofer, 1821, contained but a few thousand lines, and had a correspondingly low resolving power—quite sufficient, however, to separate the sodium doublet. A considerable improvement was effected by Nobert, whose gratings were used as test objects for microscopes; but these were still very imperfect as spectroscopic instruments, and it was not until Rutherford, of New York, 1879, constructed a ruling engine with a fairly accurate screw that gratings were furnished which compared favourably with the best prisms in existence.

With 30,000 lines (covering more than 40 mm.) the theoretical resolving power would be 30,000; practically about 15,000—sufficient to separate doublets the components of which were only one-fifteenth as far apart as those of the sodium doublet.

An immense improvement was effected by Rowland, 1881, whose gratings have been practically the only ones in service for the last thirty years. Some of them have a ruled surface of 150 mm. × 60 mm., with about 100,000 lines, and can separate doublets the distance of which is only 1/100 of that of the sodium doublet in the spectrum of the first order. In the fourth order it should resolve lines the distance of which is only one-fourth as great.

Practically, however, it is doubtful if the actual resolving power is more than 100,000, the difference between the theoretical and the actual performance being due to the defect in uniformity in the spacing of the grating furrows.[1]

The splendid results obtained by Rowland enabled him to produce the magnificent atlas and tables of wave-lengths of the solar spectrum which are incomparably superior in accuracy and wealth of detail to any previous work; so that until the last decade this work has been the universally accepted standard. With these powerful aids it was possible not only to map the positions of the spectral lines with marvellous accuracy, but many lines before supposed simple were shown to be doublets or groups; and a systematic record is given of the characteristics of the individual lines, for example, whether they are intense or faint, nebulous or sharp, narrow or broad, symmetrical or unsymmetrical, reversed, &c.—characteristics which we recognise to-day as of the highest importance, as giving indications of the structure and motions of the atoms the vibrations of which produce these radiations.

One of the most difficult and delicate problems of modern astronomy is the measurement of the displacement of spectral lines in consequence of the apparent change of wave-length due to "radial velocity" or motion in line of sight. This is known as the Doppler effect, and had been well established for sound waves (a locomotive whistle appears of higher pitch when approaching and lower when receding); but it was only confirmed for light by Huggins and by Vogel in 1871, by the observation of displacements of the solar and stellar spectral lines.

It may be worth while to indicate the accuracy necessary in such measurements. The velocity of rotation of the sun's equator is approximately 2 kilometres per second, while the velocity of light is 300,000 kilometres per second. According to Doppler's principle, the corresponding change in wave-length should be 1 : 150,000—a quantity too small to be "resolved" by any prism or grating then in existence. But by a sufficient number of careful micrometer measurements of the position of the middle of a given spectral line, the mean values of two such sets of measurements would show the required shift. It is clear, however, that if such radial velocities are to be determined with any considerable degree of accuracy, nothing short of the highest resolving power of the most powerful gratings should be employed.

Another extremely important application of spectroscopy to solar physics is that which, in the hands of Hale and Deslandres, has given us such an enormous extension of our knowledge of the tremendous activities of our central luminary.

The spectroheliograph, devised by Hale in 1889, consists of a grating spectroscope provided with two movable slits, the first in its usual position in the focus of the collimator, and the second just inside the focus of the photographic lens. A uniform motion is given to the two slits so that the former passes across the image of the solar disc, while the other exposes continually fresh portions of the photographic plate.

If the spectroscope is so adjusted that light of the wave-length of a particular bright line in a solar prominence (say, one of the hydrogen or the calcium lines) passes through the instrument, then a photograph of the prominences, or sun-spots, or faculæ, &c., appears on the plate. But the character of this photograph depends on the portion of the bright spectral "line" which is effective, and as the entire range of light in such a line may be only a thirtieth part of the distance between the sodium lines, it would require a resolving power of at least 100,000 to sift out the efficient radiations so that they do not overlap.

As another illustration of importance of high resolving power in attacking new problems, let us consider the beautiful results of the investigations of Zeemann on radiation in a magnetic field. The effect we know is a separation of an originally simple radiation into three or more, with components polarised at right angles to each other. This is one of the very few cases where it is possible actually to alter the vibrations of an atom (electron), and the fact that the effect is directly calculable, as was first shown by Lorentz, has given us a very important clue to the structure and motions of the atoms themselves.

The experiment is made by placing the source of radiation (any incandescent gas or vapour) between the poles of a powerful electromagnet and examining the light spectroscopically. Now this experiment had been tried long before by Faraday, but the spectroscopic appliances at his disposal were entirely inadequate for the purpose.

Even in the original discovery of Zeemann only a broadening of the spectral line was observed, but no actual separation. In fact, the distance between components which had to be observed was of the order of a hundredth of the distance between the sodium lines, and in order to effect a clear separation, and still more to make precise measurements of its amount, requires a higher resolving power than was furnished by the most powerful gratings then in existence.

As a final illustration, let us consider the structure of the spectral "lines" themselves. Rowland's exquisite maps had shown many of these, which were then thought simple, to be double, triple, or multiple, and there are clear indications that even the simpler lines showed differences in width, in sharpness, and in symmetry. But the general problem of the distribution of light within spectral lines had scarcely been touched. Here, also, the total "width" of the line is of the order of 1/100 of the distance between the sodium lines, and it is evident that without more powerful appliances further progress in this direction was hopeless.

Enough has been said to show clearly that these modern problems were such as to tax to the utmost the powers of the best spectroscopes and the experimental skill of the most experienced investigators.

Some twenty years ago a method was devised which, though somewhat laborious and indirect, gave promise of

[1] This applies to all the Rowland gratings which have come under my notice, with the exception of one which I had the opportunity of testing at the Physical Laboratory, University, Göttingen. The resolving power of this grating was about 100,000.

furnishing a method of attack for all these problems far more powerful than that of the diffraction grating.

Essentially, the extremely simple apparatus which is called the *interferometer* consists of two plane glass plates. These can be made accurately parallel, and their distance apart can be varied at will. When light is reflected from the surfaces which face each other, the two reflected beams of light waves "interfere" in such a way as to add to each other, giving bright maxima, or to annul each other's effect, producing dark spaces between.

The alternations of light and darkness which occur when the eye observes in the direction of the normal are very marked so long as the plates are very near together; but as this distance increases the interferences become less and less distinct, until at a distance, *which depends on the character of the incident light*, they vanish completely. A perfectly definite relation holds between the "visibility curve" and the character of the radiation, so that the one can be deduced from the other.

Now the "resolving power" of such an apparatus is measured by the number of light waves in the doubled distance between the surfaces. This is about 100,000 for a distance of 1 inch; but the distance is, in fact, *unlimited*, and as the instrument itself is practically free from errors of any sort, its resolving power is practically unlimited.

The use of this method of light-wave analysis is attended with certain difficulties, and the results obtained are not always free from uncertainties; but in view of the fact that at this time no other methods of this power had been devised, it has amply proved its usefulness. Among the results achieved by it may be mentioned the resolution of many lines supposed single into doublets, quadruplets, &c.; the measurement of their distances apart; the distribution of light in the components; the measurement of their width and the changes produced in them by temperature, pressure, and presence of a magnetic field.

Among the radiations thus examined, one proved to be so nearly homogeneous that more than 200,000 interference bands could still be observed. Otherwise expressed, the exact number of light waves in a given distance, say 10 cm., could always be determined, and by a comparison with the standard meter the absolute wave-length of this radiation could be measured and made to serve as a basis for all wave-lengths.

The standard of length itself, the standard metre, is defined as the distance between two lines on a metal bar; and notwithstanding all the care taken in its manufacture and preservation, there is no assurance that it is not undergoing a constant slow change, doubtless very small, but perhaps appreciable by the refinements of modern metrological methods if there were any fundamental unchangeable standard with which it could be compared. The earth's circumference was supposed to be such a standard, and the metre was originally defined as the millionth part of an earth-quadrant; but the various measurements of this quadrant varied so much that the idea was abandoned. The attempt to base the standard on the length of a seconds-pendulum was no more successful.

But we have now the means of comparing the standard metre with the length of a light wave (the standard metre contains 1,553,163 waves of the red radiation from cadmium vapour), so that should the present standard be lost or destroyed, or should it vary in length in the course of years, its original value can be recovered so accurately that no microscope could detect the difference. True it is that in the course of millions of years the properties of the atoms which emit these radiations and the medium which propagates them may change—but probably by that time the human race will have lost interest in the problem.

The difficulties in the application of the interferometer method of investigating the problems of spectroscopy, it must be admitted, were so serious that it was highly desirable that other instruments should be devised in which these difficulties were avoided. This need was supplied by the "echelon," an instrument based on the same principle as the diffraction grating, but consisting of a pile of glass plates of exactly equal thickness and forming a kind of stairs, whence its name.

The grating acts by assembling light-waves the successive wave trains of which are retarded by some *small* whole number of waves (usually less than six, the distance between the grating spaces being about six light waves), whereas this retardation in the echelon is many thousand.

But the resolving power depends on the *total* retardation of the extreme rays, and this may be made very large either by having an enormous number of elements with small retardations, or by a comparatively small number of elements with large retardations. For example, an echelon of thirty plates of glass 1 inch thick, each producing a retardation of 25,000 waves, would have a resolving power 750,000, about seven times that of the grating; and this high value has actually been realised in practice.

Simultaneously, Perot and Fabry showed that by the repeated reflections between two silvered surfaces[1] a very high resolving power is obtained, and a few years later Lummer devised the plate interferometer, which embodies practically the same idea.

The resolving power of all of these newer devices is clearly many times as great as that of the grating; but all equally share the objection which holds (but to a far less extent) for the grating—that the different succeeding spectra overlap. It is true that this difficulty may be overcome (though with some loss of simplicity and considerable loss of light) by employing auxiliary prisms, gratings, echelons, &c., and in this form all these modern instruments have contributed results of far-reaching importance, which would have been impossible with the older instruments.

The diffraction grating possesses so many advantages in simplicity and convenience of manipulation that it is even now used in preference to these modern instruments, except for such refinements as require an exceptionally high resolving power. But has the resolving power of the grating been pushed to the limit? We have seen that this depends on the number of rulings; and it is certainly possible to increase this number. But the theoretical value is only reached if the rulings are very accurately spaced; for instance, the resolving power of the Rowland grating is only one-third of its theoretical value. This is a direct consequence of inaccuracies in the spacing of the lines. If a grating could be constructed of, say, 250,000 lines with exact spacing, the resolving power would be equal to that of the most powerful echelon. The problem of the construction of such gratings has occupied my attention for some years; and while it has met with some formidable difficulties, it has had a fair measure of success, and gives promise of still better results in the near future.

The essential organ in all ruling engines in actual use is the screw, which moves the optical surface to be ruled through equal places of the order of a 500th to 1000th of a millimetre at each stroke; and the principal difficulty in the construction of the machine is to make the screw and its mounting so accurate that the errors are small compared with a thousandth of a millimetre.

This is accomplished by a long and tedious process of grinding and testing, which is the more difficult the longer the screw. A screw long enough to rule a 2-inch grating could be prepared in a few weeks. Rowland's screw, which rules 6-inch gratings, required two years or more; and a screw which is to rule a grating 15 inches wide should be expected to take a much longer time, and, in fact, some ten years have been thus occupied.[2]

I may be permitted to state a few of the difficulties encountered in this work, some of which would doubtless have been diminished if my predecessors in the field had been more communicative.

First is the exasperating slowness of the process of grinding and testing the screw. This cannot be hurried, either by grinding at greater speed or by using any but the very finest grade of grinding material. The former would cause unequal expansions of the screw by heating, and the latter would soon wear down the threads until nothing is left of the original form.

Secondly, in ruling a large grating, which may take

[1] Boulouch, 1893, had observed that Na rings were doubled both by reflection (grazing incidence) and transmission (normal incidence) with a light silver film.

[2] A method of ruling gratings accurately, which is independent of any mechanical device, is now in process of trial, in which the spacing is regulated by direct comparison with the light waves from some homogeneous source such as the red radiations of cadmium.

eight to ten days, the ruling diamond (which must be selected and mounted with great care) has to trace a furrow several miles long on a surface as hard as steel, and often breaks down when the grating is half finished. The work cannot be continued with a new diamond, and must be rejected and a new grating begun.

Thirdly, the slightest yielding or lost motion in any of the parts—screw, nut, carriage, or grating—or of the mechanism for moving the ruling diamond, is at once evidenced by a corresponding defect in the grating. When, after weeks, or sometimes months, of preparation all seems in readiness to begin ruling, the diamond point gives way, and as much time may have to be spent in trying out a new diamond.

When the accumulation of difficulties seems to be insurmountable, a perfect grating is produced, the problem is considered solved, and the event celebrated with much rejoicing, only to find the next trial a failure. In fact, more time has been lost through such premature exhibitions of docility than in all the frank declarations of stubborn opposition!

One comes to regard the machine as having a personality—I had almost said a feminine personality—requiring humouring, coaxing, cajoling, even threatening! But finally one realises that the personality is that of an alert and skilful player in an intricate but fascinating game who will take immediate advantage of the mistakes of his opponent, who "springs" the most disconcerting surprises, who never leaves any result to chance, but who nevertheless plays fair, in strict accordance with the rules of the game. These rules he knows, and makes no allowance if you do not. When *you* learn them, and play accordingly, the game progresses as it should.

As an illustration of the measure of success attained in this work, I would direct attention to a recent comparison by Messrs. Gale and Lemon of the performance of a grating of 6½-inch ruled surface with that of the echelon, the Perot and Fabry interferometer, &c. The test object is the green radiation from incandescent mercury vapour. The spectrum of this radiation had been supposed a simple line until the interferometer showed it to be made up of five or more components. The whole group occupies a space about one-fifteenth of that which separates the sodium lines.

The grating clearly separates six components, while the more recently devised instruments give from six to nine. Two of these components are at a distance apart of only 1/150 of the distance between the sodium lines, and these are so widely separated by the grating that it would be possible to distinguish doublets of one-half to one-third this value, so that the actual resolving power is from 300,000 to 400,000—of the same order, therefore, as that of the echelon.

It may well be asked, why is it necessary to go any further? The same question was put some twenty years ago when Rowland first astonished the scientific world with resolving powers of 100,000, and it was his belief that the width of the spectral lines themselves was so great that no further "resolution" was possible. But it has been abundantly shown that this estimate proved in error, and we now know that there are problems the solution of which depends on the use of resolving powers of at least a million, and others are in sight which will require ten million for their accurate solution, and it is safe to say that the supply will meet the demand.

To return to our comparison of the telescope and the spectroscope; while the progress of investigation of the stellar universe will be ever furthered by increased size and resolving power of the telescope, this is very seriously hampered by the turbulence of the many miles of atmosphere through which the observations must be made. But there is no corresponding limit to the effective power of spectroscopes, and the solution of the corresponding problems of the subatomic structures and motions of this ultramicroscopic universe may be confidently awaited in the near future.

The messages we receive from the depth of the stellar firmament or from the electric arcs of our laboratories, come they in a millionth of a second or in hundreds of light-years, are faithful records of events of profound significance to the race. They come to us in cypher—in a language we are only beginning to understand.

Our present duty is to make it possible to receive and to record such messages. When the time comes for a Kepler and a Newton to translate them we may expect marvels which will require the utmost powers of our intellect to grasp

THE CARBONISATION OF COAL.[1]

I.

BEFORE it is possible to explain the highly complex actions taking place in the destructive distillation of coal, it is important to have some definite idea of the nature of the raw material with which we have to deal; and although many attempts have been made to gain an insight into the composition of coal, the wide variations in its characteristics, the difficulties attending any attempt to separate its constituents, and the ease with which the products of its decomposition undergo secondary changes at the temperatures employed in breaking it up, have prevented any very satisfactory solution of the problem being arrived at.

The one thing generally admitted is that coal is the fossil remains of a vegetation that flourished in the carboniferous period of the world's history, and that it has passed through successive stages of checked decay; the action of time, temperature, and pressure, generally out of contact with air, resulting in the conversion of these into the tertiary coals (such as brown coals or lignites), and probably by a continuance of the action yielding eventually the true coal.

All the plants of which we have fossilised record in our coal measures consisted of sedges and reeds, tree ferns, club mosses or lycopodia, and trees akin to the pine; but in those prehistoric days the conditions of growth —warmth, moisture, and carbon dioxide—were such that these plants grew with a succulent freedom and rapidity unknown in latter days, and which rendered their tissues an easy prey to decay and fermentation—actions which left only the more resistant unchanged. The work of Morris, Carruthers, Fleming, and Huxley has shown us that the bituminous matter in coal is largely derived from the spores of fossil mosses akin to the lycopodia. If we take the club mosses of to-day, we find their spores give us the body known as lycopodium—a substance so resinous in its nature that it resists the action of water, and is used to coat pills, while the same resinous characteristics render it so inflammable that a little blown through a flame provides the theatrical world with its artificial lightning. Spores of this character, from the giant growths of the carboniferous period, together with the more resinous portion of plants akin to the pine, are the substances which have best resisted the actions taking place during the ages that have elapsed in the formation of coal.

Starting with the fibre of the original plants, we find two well-defined bodies—cellulose, as represented by cotton fibre, and lignose, as represented by jute fibre. In the former, the percentage of carbon is 44, in the latter 47 —each giving distinctive reactions with dilute acids at 70° C., with anilin sulphate, with Schultze solution, and with mixtures of sulphuric and nitric acids. In the cellular tissue, we find starch; and besides these bodies, there are present the extractive and mineral matters of the sap.

Among the extractive matter we find gums—such as those exuding from the acacia and cherry, but also present in the juice of many plants—mucilage, vegetable jelly (which gives many juices their power of gelatinising), resins, essential oils, and other well-defined bodies. With some forms of vegetation, the essential oils undergo oxidation and form resins; and these, being more resistant to change, accumulate in masses of decaying vegetable matter, so that large quantities of them are found in lignite beds in a fossilised, but little changed, state.

The changes in the carbohydrates and extractive matters depend largely upon the conditions of decay. Given moisture and air, they become converted into carbon dioxide and water; check the decay by cutting off free access of

[1] From a course of Cantor Lectures given at the Royal Society of Arts in November and December, 1911, by Prof. Vivian B. Lewes.

air, the action is slowed down, and the gases evolved are carbon dioxide and methane.

It is clear that in a mass of rotting vegetation undergoing checked decay, fermentation must play an important part; and Renault found, in an extensive series of researches upon peat, that the most important factor in the conversion of vegetable deposits into peat was fungi and bacterial ferments, which give rise to the production of ulmic compounds of the composition: Carbon 65·31, hydrogen 3·85, oxygen 30·84. Mulder also, at an earlier period, found that bodies could be extracted from peat, to which he gave the name of humic and ulmic acids; and Einof, Proust, and Braconnot found that such bodies formed the chief portion of peat.

These humus bodies have also been frequently identified in the lignites and also in the true coals.

None of these bodies are probably definite compounds, and resemble the residues obtained by the action of dilute acids on sugar and starch. The evidence, however, seems to point to the presence in all bituminous forms of coal of degradation products of the original vegetation of a humus or ulmic character, and which is probably the portion carrying the nitrogen; and in round numbers the proportions of the carbon, hydrogen, and oxygen will be not far removed from: Carbon 62 per cent., hydrogen 5 per cent., oxygen 33 per cent.

It is also well known that tertiary coals, like the brown coal and lignite deposits, are rich in fossil gums and resins, derived from the extractive matter of the vegetation; and a number of these have been isolated and analysed; whilst it is evident that in coal there are resin bodies of this character approximating to the general composition: Carbon, 79 per cent.; hydrogen, 11 per cent.; oxygen, 10 per cent.

The amount of resin constituents in the original vegetation, and which concentrates itself in the coal, must play an important part in chemical changes taking place during the formation and ultimate composition of the coal; and it is clear that although the vegetation that flourished in the coal age was of a very different character from that of later periods, yet in all probability the variations in the extractive matters of the plants varied to much the same extent as in the flora of to-day. Thus some deposits would be formed from vegetation containing but little of the resin-forming constituents, while others would be rich in them. We know the wide differences there are in the physical characteristics of the lignites—sometimes more like wood than coal, at others black, shining, and with a conchoidal fracture; these variations in appearance being due to the conditions under which they have been formed and the amount of resin constituents present.

If we start with the humus and resin constituents as they exist in the peat deposits of to-day, the latter are present only to the extent of 5 to 10 per cent.; but in the decaying vegetation of the carboniferous age, they were probably present in much larger quantities. The humus, unprotected by it, rapidly undergoes decomposition, with concentration of carbon and evolution of methane, carbon dioxide, and water. As the layers of deposit above the carbonising mass grow thicker, so probably the temperature rises. The ratio of resin constituents increasing in proportion binds together the mass, and so helps to protect the remaining humus; and with the lapse of centuries lignite is formed. If the amount of resin constituents has been small, or, owing to local circumstances, has not been distributed evenly throughout the mass, the lignite is loose in structure, and during the ensuing ages continues decomposing until, if the pressure has been great and the temperature high, nothing but the residual basis and trace of resin constituent are left in the form of steam coal or anthracite. Under other conditions they may remain mixed with the bituminous coal in a seam and form the "mother of coal."

If the percentage of resin bodies has been very high —as in a drifted deposit of spores from lycopodia—and the temperature has been high, the resin bodies may become semi-liquid, and, mingling with surrounding earthy deposits, will give such compounds as boghead cannel, the organic matter in which has the same composition as resin, while it yields 33 per cent. of ash. Some of the cannels, however, are simply very rich bituminous coals. When the temperature has been high enough, some of the resin constituents practically distil into the underlying clay, yielding some forms of shale.

Heat also may cause isomeric and other changes in the resin bodies, thus altering their behaviour towards solvents; while the effect of heat under pressure upon the resins is in some cases to decompose them, with formation of hydrocarbons, a long series of which were isolated by Renard—among them being both saturated and unsaturated groups, together with hydrocarbons containing oxygen. Hydrocarbons, like retene ($C_{18}H_{18}$), have frequently been isolated; and this body is found in many lignites. Within the last few months, Pictet and Ramseyer have isolated hexahydrofluorene ($C_{13}H_{16}$) and others of the hydro-aromatic hydrocarbons from coal—bodies which are resolved into aromatic hydrocarbons and hydrogen on destructive distillation. Renard long ago isolated not only saturated hydrocarbons like pentane and hexane, but also hexahydrides or naphthenes isomeric with the ethylene series, from the resin oil obtained by distilling wood resin at a low temperature (350° C.); among these hexahydrides being C_7H_{14}, C_9H_{18}, and $C_{10}H_{20}$. The presence of bodies of this character in low temperature coal tar is a further proof of the presence of the resin bodies in coal.

All these degradation products of the original vegetation are to be found in the bituminous coals, the residual body and humus forming the basis, which is luted together by the hydrocarbons and resins; and the characteristics of the various kinds of coal are dependent upon the proportions in which the four groups of the conglomerate are present. These constituents of the coal have their own characteristic products of decomposition when the coal is subjected to carbonisation. The humus bodies during carbonisation yield a large proportion of the gaseous products, and under the influence of heat show no sign of melting, but begin to break up at about 300° C. The decomposition becomes more rapid as the temperature rises. Water distils over in the early stages; the tar is thin and poor in quantity, and the gases up to 600° C. consist of hydrogen, methane, and carbon dioxide, with smaller quantities of carbon monoxide and traces of other saturated hydrocarbons. The decomposition can be completed below 800° C.; but if the temperature is run up to 1000° C., the carbon dioxide is reduced in quantity by the action on it of the red-hot carbon. Carbon monoxide increases correspondingly, while hydrogen and methane are still evolved.

The decomposition of the humus is also largely affected by the rate of heating. If slowly heated, a large proportion of the oxygen is given off in combination with hydrogen as water vapour, while if quickly raised in temperature more combines with carbon to form carbon dioxide and monoxide. The residue shows no sign of caking, while, like the naturally formed residue—mother of coal—it requires a large proportion of cementing material to make the particles cohere. The resin bodies and hydrocarbons which form the cementing portion in the coal melt between 300° C. and 320° C.; and if a coarsely powdered sample of the coal becomes pasty or semi-fluid at this temperature, it is a strong inference that the coal will coke on carbonisation—a fact noted by Anderson, and which is very useful in practice as a rough test. About these temperatures, also, the resin bodies and hydrocarbons begin to decompose.

The resin bodies at low temperature yield saturated hydrocarbons, unsaturated, chiefly hexahydrides or naphthenes, together with some oxygenated compounds; while the hydrocarbons yield paraffins and liquid products—all these primary constituents undergoing further decompositions at slightly higher temperatures. The liquids so produced begin to distil out as tar vapours and hydrocarbon gases, and leave behind with the residuum pitch, which at 500° C. forms a mass already well coked together if the residuum from the humus is not too large in quantity. The coke formed at this temperature is, however, soft; but if the heat be raised to 1000° C. the pitch residue undergoes further decomposition, yielding gas and leaving carbon, which binds the mass into a hard coke.

It has been shown by Muck and other observers that it is not always the coal containing the largest amount of volatile matter that evolves gas most rapidly or is richest in hydrocarbons, and this naturally follows from the fact that the coals which have the highest oxygen percentage are mostly those giving high volatile matter. As these are rich in the humus bodies which yield most of the diluting gas and but little tar or rich hydrocarbon gases, they cannot give the high result of a coal in which the oxygen content is about 10 per cent. or rather lower, and which contains a large percentage of resin bodies.

Experience shows that the weathering of coal is a phenomenon which is dependent upon the absorption of oxygen from the air; and this weathering is fatal to the coking of some coals, the slacks of which are so susceptible to oxidation that a few days' or weeks' exposure destroys their coking power. Now the avidity of oxygen for some vegetable resins is well known; the rapidity with which copal will absorb oxygen from the air may be taken as an example. Common resin has itself been formed by the oxidation of turpentine, and countless ages under conditions tending to reduction may well have whetted anew the resinic appetite for oxygen. In any case, the resin bodies are the compounds present in the coal most likely to possess this property; and it is the chemical actions so caused which lead to slow combustion, and, when accelerated by any rise in the surrounding temperature, is capable of generating sufficient heat to lead to the spontaneous ignition of masses of broken coal large enough to prevent the escape of the heat as it is developed.

Coal exhibits, to a lesser extent, the same property of absorbing gases that charcoal does. The least absorbent will take up one and a quarter times its own volume of oxygen, while many bituminous coals will absorb more than three times their volume of the gas. This action, at first largely physical, presents the oxygen in a probably active condition to the resin bodies in the coal, and leads to the rapid "weathering" and destruction of the coking properties found with some kinds of coal.

Boudouard has shown that when coal is weathered humus bodies are produced, and the coking power is lessened or destroyed. In seven samples of various coals the humus constituents were increased by the oxidation, which seems to show that the action of the absorbed oxygen is to attack the resin compounds; and as we know that carbon dioxide and moisture are the chief products of the earlier stages of heating of masses of coal, it seems probable that the result is a conversion of resinic into humus bodies with evolution of these gases. It is this change that leads to the serious deterioration in the gas and tar made from coal which has been too long in store; while the fact that a cannel coal like boghead or a shale does not weather is partly due to its dense structure, and also, in the same way, is an indication that the resin bodies of which it is chiefly composed are of a different type—a fact borne out by their resistance to certain coal solvents which freely attack the ordinary resin matter.

It has been shown that the coals richest in resin bodies are the cannels, whilst those that contain most of the residues of the humus bodies and least of the resin constituents are the steam coal and anthracite, and between these extremes come the large class of bituminous coals.

Many classifications of coal have been suggested, some based on their chemical, some on their physical, and others on their coking properties. Of the latter, the most generally adopted is that suggested by Gruner, in which he tabulates bituminous coals into five classes. Although Schondorff, Muck, and others have shown that it is not applicable to all kinds of coal, still this criticism applies to all classifications that have been proposed.

		Carbon	Hydrogen	Oxygen
1. Dry Coal ...	Long flame and non-coking ...	75–80	4·3–5·5	13·0–18·5
2. Fat gas coal ...	Coke porous and brittle	80–85	5·0–5·8	10·0–13·2
3. Semi-fat or furnace coal	Good coke, but porous... ...	84–89	5·0–5·5	5·5–10·0
4. Coking coal ...	Best coke ...	89–91	4·5–5·5	4·5– 5·5
5. Lean coals and anthracite ...	Non-coking ...	90–93	3·0–4·3	3·0– 4·5

This arrangement shows not only the coking properties, but also the changes in composition which the coal undergoes, the concentration of carbon, and reduction in highly oxidised bodies. In the first class we have the dry coals, yielding large volumes of gas and liquid products on distillation; and these—as might be expected—most resemble the lignites, and share with them the property of non-coking or binding together of the residue on carbonisation. This is due to the fact that the humus-like bodies are still present in much larger quantities than the resinic compounds and hydrocarbons, and as on distillation they leave no binding material in the residue, the resinic bodies cannot supply enough to give more than a friable mass.

In the second class of coals, altered conditions of temperature, pressure, and time have led to further decompositions of the humus bodies, and the resinic constituents and hydrocarbons having increased in ratio by concentration, a point is reached at which coking takes place, although not of a really satisfactory character.

In the third class, the action has still continued with further concentration of the resin bodies, hydrocarbons, and residuum, with the result that the former bodies are so increased in comparison to the humus and residuum that a good coke results, although, for reasons that will be discussed when speaking of coking processes, it is rather too porous and bulky.

In the fourth class, the proportion of resin and hydrocarbon bodies has reached the right ratio as compared with the humus and residuum, and the best coking coal is obtained. Bituminous coals of the kind classified by Gruner may therefore be looked upon as an agglomerate of humus and the degradation products of these bodies down to carbon, luted and protected by resin bodies and their derivatives; steam coal and anthracite as the degradation products of humus which has nearly completed its decomposition owing to the small quantity of resin bodies in the original vegetation; cannel coal as consisting mainly of resin bodies, which, having been in a semi-fluid condition, have mingled with the earthy matter in contact with it, so obtaining the high ash found in many kinds.

In putting forward this theory as to the composition of coal, I wish it distinctly understood that by the terms "humus" or "resin" bodies I do not imply any one definite compound, but merely bodies of this character—the humus bodies all containing a percentage of hydrogen from 5 per cent. downwards, while the resin bodies all contain a percentage of hydrogen above 5 per cent. If it is once admitted that coal is a conglomerate of the kind I have indicated, it explains all those obscure points which no other theory touches—such as why with two coals of almost identical composition and of high oxygen content one should be a coking and the other a non-coking coal, the reason being that in the one the high oxygen content is due to humus bodies, which will not coke owing to the low pitch-forming nature of the hydrocarbons, while with the other the oxygen is due to resin bodies, which are essential to good coking.

In 1898 Anderson and Roberts, as the result of a long research upon the chemical properties of Scotch coals, came to the conclusion that a considerable part of the organic matter in coal consists of a complex compound comparatively rich in nitrogen, and also containing sulphur, and that there is also present resinous material, while the remaining constituents are composed of degradation products of the original carbohydrates of the coal plants, a theory which in its essentials agrees very well with my views on the subject.

During the present year (1911) Burgess and Wheeler have published the results of a series of experiments upon the distillation of coals at various temperatures which lead them to conclude that coal contains two types of compounds of different degrees of ease of decomposition. The more unstable decomposes below 750° C., and yields on distillation the paraffin hydrocarbons and no hydrogen; the other decomposes only at or above 750° C., and yields hydrogen only, or possibly hydrogen and oxides of carbon. The latter they suppose to be a degradation product of cellulose; the former to be derived from the resins and gums from the coal plants. The authors consider that the difference between one coal and another is determined by the proportion in which these two types exist in the coal.

All the evidence that can be adduced shows that when a coal undergoes destructive distillation all the hydrocarbons, together with the resin and humus constituents, undergo decomposition at a temperature certainly well below 700° C., and that as the liquid and gaseous products distil out they leave behind their less volatile residues as a pitch, which lutes together the carbon particles and forms soft coke; while as the temperature rises above 750° C., the pitch residue decomposes, yielding hydrogen, carbon monoxide, and methane as gases, while the carbon residue from the pitch binds the residual mass into coke. It is this residual pitch that Burgess and Wheeler have mistaken for a primary constituent of coal.

It is clear, however, that (putting detail on one side until our knowledge has been broadened by experience) the answer to the question as to what is the composition of coal—whether the answer is derived from a consideration of the actions taking place during its formation and of the substances from which it was derived, or is obtained from analytical data, as was done by Anderson and Roberts, or from the products of distillation, as has been done by Burgess and Wheeler—must be that coal is a conglomerate of humus and its degradation products with the resinic bodies and their derivatives.

(In the second lecture of the series, Prof. Lewes traced the alterations in the methods of carbonisation from Murdoch's pot stills to the latest forms of gas-making retorts, showing the reasons that led to the horizontal iron retort, its gradual replacement by fire-clay retorts, the introduction of the inclined retort, and the improvements in gas settings.)

Since 1893, when the advent of the incandescent mantle as a practical method of developing light began to do away with the necessity for gas of high illuminating value, so general became the adoption of the mantle that in 1900 applications began to be made in Parliament in various Gas Bills to reduce the standard of light for those companies whose previous average had been about 16 candles, it being felt that a 14-candle gas was better fitted for yielding light with the incandescent mantle, power in the gas engine, and for heating in gas stoves than higher qualities; and it also gave the possibility of economies in manufacture, which it was hoped might lead to lowering of the price of gas to a point at which it would better compete with fuel gas for power purposes.

During the last ten years there has been an amount of activity in attempts to alter the process of gas manufacture which has exceeded any that has taken place since the first few years of its inception, and this new era may be considered to have started with the inauguration of the vertical retort, in which, by utilising a large oval fire-clay retort set on end with a slight taper from bottom to top, much larger charges could be used than had been possible with the horizontal or inclined retorts, and in which also gravity was utilised to the full for charging and discharging.

The vertical retort dates back to 1828, when it was first introduced by John Brunton, who, finding that the gas could not escape freely from the lower portions of the charge, and so created considerable pressure, put a perforated pipe in the centre of the charge to afford an easy way of escape. Nothing more was heard of the process, so it probably failed; but at later dates attempts of the same kind were made by Lowe and Kirkham and also by Scott.

After these early experiments nothing seems to have been done for sixty years until the summer of 1903, when Settle and Padfield put up a vertical retort at Exeter, and Dr. Bueb started experimenting on the subject in Germany.

Vertical retorts during the last few years have met with great success on the Continent, and their use has spread with the greatest rapidity.

In England it has been felt that, good as are the results obtained with the vertical retort working intermittently, *i.e.*, by putting in a full charge of coal, carbonising and drawing, and then recharging in the same way as with the old form of retorts, great improvements could be effected by making the process continuous, as was first attempted by Settle, so approaching more nearly to uniform conditions of carbonisation. Vertical retorts on this principle have been devised by Messrs. Duckham and Woodall, and by Messrs. Glover and West, and they certainly show results which will lead to continuous carbonisation being one of the most important factors in the future of gas manufacture.

The economies to be derived from carbonisation in bulk have on the Continent led to still further advances in the size of the charge, and little more than three years ago chamber carbonisation was introduced at Munich, in which charges of 3 to 8 tons of coal can be dealt with at a time, and this method also has met with a large amount of success, a number of installations having been erected on the principles laid down by Ries, Koppers, and others.

Many observers felt that the old horizontal retort could be made to yield better results than had hitherto been obtained, and Mr. C. Carpenter, at the South Metropolitan Gas Company's works, found that great advantages may be obtained by packing the old horizontal retorts full of coal, as had been suggested by Kunath in 1885, instead of only partly filling them, this doing away with the large space that had always been left above the charge of carbonising coal, and so eliminating to a great extent the baking of the gases and contact with the heated crown of the retort, this giving a distinct advance in make and quality not only in the gas, but in the tar.

Whilst these changes in form have been taking place, improvements in the settings, gas fuel, and regenerative firing have made such strides that the temperatures employed are limited only by the nature of the refractory materials used, and the result of these higher temperatures with light charges is to largely increase the volume of the gas obtainable per ton of coal, but at the same time its illuminating value is reduced, and the tar is deteriorated, and it also gives rise to stoppage of ascension pipes and an increase in naphthalene troubles in the service.

When iron retorts were used, the temperatures that could be employed were limited by the softening point of the iron, and rarely rose above 800° C., and although only 9000 cubic feet of gas were made per ton of coal, the gas was rich in heating and lighting value, and the tar excellent in quality. The advent of the fire-clay retort, as has been seen, enabled temperatures to be increased, and 10,000 cubic feet of gas was the general yield. With the introduction of regenerative firing, the volume of gas obtained rose to 11,000 cubic feet, whilst the more modern developments approach a yield of 13,000.

In all these changes the gas manager has been actuated by the desire to get the greatest volume of gas possible per ton of coal, and at the same time to do it with the greatest economy, and but little attention has been paid to the quality of the tar and coke, which have been looked upon as by-products. In point of fact, the tar, when temperatures were pressed to their highest in lightly charged horizontal retorts, became so poor and choked with naphthalene and free carbon as to be almost valueless.

The introduction of large masses of coal in carbonisation, for reasons which will be discussed fully later, has led to distinct improvements in this respect, and although there is no modern tar which approaches in value the product of the old iron retort, the improvement in many places of late has been very marked.

(The gradual growth of the coke-making industry was then dealt with from the Meiler heap to the modern coke recovery ovens.)

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—The following are among the courses that will be held in the Faculty of Science at University College during the present term:—"General and Geological Aspects of Palæobotany," by Dr. Marie Stopes, on Tuesdays at 4 p.m., beginning on January 16; "Instruments and Maps," by Mr. M. T. Ormsby, on Tuesdays at 4 p.m., beginning on January 23; "Vertebrate Palæontology," by Prof. J. P. Hill, on Tuesdays at 5 p.m., beginning on January 23. In connection with the Francis Galton Laboratory for National Eugenics, Prof. Karl Pearson will deliver two lectures on "Sir Francis Galton," on Tuesdays, January 30 and February 6, at 8.30 p.m., to be followed on subsequent Tuesdays by a course of six lectures on "Some Problems of Eugenics."

WE learn from the *Revue Scientifique* that M. Georges Leygues has just given 25,000 francs to the University of

Paris in aid of the new Institute of Chemistry, and that M. David Weill has made a third donation of 30,000 francs to the University.

BUILDINGS costing nearly 200,000*l.* are, says *Science*, either being constructed or will be started at the University of Wisconsin before the next academic year opens. Nine new structures will be completed within the next twelve months on various parts of the University grounds. The new buildings and their cost will be as follows:—Biology hall, 40,000*l.*; wing to library, 33,000*l.*; home economics building, 23,000*l.*; model high school, 30,000*l.*; women's dormitory, 30,000*l.*; agricultural chemistry, 18,000*l.*; chemistry building wing, 15,300*l.*; horticultural building, 11,400*l.*; gymnasium annexe, 3000*l.*

A COURSE of ten lectures on illuminating engineering will be given on Tuesday evenings at the Northampton Polytechnic Institute, St. John Street, London, E.C., commencing January 16. The lectures are intended for a technical audience, and each lecture will be given by a specialist in the particular subject. The subjects of the lectures are:—"The Nature of Light and of Radiation"; "Photometry and the Measurement of Light"; "The Production of Electric Light and its Distribution"; "The Chemistry of Gas Manufacture and Lighting"; "The Use of Shades and Reflectors"; "Physiological Factors in Illumination"; "The Practical Use of Arc Lamps"; "The Practical Use of Metallic Filament Glow Lamps"; "The Practical Use of Gas Lamps."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Microscopical Society, December 20, 1911.—Mr. H. G. Plimmer, F.R.S., president, in the chair.—F. Shillington **Scales**: The photomicrography of the electrical reactions of the heart. The lecturer described the principle and construction of the Einthoven string galvanometer, with especial reference to the optical arrangements and the methods of photographing the movements of the wire, resulting from the differences in potential set up by the heart-beat. Photomicrographs of the movements of the hearts of various animals under the influence of drugs were shown.—Rev. Hilderic **Friend**: British Tubificidæ. The author first gave a brief historical sketch, alluding to the work of Lankester, Beddard, and Benham, and the various Continental and other authorities who have in past years written on the family. After showing the difficulties attending definition, and the value of the setæ for the purposes of classification, the author proceeded to arrange the British species in two classes:—(1) those genera which are destitute of capilliform setæ; and (2) those which possess them. These two groups are again subdivided, and no fewer than thirty species, besides some subspecies and varieties, are placed on record, of which ten are described for the first time, and sixteen have been added by the author during the year. Specially interesting is the discovery of a new genus, named Rhyacodrilus, containing two species, of which one (*R. bichaetus*, Friend) is new to science. These two species are as yet known only in Derbyshire. Hyodrilus is now definitely recorded as British, with no fewer than five species.

Linnean Society, December 21, 1911.—Dr. D. H. Scott, F.R.S., president, in the chair.—Rev. Hilderic **Friend**: Some annelids of the Thames Valley.

DUBLIN.

Royal Irish Academy, December 11, 1911.—Rev. Dr. Mahaffy, president, in the chair.—W. F. de V. **Kane**: Clare Island Survey Reports.—Butterflies and moths. The lepidopterous fauna of Clare Island is relatively poor, and shows a marked preponderance of northern species. The island affords a second Irish habitat for *Dasydia obfuscaria*, a remarkably melanic variety. The coast sandhills of Achill and of isolated points on the adjoining mainland are noteworthy for the occurrence of *Nyssia zonaria*, and the discontinuous range of this species, with its wingless female and sluggish herb-eating larva, presents an interesting and difficult problem to the student.—F. Balfour **Browne**: Water-beetles. Ninety species of water-beetles are now known to occur in the Clare Island district. Amongst these are some uncommon species, notably *Deronectes griseo-striatus* and *Agabus congener*; the latter insect had not been previously found in Ireland. The local *Octhebius legolissii* occurred on Clare Island. In addition to the full lists of species, a careful analysis is given of the West Mayo water-beetle fauna. The author recognises the occurrence of a distinct west-ranging Irish group of species—of both northern and southern European origin—a fact which has also been noticed in other sections of the fauna of the west of Ireland.—Miss Jane **Stephens**: Fresh-water sponges. Five species of fresh-water sponges were found, namely, *Spongilla fragilis*, *S. lacustris*, *Ephydatia mülleri*, *E. fluviatilis*, and *Heteromeyenia ryderi*. The first-named is new to Ireland. Of the remaining species, *H. ryderi*, a sponge common to North America and the west of Ireland, is very widely distributed throughout the district examined. Different forms of this species are described for the first time from Ireland. The differences between the sponges growing in lakes lying on limestone and those in lakes on non-calcareous rocks are noted.

BOOKS RECEIVED.

Die Chemie der Cellulose unter besonderer Berücksichtigung der Textil- und Zellstoffindustrien. By Prof. C. G. Schwalbe. Zweite Hälfte (Schluss des Werkes). Pp. 273–666+xii. (Berlin: Gebrüder Borntraeger.) 14.80 marks.

Handbuch der bautechnischen Gesteinsprüfung. By Prof. J. Hirschwald. Erster Band. Pp. xi+387. (Berlin: Gebrüder Borntraeger.)

Annuaire Astronomique et Météorologique pour 1912. By C. Flammarion. Pp. 360. (Paris: E. Flammarion.) 1.50 francs.

Mineralogy. By Dr. F. H. Hatch. Fourth edition. Pp. ix+253. (London: Whittaker and Co.) 4*s.* net.

Increasing Human Efficiency in Business. By Prof. W. D. Scott. Pp. v+339. (London: Macmillan and Co., Ltd.) 5*s.* 6*d.* net.

The Rational Arithmetic for Rural Schools. By G. Ricks. Scholar's Book. Third Year's Course. Pp. 48. Fourth Year's Course. Pp. 48. (London: Macmillan and Co., Ltd.) 3*d.* each.

Black's Literary Readers. By J. Finnemore. Book vi. Pp. 268. (London: A. and C. Black.) 1*s.* 9*d.*

Twenty-seventh Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1905–6. Pp. 672. (Washington: Government Printing Office.)

Supplement to the Fourth Report of the Wellcome Tropical Research Laboratories at the Gordon Memorial College, Khartoum. By Dr. A. Balfour, Captain R. G. Archibald, and others. Pp. 448. (London: Baillière, Tindall and Cox.) 15*s.* net.

Handbuch der vergleichenden Physiologie. Edited by H. Winterstein. 18 Lieferung, Band ii., Erste Hälfte. Pp. 1145–1563+x. 19 Lieferung, Band iii., Erste Hälfte. Pp. 160. (Jena: G. Fischer.) 5 marks each.

Complete Yield Tables for British Woodlands and the Finance of British Forestry. By P. T. Maw. Pp. xii+108. (London: Crosby Lockwood and Son.) 7*s.* 6*d.* net.

Shackleton in the Antarctic: being the Story of the British Antarctic Expedition, 1907–9. By Sir E. Shackleton, C.V.O. Pp. 255. (London: W. Heinemann.) 1*s.* 6*d.*

Flashes from the Orient, or a Thousand and One Mornings with Poesy. By J. Hazelhurst. Book four—Winter. Pp. xi+284. (London: Hazell, Watson and Viney, Ltd.) 1*s.* 6*d.* net.

An Intermediate Course of Practical Physics. By Rajanikanta De. Pp. xii+284. (Calcutta: International Publishing Company.)

Willing's Press Guide, 1912. Pp. xiv+489. (London: J. Willing, jun., Ltd.) 1*s.*

Biological Aspects of Human Problems. By Dr. C. A. Herter. Pp. xvi+344. (London: Macmillan and Co., Ltd.) 6*s.* 6*d.* net.

A Geography of the World. By B. C. Wallis. Pp. xvi+372. (London: Macmillan and Co., Ltd.) 3*s.* 6*d.*

The Chemistry of Bread-making. By J. Grant. Pp. vi+224. (London: E. Arnold.) 5*s.* net.

Memories of a School Inspector: Thirty-five Years in

Lancashire and Suffolk. By A. J. Swinburne. Pp. 274. (Saxmundham: The Author; and London: McDougall's Educational Company, Ltd.) 2s. 6d. net.

Microbiology for Agricultural and Domestic Science Students. Edited by Prof. C. E. Marshall. Pp. xxi+724. (London: J. and A. Churchill.) 10s. 6d. net.

The Metallurgy of Steel. By F. W. Harbord and J. W Hall. 2 vols. Fourth edition. Vol. i. Pp. xvi+522+xxix. Vol. ii. Pp. xviii+523–933+xxix. (London: C. Griffin and Co., Ltd.) 36s. net.

From Constantinople to the Home of Omar Khayyam. Travels in Transcaucasia and Northern Persia for Historic and Literary Research. By Prof. A. V. W. Jackson. Pp. xxxiii+317. (London: Macmillan and Co., Ltd.) 15s. net.

Die Reizbewegungen der Pflanzen. By Dr. E. G. Pringsheim. Pp. viii+326. (Berlin: J. Springer.) 12 marks.

A Text-book of Botany for Colleges and Universities. By Members of the Botanical Staff of the University of Chicago, Drs. J. M. Coulter, C. R. Barnes, and H. C. Cowles. Vol. ii. Ecology. Pp. x+485–964+pp. a—q. (New York, &c.: American Book Co.)

DIARY OF SOCIETIES.

THURSDAY, JANUARY 11.

ROYAL SOCIETY, at 4.30. — On the Propagation of Waves through a Stratified Medium, with Special Reference to the Question of Reflection: Lord Rayleigh, O.M., F.R.S.—On the Variation of the Specific Heat of Water, with Experiments by a New Method: Prof. H. L. Callendar, F.R.S.—The Mechanism of the Semipermeable Membrane and a New Method of Determining Osmotic Pressure: Prof. F. T. Trouton, F.R.S.—Mobility of the Positive and Negative Ions in Gases at High Pressures: A. L. Kovarik.—A New Method of Determining the Radiation Constant: G. A. Shakespear.—The Mechanics of the Water Molecule: Dr. R. A. Houston.

MATHEMATICAL SOCIETY, at 5.30.—Successions of Integrals and Fourier Series: W. H. Young.—A New Condition for the Truth of the Converse of Abel's Theorem: G. H. Hardy and J. E. Littlewood.—On Mersenne's Numbers: A. Cunningham.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Some General Principles Involved in the Electric Driving of Rolling Mills: C. A. Ablett.

CONCRETE INSTITUTE, at 8.—Discussion on Two Reports of the Reinforced Concrete Practice Standing Committee: (*a*) The Standardisation of Drawings of Reinforced Concrete Work; (*b*) Consistency of Concrete.

FRIDAY, JANUARY 12.

ROYAL ASTRONOMICAL SOCIETY, at 5.— Note on Certain Co-efficients appearing in the Algebraic Development of the Perturbing Function: R. T. A. Innes.—Sur la longitude de l'Observatoire de Lille, déterminée par télégraphie sans fil: R. Jonckheere.—The Constitution of the Ring Nebula in Lyra (N.G.G. 6720): J. W. Nicholson.—Observations of Occultations of Stars by the Moon made in the year 1911: Royal Observatory, Greenwich.—An Example of the Use of Spherical Harmonic Analysis: F. G. Brown and H. H. Turner.—A New Form of Observatory Dome: C. P. Butler.

MALACOLOGICAL SOCIETY, at 8.—Note on the Genus Panope Ménard: W. H. Dall.—Nomenclature of the Veneridæ.—A Reply to Dr. W. H. Dall: A. J. Jukes-Browne, F.R.S. — The Occurrence of *Helicella heripensis* in Great Britain; Notes on Some British Non-marine Mollusca: A. W. Stelfox.—Characters of Two Undescribed Land Shells from Colombia; Explanation of the Figures Occurring in Westerlund's "Sibirien's Land och Söttvatten Mollusker," 1876; On Two Pre-occupied Specific Names in Gasteropoda: G. K. Gude.

MONDAY, JANUARY 15.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.

TUESDAY, JANUARY 16.

ROYAL INSTITUTION, at 3.—The Study of Genetics: Prof. W. Bateson, F.R.S.

ROYAL STATISTICAL SOCIETY, at 5.—The Recruiting of the Employing Classes from the Ranks of the Operatives in the Cotton Industry: Prof. S. J. Chapman and F. J. Marquis.

ILLUMINATING ENGINEERING SOCIETY, at 8.—Colour Discrimination by Artificial Light: T. E. Ritchie.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Further Discussion:* Reinforced Concrete Wharves and Warehouses at Lower Pootung, Shanghai: S. H. Ellis.—The Direct Experimental Determination of the Stresses in the Steel and in the Concrete of Reinforced-Concrete Columns: W. C. Popplewell.—Composite Columns of Concrete and Steel: W. H. Burr.

WEDNESDAY, JANUARY 17.

ROYAL METEOROLOGICAL SOCIETY, at 7.45.—Annual General Meeting.—Presidential Address, Some Meteorological Observations: Dr. H. N. Dickson.

ENTOMOLOGICAL SOCIETY, at 8.—Annual General Meeting.

ROYAL MICROSCOPICAL SOCIETY, at 8.—President's Annual Address: On Certain Blood Parasites.

INSTITUTE OF METALS, at 10.30.—A Metallographic Hygroscope: Prof. Carl A. F. Benedicks.—A Study of the Properties of Alloys at High Temperatures: Dr. G. D. Bengough.—Further Experiments on the Inversion at 470° C. in Copper-Zinc Alloys: Prof. H. C. H. Carpenter.—The Influence of Oxygen on Copper containing Arsenic or Antimony: R. H. Greaves.—The Influence of Tin and Lead on the Micro-structure of Brass: F. Johnson.—A Contribution to the History of Corrosion; The Corrosion of Condenser Tubes by Contact with Electro-Negative Substances: Arnold Philip.—The Nomenclature of Alloys: Dr. W. Rosenhain. The Behaviour of Certain Alloys when Heated in Vacuo: Prof. T. Turner.

THURSDAY, JANUARY 18.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* The Physiological Effects of Low Atmospheric Pressures, as observed on Pike's Peak, Colorado (Preliminary Communication): Dr. J. S. Haldane, F.R.S., C. G. Douglas, Prof. Y. Henderson, and Prof. E. C. Schneider.—A paper on the effect of altitude on the dissociation curve of the blood: J. Barcroft, F.R.S. — Note on *Astrosclera willeyana* Lister: R. Kirkpatrick. — *Herpetomonas pediculi*, nov. spec., parasitic in the Alimentary Tract of *Pediculus vestimenti*, the Human Body Louse: Dr. H. B. Fantham.—Antelope Infected with *Trypanosoma gambiense*: Capt. A. D. Fraser and Dr. H. L. Duke.

ROYAL INSTITUTION, at 3.—The New Astronomy: Prof. A. W. Bickerton.

LINNEAN SOCIETY, at 8.—Some Features of the Marine Flora of St. Andrews: Dr. A. Anstruther Lawson.

ROYAL SOCIETY OF ARTS, at 4.30.—The Old District Records of Bengal: Rev. W. K. Firminger.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—*Adjourned Discussion:* Residence Tariffs: A. H. Seabrook.

INSTITUTION OF MINING AND METALLURGY, at 8.—A Submerged Flexible-joint Main: F. Reed.—Unwatering Tresavean Mine: C. Brackenbury.—Notes on the Operation of Two Winding Engines: H. M. Morgans.—Stoping at the Calamon Mine: C. P. Corbett Sullivan.

FRIDAY, JANUARY 19.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—The Evolution and Present Development of the Turbine Pump: Dr. Edward Hopkinson and Alan E. L. Chorlton.

ROYAL INSTITUTION, at 9.—Heat Problems: Sir J. Dewar, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Turbo-blower and Turbo-compressor: G. Ingram.

SATURDAY, JANUARY 20.

ROYAL INSTITUTION, at 3.—The Banyoro—A Pastoral People of Uganda; (1) The Milk Customs: Rev. J. Roscoe.

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