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Popular Science Exhibitions.

NOW that the British Empire Exhibition has come to an end—for this year at any rate—it may be of interest to record some impressions of the manner in which the Royal Society's Exhibition of Pure Science, which was arranged in the Government building, has appealed to the public, and of the extent to which it has fulfilled the objects with which it was organised.

The arrangement of this exhibition was undertaken by the Royal Society, at the request of the Government, for the purpose of showing the essential part played by pure science among the multifarious interests and activities of the Empire. Everywhere in the great Exhibition the applications of science to industry were to be seen, but the fundamental work of scientific inquiry, in which many of them had their origin, would have been unrepresented unless some special effort had been made to bring it to the public notice. Accordingly, this exhibition, illustrating many aspects of purely scientific research at the present time, and indicating how industry has developed from similar inquiries in the past, was arranged.

The exhibition has not been without its humours. One was the difficulty of returning a satisfactory answer to the inquirer who, after spending some time in the galleries, said, "Yes, but how do you know there is an atom, and how do you know there are electrons inside it?"; and another, the problem presented by a visitor who, on observing that the Milne-Shaw seismograph has a rotating drum giving a record which has to be changed every twenty-four hours, asked, "What happens if there is an earthquake while you are changing the record?"

Nevertheless, it may be said that the exhibition has been an unqualified success. The public, non-scientific as well as scientific, has been really interested, and some, at least, must have gone away with a clearer understanding of the purposes for which men devote their lives to scientific experiment and inquiry. This success may be attributed largely to the policy adopted of making the exhibition a living one. The exhibits were contributed by scientific workers actually engaged in the researches represented, and supplemented, where necessary to illustrate a subject fully, by instruments contributed by some of the leading makers. Wherever possible, actual demonstrations were given, and a scientific staff was in attendance throughout to carry out the demonstrations and to explain the exhibits. This policy was fully justified by the continued interest of visitors.

The Handbook published in connexion with the exhibition has been of great assistance. In this book is

made available, for the small cost of a shilling, a series of non-technical articles on current scientific topics by leading authorities; and the best proof of its popularity is the fact that more than two thousand copies were disposed of, while its sale is increasing as it becomes better known, and is likely yet to continue now that the Exhibition is closed.

The encouraging success which has met this attempt to present pure science in a less austere light than often surrounds it in the eyes of the general public, leads naturally to the inquiry as to whether a greater use cannot be made of scientific exhibitions as a means to this end. Nothing but good can result from such efforts to spread a clear understanding of the true aims and purposes of science. That pure science is the modern expression of the elementary desire for knowledge—for the discovery of natural truths—that it is only by the disciplined quest in unknown fields that those benefits which science gives to the human race can accrue, is too little understood and too easily lost sight of, because of the very magnitude of the results themselves.

It ought to be possible to make an exhibition of this kind an annual event. The Scientific Products Exhibitions, organised by the British Science Guild in 1918 and 1919; the Scientific Novelties Exhibitions held at King's College, London, in connexion with the King Edward's Hospital Fund in January 1923 and 1924, and experience at Wembley show that such displays of scientific work and results are much appreciated by the public. The desire for truth is at least as strong and as laudable an inspiration to the human spirit as the desire for beauty, and an event of this kind might well become to the world of science what the annual exhibition of the Royal Academy is to the world of art.

Such an annual exhibition would serve to maintain interest in the work of scientific inquiry, and help to keep it in the public mind in its just relation to the other activities in life. To men of science it might become a valuable auxiliary to the usual methods of publication of new scientific work, by reaching a wider public than the transactions of the scientific societies or the scientific periodicals can ever hope to do; and to the museums, it could be a source from which to obtain objects of interest from time to time, and thereby do much to prevent such national misfortunes as, for example, the dispersal, during the War, of the apparatus used by H. G. J. Moseley in his historic work on the X-ray spectra of the elements. It is to be hoped, therefore, that whatever facilities or funds are required to secure the continuance of the pure science exhibits and demonstrations now at Wembley will be provided.

Archæology of Stonehenge.

The Stones of Stonehenge: a Full Description of the Structure and of its Outworks. By E. Herbert Stone. Pp. xv+150+36 plates. (London: Robert Scott, 1924.) 21*s.* net.

MR. STONE is to be congratulated on having written a book which has long been wanted for giving a good up-to-date description of Stonehenge. He has gone very thoroughly into the subject, viewing it from all points, describing the arrangement of the stones, their source and geological nature; also a great many little items of particular interest which the monument and the site afford, and they are very well illustrated by photographs and drawings. Being a civil engineer and of much experience, his profession has taken him to places and amongst primitive people where he was able to note ways and means of working stones analogous to those at Stonehenge, so he is well qualified to give a description. This will be seen in the chapter on quarrying, where he mentions and illustrates methods in use in India comparable with those employed by neolithic man, and a stone maul can be seen in one photograph which is identical with those found at Stonehenge.

To gain a greater knowledge of this subject, Mr. Stone has experimented upon actual Sarsen boulders derived from the source the Stonehenge Sarsens were taken from. He has culled the best information from modern archæology and gives also the opinions and accounts handed down to us from early pioneers, some of them rather impossible views, but amongst them a certain amount of good reasoning which the reader may find pleasure in sifting. He also quotes the account of the foreign stones given by Dr. Thomas, whose long and patient search for their source was rewarded by finding all the Stonehenge varieties at one locality in Pembrokeshire, putting beyond doubt the source of their origin.

The author is at his best as an engineer when he explains a simple method of erecting the stones, which, if not exactly similar in all details, must approach very nearly the one employed by the builders. He calculated with precision the weights and strains and the forces necessary for movement, and has shown by actual experiments carried out by himself how primitive people, with simple contrivances, could handle massive stones and set them up with great accuracy and with comparatively little labour. Thick raw-hide ropes no doubt would have been used, and their great tensile strength can be judged when remembering what a strain an ordinary violin string can endure. The chapter devoted to this account of engineering skill will certainly be read with great interest.

The author is in error over a fallen foreign stone which figures in Plate 6, Fig. 2, in supposing the two holes seen on it were made, after it had fallen, by Romano-British people for grinding corn, first, because the cupped holes would be too small, and secondly, because the stone is evidently a lintel. It is curved in the same way as are those of the outer circle, but in this one the curve is sharper, showing it belonged to something smaller. The holes in the stone are equidistant from the ends and are dowe holes like those in the big lintels, and this stone may formerly have fitted over the terminal upright stones of the horseshoe. It is unlikely that a Romano-British peasant would have gone to the arduous task of making holes in a stone so hard when querns could be easily procured. That this was so is evident from the great quantity of broken querns found in British villages; even those of Andernach lava are fairly common, and no doubt were brought in the finished state by hawkers and perhaps by the same route as the Romano-Gallo ware.

A love for mathematics and careful measurements may have prompted the author to become interested in Sir Norman Lockyer's conclusion that the place had been laid out on astronomical lines. He has evidently studied the subject very carefully, and his exposition of it is of decided interest. It has been a bitterly controversial subject amongst archæologists, but is nevertheless one which cannot be lightly passed over, for there are certainly some points in it which are well worthy of consideration. The contention has been that Stonehenge is sepulchral, because stone circles and dolmens almost invariably shelter the dead, and that they do may be taken for granted.

Recent research at Stonehenge makes it appear beyond doubt that the site on which it stands has had a long history, and certain appearances have come to light of changes of building anterior to the present monument. The ditch is extremely primitive and well within neolithic times. It was certainly defensive, for there is a palisade at the entrance, and at that time it would be secular, sheltering a little community under a much-respected chief. When he died he would have been buried, possibly under a dolmen in the middle of the enclosure, and a circle of stones erected within the rampart. It would then have become sacred, and the ditch, no longer wanted, would be allowed gradually to silt up. After a long lapse of years, and for some unknown reason, it was decided to erect Stonehenge, and to do so the dolmen and circle disappeared. Whether the neolithic inhabitants of the country decided amongst themselves to do this, or were prompted to it by the advent of a foreigner, it is impossible to say, but the latter idea is the more probable, and although incapable of such a conception themselves, they would willingly do the work from tuition.

It is quite evident that the place was not a first attempt at building, and must have been designed by a master mind and a great engineer who had had much previous experience. He probably came from the south, and may even have participated in megalithic work in Egypt, though not an Egyptian. Under his careful guidance and drilling, and perhaps rehearsal of the work, he made the people do all he wanted. Whether or not he had acquired all the knowledge of the Egyptians one cannot say, but he must have been able to make an elaborate plan in laying out the place, and to calculate with fair accuracy the weight of stones and strain upon ropes, and other mechanical details.

Every one seems to be agreed that Stonehenge is definitely orientated towards the north-east, but the chief question is whether it was built entirely for sepulchral use. Probably it was not, because, having been previously a sepulchral spot, it is scarcely likely they would interfere with the buried remains and replace them with those of another person. It would preserve its sanctity because of the previous burial and be combined with the purpose for which it was erected. If that, or one of the purposes, was for determining the beginning of a particular season of the year, no very precise astronomical knowledge would be necessary, and it might well have been used for this purpose. A building so unique would command fame and reverence, making it a centre for the gathering of headmen of tribes to settle their important matters. No interment belonging to the period it represents has yet been found; cremated remains that have occurred belong to the Bronze Age, and therefore later in date, show that although it may have been secularised it still retained a sacred significance to a later race. The east and west stones on the rampart have not yet been archæologically explained, and one which was examined did not appear to be for sepulchral use.

The author has admirably expounded his theory in the chapter devoted to it, and even those who disagree with the astronomical theory will find much matter for careful consideration. Whether the research when concluded will throw more light upon the matter cannot be foretold, but when all is said and done there will yet be questions which will elicit the answer, "We do not know."

The book will prove interesting and instructive, not only to students of archæology, but also to all who take an interest in Stonehenge.

Rhododendrons.

Rhododendrons and the various Hybrids. By J. G. Millais. Second series. Pp. xii+264+53 plates. (London: Longmans, Green and Co., 1924.) 210*s.* net.

IT says much for the hold rhododendrons have secured in the estimation of horticulturists that Mr. J. G. Millais was so much encouraged by the success of his first work on the genus in 1917 as to prepare and publish a second volume of the same sumptuous character as its predecessor. The cost of the two volumes amounts to eighteen guineas, and there is certainly no other genus of trees or shrubs in which public interest is sufficiently strong to render possible the profitable issue of such volumes as these.

Whilst no genus of shrubs is so popular at the present time as Rhododendron (including, as it does, Azalea), that popularity is by no means a new one. Since the middle of last century at least, rhododendrons have been regarded as one of the most essential elements of the open-air garden. No rhododendron is indigenous to the British Isles, and only some half-a-dozen to the whole of Europe, the best known of which are the two species so abundant on the mountains of Central Europe—the so-called "Roses des Alpes." In 1736 *R. maximum* was introduced from the mountain summits of the Carolinas and Tennessee; in 1763 *R. ponticum* was brought from the Pontus region in Asia Minor; and between that date and 1809 were acquired for English gardens *R. caucasicum*, *R. catawbiense*, and *R. punctatum*. By this date also three species of the deciduous-leaved or Azalea section had reached Great Britain, namely, *R. viscosum* and *R. calendulaceum* from North America and *R. flavum* from Asia Minor. It was to these comparatively few species that the labours of the hybridists of one hundred years ago were necessarily confined. The range of colour amongst the evergreen species was a narrow one and extended only from white to pink and purple, but in 1825 *R. arboreum* from Northern India produced for the first time its blood-red flowers in Britain and thereby added a new and very valuable pigment to the hybridiser's palette. It may indeed be truly said to have completed the group of species from which the common type of garden hybrid rhododendron as we knew it up to twenty or thirty years ago was almost entirely derived.

Sir Joseph Hooker, during his famous journeys in the Himalaya (1847–1851), especially in Sikkim, sent home seeds of practically all the species native of that region, but most of them are only hardy in the southern and western maritime counties of England, and it was not until the 'eighties of last century that their "blood" began to show in the hardier hybrids. But now some of the best hardy varieties owe their merit largely to what they have inherited from *R. Aucklandii*, *barbatum*, *Thomsonii*, and *ciliatum*. The Himalayan species may be said to have initiated the second phase in the development of the modern garden rhododendron.

The third and contemporary phase is bound up almost entirely in the exploitation of the flora of Western China and Tibet, which we owe in the main to four British collectors, namely, Wilson, Forrest, Kingdon Ward, and the late Reginald Farrer. Wilson's travels in China ended in 1910, and the rhododendrons he introduced were fully dealt with in Mr. Millais' first volume. The new volume is for the most part concerned with the work of the last three collectors, of whom George Forrest is much the most prominent. Mr. Millais calculates the number of species of rhododendron now known to be about 670, about 300 of which have been brought to the knowledge of botanists by that collector.

In assembling in one volume full and adequate descriptions of all the new species published up to the present time, Mr. Millais has rendered a very valuable service to rhododendron lovers. The arrangement is alphabetical, but the student is helped by being told the "series" to which each species belongs, and in that way is given a useful lead towards visualising its general character. As a matter of fact, the genus is in a rather chaotic state at present. Species have been described in large numbers, many on very trivial differences, but no serious attempt has yet been made to co-ordinate them. The influx of new material is still going on, so perhaps the time for that is not yet.

Mr. Millais' book contains a good deal more than mere descriptive matter. He commences with a dissertation on shrub gardening in general, which, although somewhat outside the main theme, is extremely interesting and useful. That there is no one better qualified to discourse upon it, all who know Mr. Millais' own charming garden at Horsham will cordially agree. A valuable chapter on Chinese rhododendrons and the work of Forrest, Ward, and Farrer contains much original information supplied by the collectors themselves about rhododendrons as they were seen growing in their native habitats and the conditions under which they exist.

There is nothing rhododendron growers are more keen about than hybridisation. So many wonderful results have been obtained in the past that one cannot be surprised at that. Hybridising these shrubs is not unlike the labours of the old-fashioned gold miners. Conducted on well-reasoned lines, one may always be sure of obtaining something good, with the possibility of an occasional large nugget such as the late Sir Edmund Loder secured in *Rhododendron Loderi*. The author's useful résumé of the work done by prominent

breeders during recent years will be read with much interest. A chapter on cultural matters concludes the introductory part of the work.

Mr. Millais is to be congratulated on the successful accomplishment of a very arduous task. He has brought together very nearly all the knowledge about rhododendrons that really matters — which is a great thing to have done. Handling his book, one could wish sometimes that it were not so large, but then we should have missed the fine coloured pictures by Miss Beatrice Parsons and Miss Winifred Walker. Other coloured plates by Miss Snelling are excellent, and besides all this the book is lavishly illustrated by reproductions from photographs of plants both wild and cultivated.

W. J. BEAN.

The Origin of Solubility.

Solubility. By Prof. Joel H. Hildebrand. (American Chemical Society Monograph Series.) Pp. 206. (New York: Chemical Catalog Co., Inc., 1924.) 3 dollars.

TO a reader who has not followed recent American work on solubility, the contents of Prof. Hildebrand's book provide a pleasant surprise. Instead of a mere compendium of data, there is here a real attempt to develop a general theory of solubility, and of the even wider problems of miscibility in liquids, and of the properties of the resulting mixtures. The starting-point of this general theory is not the familiar Law of Osmotic Pressure of van 't Hoff, but the more fundamental Law of Vapour Pressures of Raoult. Thus, in the case of certain mixtures, Raoult's law is valid over the whole range of concentrations from 0 to 100 per cent., whereas van 't Hoff's law is limited to dilute solutions and, even when modified, cannot be extended in a similar way. An ideal solution is therefore defined as one which obeys Raoult's law at all temperatures and all pressures. This depends on the internal forces remaining undisturbed on substituting molecules of solute for molecules of solvent. The author discusses what are the properties of the individual liquids, the equality of which is likely to lead to this result, and concludes that equality of "internal pressure" is the most important factor. Moreover, if this condition is realised at one temperature and pressure, it is likely to be realised over the whole range.

Deviations from Raoult's law are of two types. "Negative" deviations are accompanied by a contraction and evolution of heat on mixing, and may be accounted for, at least in some cases, by the formation of unstable compounds of solvent and solute. "Positive" deviations, accompanied by an expansion and absorption of heat on mixing, are less easily explained. In general they could be accounted for by the *association* of one of the pure liquids, so that dilution with an inert solute would give rise to *dissociation*; but, when this is regarded as the only possible explanation, it leads to the assumption of polymerised molecules of argon in solution in liquid nitrogen, and in general to the necessity for assuming an altogether unreasonable degree of molecular complexity in order to account for the larger deviations. Positive deviations from Raoult's law can also be "explained" by the existence of wide differences in "internal pressure," but this is in a sense little more than a paraphrase.

The author is, however, considerate enough to give a simpler (if less rigidly proved) explanation, by using the familiar classification of liquids into (i) "normal" liquids with low dielectric constants and small residual fields of force round the molecules, and (ii), "polar" liquids with high dielectric constants and large or unsymmetrical fields of force. The polar molecules, he says, have an abnormally great attraction for each other, thus producing greater cohesions, internal pressures, surface tensions and heats of vaporisation. They therefore tend "to squeeze out, as it were, non-polar or slightly polar molecules from their midst"; and on account of this selective attraction of the polar molecules for each other, "the squeezing-out effect may be greater than it would be in the case of high internal pressure alone, unaccompanied by polarity." The result is a strong positive deviation from Raoult's law, with a corresponding influence on solubility. This classification is, of course, not a rigid one, but it agrees well with the familiar experience of all chemists that "if substances are divided into two groups, polar and non-polar respectively, those within either group are usually most soluble in the other substances within the same group and least soluble in those of the other group."

The summary given above of some of the points discussed by the author would probably give quite a wrong impression of the book, by suggesting that it is qualitative and non-mathematical in character. It may be taken as an unsolicited testimonial to the skill of the author that it should be possible to deal in this way with a book that is rigidly thermodynamical in its method of treatment. He has, indeed, written in such a way that a reader who is unskilled in thermodynamics and who "funks differentials" can nevertheless follow his argument with comfort. Such a reader is permitted to shut his eyes whilst traversing the thermodynamic tunnels, in the expectation that he will soon emerge, not merely into the daylight of an open cutting, but into broad stretches of open country. The book is therefore one that is well worth reading, and the author is to be congratulated on his success in presenting a difficult subject in so attractive a form.

T. M. L.

Hydrodynamics.

Hydrodynamics. By Dr. Horace Lamb. Fifth edition. Pp. xvi + 687. (Cambridge: At the University Press, 1924.) 45*s.* net.

LAMB'S text-book has long been the chief store-house of information of all workers in hydrodynamics. One may note that the interval between the first and second editions was 16 years, and that successive editions have followed at intervals of 11, 10, and now 8 years respectively. Perhaps the steady decrease is to be attributed to the development of interest in the subject, which has during the last ten years come into closer relation with experience than the most optimistic student could have anticipated previously. In any case, the fifth edition is welcome, for it contains not only all the good features of its predecessors, but also most valuable accounts of recent discoveries. Dr. Lamb's alertness to modern advances may be estimated from the fact that ten entries relating to Prof. G. I. Taylor occur in the index. Abundant references to original papers are given in the footnotes.

A new section (91*a*) gives a short account of the expansion of a spherical cavity in water due to an internal explosion, and of the collapse of an exhausted cavity. Section 159*a* deals with the two-dimensional motion of solids in a liquid with uniform vorticity. Section 205*a* gives a new theorem relating to small oscillations of a gyrostatic system about a steady motion. Rayleigh proved that the normal modes of vibration of a non-gyrostatic system were those that made the periods stationary for small variations in the adopted ratios of the co-ordinates. Lamb here proves the corresponding theorem for a gyrostatic system.

The account in Section 284 of the propagation of a wave of discontinuity in air has been much improved by the inclusion of a discussion of the modification introduced by conduction, with an estimation of the extent of the region of transition. Section 330*a* describes the theory of a case of lubrication. In Section 334*a* several cases of the transference of momentum in a viscous fluid in a non-steady state are worked out, and also the theory of the maintenance of an ocean current by a steady wind blowing over the surface. The effect of porous bodies in absorbing sound is discussed in Section 360*a*. A few simple cases of turbulent motion are treated in Section 366*a*, *b*, and *c*. The nature of the theory of the motion of solids in a real fluid is outlined in Section 372*a* and *b*. A new section at the beginning of the chapter on rotating masses of fluid gives proofs of the theorems of Poincaré and Lichtenstein on the possible modes of rotation of a fluid mass. Two slips of the pen which have been noticed are, on p. 643, $2{\cdot}2 \times 10^{19}$ is printed instead of $1{\cdot}1 \times 10^{19}$, and, on p. 648, $-\omega^2 z$ appears instead of 0 for the z acceleration.

A few remarks concerning Dr. Lamb's use of the reversed sign for the velocity potential may not be out of place. He justifies this course on two grounds. First, it gives the velocity potential the same sign as the impulsive pressure needed to start the motion; second, it completes analogies with other branches of mathematical physics. Neither of these arguments appears to the reviewer to have much weight. From analogy with elasticity, where the positive stress and strain both correspond to an extension, an impulsive tension appears to be a more suitable standard than an impulsive pressure, and the velocity potential without reversal has the same sign as the impulsive tensions. The use of pressure instead of tension in hydrodynamics arises from the fact that it is usually (though not always) the pressure that is positive in fluids; the adaptation of the sign of the velocity potential to this fact tends to obscure the physical analogy between elasticity and hydrodynamics. Again, while the reversed sign agrees with the usual practice in electrostatics, it disagrees with that usual in gravitational theory, which is more closely associated with actual hydrodynamic problems. In each of these cases the current convention has been adopted purely in order to reduce the number of times the minus sign has to be written; which is in itself a reason for not reversing the sign of the velocity potential.

H. J.

Psychical Research.

Experiences in Spiritualism with D. D. Home. By the Earl of Dunraven. Pp. iv+285. (London: Society for Psychical Research, 1924.) 7*s.* 6*d.*

THIS book ought to have been published long ago. In a way indeed it was, to wit in 1870, but only for private circulation, on account of the violent prejudices which its subject then excited both in religious and in scientific circles. It is a record of the marvels which seemed to those present to happen in connexion with D. D. Home, the most famous "medium" of modern times, and is composed mainly of reports, written by the present Earl of Dunraven, then Viscount Adare, to his father, on seventy-eight sittings with Home in the years 1867–69; but in ten cases the notes were taken by the late Earl, who also wrote an introduction. The present Earl has now reprinted the material and equipped it with a preface, and with a lucid and temperate introduction by Sir Oliver Lodge; but he has not attempted to fill in the

gaps which were left in the evidence where matters were considered too intimate for publication. After a lapse of more than fifty years, most of these could surely have been filled in without offence, and thus have counteracted the attenuating effect which the mere lapse of time has on the scientific value of any historical narrative. Nor is the recording itself as full and expert as Crookes's account of his experiments with the same medium.

Nevertheless, Lord Dunraven has put under a deep obligation all students of the secular struggle between the champions of "law," convention, prejudice, scepticism, conservatism, on one hand, and of "fact," eccentricity, open-mindedness, credulity, revolution, on the other. The continuance of this struggle is due to the fact that the progress of knowledge demands a co-operation of both these tendencies, so that neither can lay exclusive claim to the term "scientific"; while the question as to which party is right cannot be settled by any appeal to general principles, but only (if at all) by patient and prolonged examination of each case.

All this applies with peculiar force to "spiritualism," which excites strong emotions on both sides, and displays a dramatic clash between established principles and subversive testimony. But it would be utterly unscientific to burke investigation on this account, after the fashion of Hume, by declaring that "miracles" are alleged, and that miracles are impossible. This is mere *a priori* dogmatism, which is discreditable alike to philosophy and to science.

It may be that the times are not yet ripe for a truly scientific inquiry into the facts alleged; certainly neither party as yet welcomes examination. The man of science professes to be more interested in, say, the nephridia of worms than in the immortality of his soul, while the spiritualist, though he rests his case on observable facts, fights singularly shy of test conditions. Even when a "medium" can be got to submit to examination, it is usually hard to find a man of science who will conduct it; as was recently shown when, in spite of a handsome salary, such a post went a-begging, until a physicist already compromised by interest in the supernormal accepted it, and speedily exploded a famous medium.

Perhaps the truth of the matter is that both sides are not quite sure of their ground and afraid to test their convictions. Still, one cannot read Lord Dunraven's book without feeling that progress is being made, though slowly; perhaps it is not too much to hope that, in another fifty years, science will have given an explanation satisfactory to both the scientific worker and the spiritualist of the mysteries that are still in dispute. F. C. S. S.

Our Bookshelf.

The Morphology and Evolution of the Apes and Man. By Dr. Charles F. Sonntag. Pp. xi + 364. (London: J. Bale, Sons and Danielsson, Ltd., 1924.) 12*s.* 6*d.* net.

FULLY sixty years ago, Huxley systematised our knowledge of the anatomy and nature of anthropoid apes in a famous treatise to which he gave the title "Evidence as to Man's Place in Nature." Anatomists have been busy since then; there has been an enormous output of papers relating to the anatomy of apes, and there has grown up a great need for an ordered presentation and interpretation of the new material.

Dr. Charles F. Sonntag, Prosector to the Zoological Society of London, has stepped into the breach and sought to supply this need in "The Morphology and Evolution of the Apes and Man." This book, Dr. Sonntag informs us in his preface, "is intended to serve as an introduction to Anthropology, for it deals with the first steps in that science, namely the relations of Man to lower animals."

The scope of Dr. Sonntag's treatise is best indicated by citing the contents of its chapters. Chapter i. is devoted to a systematic account of lemurs and Tarsius, Chapter ii. to the New World monkeys, Chapter iii. to the Old World monkeys. Then follow nine chapters on the anthropoid apes. One is devoted to a description of their external characters, habits, and classification; then follow others in which plain accounts are given of their skeletons and teeth, of their muscles, of their organs of digestion, of their organs of circulation, of their respiratory systems, of their urino-genital systems, and of their nervous systems. In all of these chapters, Dr. Sonntag keeps his personal opinions in the background, being content to play the part of descriptive anatomist, leaving the interpretation of his facts to others.

In a final chapter a brief account is given of the evolution of the primates, the text of this chapter being greatly assisted by a clearly drawn phylogenetic tree. In this chapter, as in others, Dr. Sonntag is an eminently safe guide for both student and expert, for he has preferred to give a detailed account of the anatomy of apes, rather than to discuss the problems relating to their origin. Anatomists are indebted to Dr. Sonntag for this work, particularly for the full bibliography which is appended.

Institution of Petroleum Technologists. Standard Methods of Testing Petroleum and its Products. Pp. x + 102. (London: Institution of Petroleum Technologists, 1924.) 6*s.* net.

THE Committee appointed by the Institution of Petroleum Technologists to standardise methods of oil-testing has, under the above title, published its first report in the form of a concise manual. It was no easy task to criticise existing methods, to comment on relative advantages and disadvantages inherent thereto, to keep pace with current developments, and at the same time to issue an authoritative work formulating agreed methods of oil-analysis consistent with home and foreign procedures; but the Committee has

acquitted itself well. A compromise between methods dictated by custom, previous decrees of the British Engineering Standards Association, publications of the American Society for Testing Material and the American Bureau of Standards, has been achieved, to the lasting benefit of petroleum chemists and the industry in general.

Methods of testing oils and suitable apparatus are discussed, but the thorny problem of nomenclature has been left alone, owing to the impossibility of considering it on other than an international basis—a wise decision. Petroleum products are dealt with as gasoline, white spirit, kerosene, gas oil, lubricating oils, transformer oils, fuel oils, asphalt, and wax, and under each class appropriate tests are given, these tests being differentiated by "serial designations," *i.e.* reference letter to the class of product and serial number to the precise test. In the language of the Committee "I.P.T. Special Designation—G.O.4" will in future indicate the standard test for sulphur in gas oil (class G.O., test No. 4), implying the use of a bomb-calorimeter of approved specification with manipulation as prescribed; similarly for other products and their routine testing. No degree of finality of methods is achieved (nor was that desirable) in the report; the fabric on which the I.P.T. standardisation is built up is sufficiently elastic to permit of modifications and additions in technique demanded by future developments. H. B. MILNER.

The Journal of the Institute of Metals. Vol. xxxi. Pp. xi+680+40 plates. Edited by G. Shaw Scott. (London: Institute of Metals, 36 Victoria Street, Westminster, 1924.) 31*s.* 6*d.* net.

THE papers contained in the present volume are mainly of scientific interest. There are several studies of the equilibrium in binary and ternary alloys, including a remarkably well illustrated account of the alloys of copper and cadmium. Sir Henry Fowler gives a survey of the use of non-ferrous metals in engineering, and the president, Prof. Turner, devotes his address mainly to the importance of research in metallurgy. A practical investigation of the failure of some brass tubes, by Mr. Millington and Prof. Thompson, is chiefly interesting through leading the authors to a rather speculative, but highly ingenious, view of the mechanism of fatigue. The discussion on this paper shows how diverse are present opinions as to the nature of fatigue. A paper from Stockholm, partly covering the same ground as a recent communication from the National Physical Laboratory, treats of the study of inter-metallic compounds by means of X-rays. The volume contains a great deal of interesting matter, and, as usual, includes very full abstracts of the current literature relating to non-ferrous metallurgy.

Lunge and Keane's Technical Methods of Chemical Analysis. Second edition. Edited by Dr. C. A. Keane and P. C. L. Thorne. Vol. 1. Pp. xx+704. (London and Edinburgh: Gurney and Jackson, 1924.) 63*s.* net.

THE new edition of this important work is distinctly better than the earlier one. It is to be in six volumes, each complete with its own index (besides a general index for the whole series), and the contents have been rearranged so that associated subjects are grouped together more conveniently than in the first edition.

Dr. Keane has enlisted the assistance of British experts throughout, and certain of the sections, such as "Fuel" and "Cyanides," have been entirely rewritten, while others are materially altered. The important sections on sulphuric acid, chlorine, and alkali have been brought up-to-date by Dr. J. T. Dunn; Dr. J. S. G. Thomas is responsible for "Gas Analysis" and for a noteworthy new section on "Physical Methods," while a new chapter on "Electrolytic Methods" is excellently dealt with by Dr. H. J. S. Sands.

Very few printer's errors have been observed, and, except for a few of the illustrations, the book is well turned out. Altogether, this first volume represents a notable advance on the earlier edition, and it is to be hoped that the high standard will be maintained through the remaining volumes. T. W. H.

The Recent Development of Physical Science. By William Cecil Dampier Whetham. Fifth edition. Pp. xvi+313+16 plates. (London: John Murray, 1924.) 9*s.* net.

TWENTY years ago, Mr. Whetham wrote a remarkable book, in which he gave, in pleasant narrative form, an account of the discovery of the electron, and other matters which were then new in physical science. The mobile electron has moved a long way in twenty years, and as a result nearly half of the new version of the book is devoted to describing ideas and facts which had scarcely come into existence when the first edition was issued. It would, however, be an injustice to suggest that Mr. Whetham has limited himself to telling, as so many others in recent years have done, the story of the electron and nothing else. Just as the earlier work included chapters on the liquefaction of gases, and on the processes of crystallisation from fusion or solution, so the later additions include a chapter on "Matter, Space and Time," under the appropriate motto "Oh, dear! What can the matter be?" and a chapter on astrophysics. On account of its breadth of treatment, the book can be commended to readers who hold that neither the naked ion of thirty years ago, nor the naked electron of to-day, important as they are, can claim a complete monopoly of interest in physical science.

Technical Writing. By T. A. Rickard. Second edition, re-written and enlarged. Pp. ix+337. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1923.) 10*s.* net.

THE second edition of Mr. Rickard's book has been thoroughly revised and enlarged. It is a useful guide to the writing of technical papers, and, although the worst examples of faults to be avoided are more often found in the technical press of the United States than in Great Britain, even a superficial student of publications on applied science must have noticed that such slovenly expressions are being increasingly used. The new sections include a chapter on "The Wrong Word," and another on punctuation. The sections on style are slight but sound, the aim of the author being to encourage clearness and simplicity in the statement of facts.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Agricultural Research.

ON returning from a lecturing tour in Canada and the United States, I find among the files of NATURE "Cantab's" interesting letter in the issue of September 27.

I had no intention of being despondent in my address to Section M (Agriculture), nor is there occasion for despondency. It is true that science has given only few aids to agriculture of the order of 100 per cent. increase in yield, but much has been done of a less spectacular nature, and agricultural experts are now able to advise farmers with considerably more certainty than was the case even thirty years ago. There have been great changes in practice, and science has helped considerably.

The history of agriculture shows that advances have come in three ways: from purely empirical methods tried by farmers with no definite scientific plan; from experiments on empirical lines made by trained workers: and from advances in pure science, whether initiated in a purely scientific, or, as has often happened, in a technical laboratory. It is a fact that in the past some of the biggest advances have been made by empirical methods, but one cannot infer that scientific methods are therefore inferior; only in recent years have they been adequately tried. Our knowledge of the biochemical changes in the soil, of the soil micro-organisms, the soil solution, and the soil colloids, quite apart from the genetical work to which "Cantab" referred, has all come as the result of purely scientific work, done solely with the view of gaining information, and with no idea of practical applications. Little of this knowledge is yet used in practice, for the simple reason that no one has found a way of using it, but all history shows that the application comes sooner or later once the scientific discovery is definitely established. There is every reason to hope that agricultural science has fresh triumphs in store.

In recent years it has been easier to apply scientific methods in agricultural investigations because many of those responsible for the management of agricultural institutions, and especially the younger men, appreciate their value and realise the necessity for the so-called "academic work." No honest person working on scientific lines would ever commit himself to a definite promise that a particular investigation would have practical results; he can, however, so conduct it that it will yield sound knowledge. It is of course true, as "Cantab" points out, that epoch-making discoveries have not yet come direct from team work or directed research. But it must also be recognised that advances of this order are in any case very rare, and when they come it is largely as the result of the less spectacular, but none the less real, advances in knowledge which can be made in the well-equipped organised institution. No research institution can do more than hope for first order discoveries, but the staff can, at any rate, ensure good development work, and secure advances which in the aggregate count for much.

Like all other forms of research, agricultural research is finally limited by the state of knowledge of other branches of science; and a logical scheme of assistance would recognise the claims of all pure science. The present schemes may not be very logical, but knowing something of the methods by which a research institute has to be sustained, I am not sure that the departments of pure science have always adopted the best methods for obtaining assistance. A great difficulty of research institutions—and it must be far greater to the layman—is to know just what are the methods and the results of science, in other words, whether the limitation imposed by lack of knowledge in pure science lies in the man or the science. The agricultural investigator received his training in pure science it may be ten or twenty years ago; he tries to keep up, but is overwhelmed by the enormous and ever-increasing volume of papers of very varying merit and lucidity. The Chemical Society facilitates his task by issuing annual reports on the different branches of chemistry, but many other scientific societies have not followed this good example. There must be many papers in pure science buried in the libraries which would prove of great value to agriculture if they were known, but they are not. At Rothamsted we have adopted various devices for keeping in touch with pure science, one of the best of these being to bring young men and women from the purely scientific laboratories from time to time to take part in our work. This is one example of the "team work" to which I referred in my address as being among the hopeful ways of securing advances in agricultural science, another being co-operation between institutions engaged on different aspects of what may be fundamentally one and the same problem.

Team work makes it possible for the different workers to keep in touch, and to utilise advances made in other subjects. It has other advantages too, for even the wisest of mortals will never see a scientific problem as a whole, but only in part.

E. J. RUSSELL.

Rothamsted Experimental Station,
Harpenden, October 20.

Series in the Spectra of Aluminum and Magnesium in the Extreme Ultra-Violet.

PASCHEN (*Ann. d. Phy.* 71, p. 152, 1923), in his investigation of the spectrum of doubly ionised aluminum (Al. III.), and Fowler ("Series in Line Spectra," p. 120), in his study of ionised magnesium (Mg. II.), have pointed out the type of series relations which exist in these substances, and have arranged many lines to conform to them. In a study of the spectra of both aluminum and magnesium in the extreme ultra-violet, under various forms of excitation, I have recently observed certain lines which appear to be higher members of some of the series discovered by Paschen and by Fowler; Millikan has already identified the two strongest, but the remainder seem to have escaped observation. The wave-lengths and the series to which these lines belong are given in the following tables.

Al. III.

$3p - md.$			$3p - ms.$			$3s - mp.$		
Obs. λ Int.	Calc. λ	*m.*	Obs. λ Int.	Calc. λ	*m.*	Obs. λ Int.	Calc. λ	*m.*
891·9 (1)	892·0	4	855·0 (3)	855·02	5		695·8	
893·8 (2)	893·9		856·7 (4)	856·76		696·0 (6)	696·2	4
			725·7 (1)	725·6	6		560·3	
			726·7 (2)	726·8		560·3 (3)	560·4	5
						511·1 (1)	511·2	6

Mg. II.

$1s-m\pi$.		
Obs. λ Int.	Calc. λ	m.
1240·1 (4)	1239·9	2
1240·5 (4)	1240·4	
	1026·0	3
1025·9 (2)	1026·1	
946·6 (1)	946·7	4

The lines in aluminum were obtained with the vacuum spark and also with a condenser discharge in an atmosphere of helium at about 1 mm. pressure. The magnesium lines were most strongly excited by an arc of 40 volts and about 10 amperes operated in a high vacuum by means of a trembler device.

The numerical values of the wave-lengths should be correct to at least two-tenths of a unit.

It must be admitted that both Millikan and Simeon list a line at λ560·5 which they credit to carbon. The line at 1025·9 in magnesium might perhaps be ascribed to hydrogen were it not for the extreme weakness of the hydrogen line at λ1216.

The persistence of impurities, especially when high voltage excitation is employed, introduces uncertainties which cannot well be eradicated. But in my judgment, the structure of the spectra and the close agreement between observed and calculated values justifies the identifications shown in the tables.

THEODORE LYMAN.
Jefferson Laboratory, Harvard University,
October 7.

Active Nitrogen.

PROF. M. N. SAHA and Mr. N. K. Sur, in an article which has just appeared in the *Philosophical Magazine* (48, 421, Sept. 1924), present a theory regarding the identity of active nitrogen which coincides in certain respects with that advanced by me last December, in a paper read before the American Physical Society (Abstract, *Physical Review*, 23, 294, Feb. 1924). Since this paper has not yet been published in full, and since there are important points of difference between the two theories, it seems advisable to present here certain of the details.

Active nitrogen was discovered in 1900 by Prof. E. P. Lewis (*Astro. Jour.* 12, 8, 1900) and was found by him to have a characteristic spectrum (*ibid.* 20, 49, 1904). It is now known without question, due to the work of Fowler and Strutt, that the α-group bands of this so-called afterglow spectrum are merely a few bands belonging to the First Positive Group of nitrogen, with, however, different relative intensity. The great majority of the bands of this group are definitely absent. Since we now know that all band spectra are due to molecules, and since various methods of investigation have proved beyond reasonable doubt that the First Positive Group is due to the neutral N_2 molecule, it follows inevitably that the emitter of the α-group bands is some form of the neutral N_2 molecule. In this letter I confine the term "active nitrogen" to the emitter of these α-group bands.

My investigation of the band spectrum of nitrogen, in the paper just mentioned, gave a partial indication of the exact form of the molecule responsible for this emission. The strongest band in each of the four groups forming the so-called α-bands corresponds, in the case of emission, to a transition from a molecular vibrational state indicated by the quantum number eleven. In a less accurate way we may speak of the molecule as possessing in the initial state eleven units of vibrational energy. The bands on either side of this strong band correspond to ten and twelve units. All other initial vibration states are entirely, or almost entirely, lacking.

It therefore seems evident, for reasons which will not be disclosed until we know the exact structure of the molecule, that the particular state of electronic excitation corresponding to the initial state of the molecule when emitting the First Positive Group bands, is *metastable*, for ten, eleven, and twelve (especially eleven) units of vibrational energy. The amount of rotational energy is seemingly immaterial. Saha and Sur do not assume a metastable condition, although to me this assumption seems vital. Active nitrogen is *formed* in the electric discharge, and then under the proper conditions diffuses out into a side tube where it may exist for some time (thirty seconds or more), *gradually* changing back to the ordinary nitrogen molecule with the emission of the α-group bands. Because of its excess energy, due to electronic excitation, it is chemically active, and in the presence of impurities it easily forms compounds or produces other excited atoms and molecules, as discussed by Saha and Sur, and also by Dr. Mulliken (NATURE, 114, 349, Sept. 6, 1924). Metastable conditions such as this are now commonly assumed to explain the origin of certain band spectra, such as the band spectrum of the helium molecule.

While the amount of vibrational energy in the active nitrogen molecule seems therefore known, the same statement cannot be made in regard to the amount of available electronic energy. The various major electronic energy levels of the neutral N_2 molecule, as calculated by the author, are given in Fig. 1, where the most stable state is on the right. These levels (X, A, B, C, and D) represent merely the electronic excitation, with no vibrational or rotational energy. B′ represents state B with the addition of eleven units of vibrational energy, where B′ − B = 17,148 (in frequency number). The frequency of the "origin" of the Fourth, Second, and First Positive Groups is thus represented by the lengths D − B, C − B, and B − A respectively, while the strongest bands in the α-group are represented

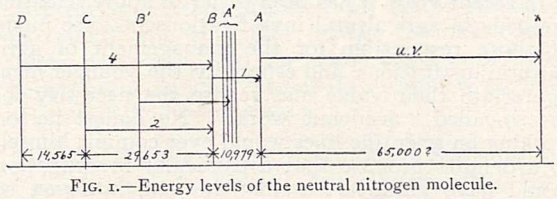

FIG. 1.—Energy levels of the neutral nitrogen molecule.

by B′ − A′, where A′ represents the A state with 9, 8, 7, and 6 units of vibrational energy, and correctly lies on both sides of B.

At the present time, experimental evidence points strongly to the conclusion that A is not the stable state of the molecule, but that there is another group of bands in the ultra-violet, connecting A with the true stable state X. It has not yet been possible definitely to identify such bands by quantitative agreement with the set of vibration levels connected with A (as illustrated by A′), but Dr. J. J. Hopfield is now investigating this matter experimentally, and has just obtained a beautiful plate showing a large number of bands, apparently constituting several distinct groups. One of these lies in the region indicated by A − X in Fig. 1. It is known that the ionisation potential of the neutral N_2 molecule is close

to 16·7 volts, and since D − A equals 55,200 (=6·8 volts), it is evident that A − X must be less than ten volts. Prof. E. P. Lewis has directed my attention to the great experimental difficulty in obtaining the Fourth Positive Group, discovered by Fowler and Strutt. There is evidently a very narrow range of experimental conditions under which it appears. This is in agreement with the above diagram, where D lies only two volts from ionisation.

The maximum available electronic energy of active nitrogen is therefore given by B′ − X, and since B′ − A = 28,127 (=3·5 volts), while A − X corresponds probably to about 8 volts, B′ − X is equivalent to about 11·5 volts. Saha and Sur assume that active nitrogen is merely a nitrogen molecule excited with 8·5 volts energy. This assumption precludes the possibility of emission of the α-group bands, and offers no explanation of the distinction, in intensity distribution, between the α-group of the afterglow and the ordinary First Positive Group.

Prof. E. P. Lewis, at the time of his original discovery, stated that a trace of oxygen was necessary for the formation of the afterglow. After a prolonged discussion, in which various investigators participated, it was mutually agreed that this statement was correct, except that *any* electro-negative substance produced an analogous effect (enhancement of the afterglow). Now a molecule can remain in a metastable state only in the absence of any disturbing field. Under the conditions obtaining in the region where the afterglow appears, the chief disturbing field is that caused by the collision of other molecules or of free electrons with the metastable N_2 molecules. Electron collisions would be particularly effective in causing a reversion to the stable state. But Prof. Lewis has shown the presence of some free electrons in the afterglow (NATURE, 111, 599, 1923), and has suggested that this trace of electro-negative substance is needed to "clean-up" the electrons in the side tube, and thus to prolong the life of active nitrogen. In terms of the present theory we would say that most active nitrogen molecules revert to the stable form in the main portion of the discharge. Some are fortunate enough to diffuse into the side tube, where under suitable conditions they could exist indefinitely. With no electro-negative element present there is sufficient concentration of free electrons to cause the immediate reversion of the active nitrogen, before it has had time to diffuse any appreciable distance, and possibly directly to the stable form X, with the emission of high-frequency bands. On the other hand, any excess amount of an electro-negative substance acts in a similar disastrous manner upon the metastable molecules.

Even with the small necessary amount of oxygen, there will be some collisions between oxygen molecules and active nitrogen molecules. We may assume that this results in the formation of a special form of electronic excited NO molecule which reverts to the (presumably) stable form of NO with the emission of the β-bands, discovered by Prof. Lewis in the afterglow. Dr. Mulliken, to whom I am indebted for many suggestions in this matter, has suggested that this type of electronic excited NO may be metastable. If this is true, we have, in one sense, another form of "active nitrogen." But, as stated, it seems preferable to reserve the term for the emitters of the α-group bands. We may assume, further, that more usual types of union of oxygen and nitrogen may produce a different form of electronic excited NO which reverts to the stable form with the emission of the γ-bands (Third Positive Group). The β- and γ-bands seem, from certain mathematical relations, to have a common final state, and if so must be due to the same molecule. This question is discussed by Dr. Mulliken (*loc. cit.*), who independently found this common state.

In conclusion, then, I assume that if the emission of any group of afterglow bands is a primary phenomenon, the emitter must be a metastable molecule, which may be called "active." This certainly seems true as regards the α-group. But if the emission is a secondary phenomenon, occurring as a consequence of "second-type" collisions with a metastable molecule, the emitter need not be metastable. It does not seem possible, at this time, to state any very definite conclusions as to the mode of excitation of the β- and γ-groups.

RAYMOND T. BIRGE.

Physical Laboratory,
University of California,
September 25.

The Shrinkage of Gelatin.

IN a letter in the issue of NATURE for October 18, Prof. D'Arcy Thompson makes the attractive suggestion that the curved surfaces generated when cylinders or simple polyhedra of gelatin gel are allowed to dry (described by me in *Koll.-Zeitschr.* 35, p. 67, 1924) bear a strong resemblance to the minimum surfaces over the corresponding boundaries. Such minimum surfaces are easily produced by stretching soap films over openings or wire frames of the desired outline.

The suggestion receives additional support from the conditions prevailing in drying bodies of elastic gel: the edges dry more rapidly than the faces, providing a framework which is almost rigid when drying has progressed sufficiently, and the faces dry more rapidly than the interior. A skin is accordingly formed under stresses not unlike those to which a soap film stretched over an opening and exposed to pressure on one side is subject. Nevertheless the resemblance is approximate only, as can easily be seen when the contours of the two types of surfaces on planes parallel to the boundary are examined.

The curved surfaces which form when cubes or regular tetrahedra of elastic gel are dried have the very peculiar property that *their contours on planes parallel to the original face are rectilinear polygons similar to the original boundary* over the greater portion of the surface. This property was found experimentally, by actually drawing the contours on the dried polyhedra. Fig. 1 shows the body

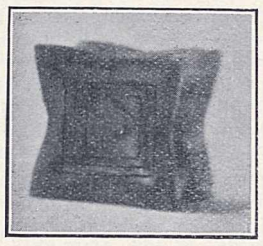

FIG. 1.

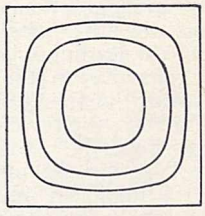

FIG. 2.

which results when a cube of 15 per cent. gel is dried at room temperature, with three contours drawn on it. It is a simple matter to express this condition analytically: if the profile curve, say, on the diagonal of the cube face is of the form $z = F(r)$, the equation of one quadrant of the surface in cylindrical co-ordinates must be of the form

$$z = F[r(\cos\theta + \sin\theta)],$$

where the r, θ plane is parallel to the original face, and $\theta = 0$ for one diagonal.

Since the equation of the profile is not known (it is very approximately a simple sine curve), the equation of the surface and that of the corresponding minimum surface over the square boundary cannot be compared directly. The surface can, of course, be easily produced by blowing up a soap film over a square opening, but the determination of contours on such a film calls for somewhat delicate experimental arrangements (cf. Griffith and Taylor, J. Inst. Mech. Eng., No. 1, 1918, p. 755). The error is probably not great if a very thin rubber membrane is blown up with low pressure, and I have carried out this experiment and drawn the contours, which are shown in Fig. 2. They are curvilinear and approximate to circles the more the apex of the surface is approached. While there is a certain resemblance between the surfaces produced by drying polyhedra and minimum surfaces over the same boundaries, the two are, therefore, certainly not identical.

A rational treatment of the problem does not appear hopeful, as two questions of very great difficulty are involved. It would be necessary to find the law according to which the water content varies from place to place, and then to deduce the conformation from the relation between water content and the elastic constants. Even the latter are known very incompletely; over a moderate range of concentration Young's modulus is approximately proportional to the square of the gelatin content (Leick, 1904), but this relation holds up to about 45 per cent. only, whereas air-dry specimens have a gelatin content of 80 to 85 per cent. EMIL HATSCHEK.

London, October 21.

The Causation of Cancer.

THE notice which appeared in the issue of NATURE of October 4 of my book, "Cancer: How it is Caused, How it can be Prevented," contains several misstatements which I must correct. The reviewer puts into my mouth the statement that "cancer is due to constipation and lack of vitamins" as a summary of my teaching, although I have stated in every chapter that cancer is due to chronic poisoning and to vitamin starvation, a totally different matter. The reviewer also states that "Almost the only authorities he quotes are surgeons" and "Their statements [are] mostly from the general press." From the bibliographical index at the end of the book every reader can see that the majority of my witnesses are physicians, physiologists and chemists, although there are a great many surgeons. Besides, my quotations are not "mostly from the general press" but from the leading scientific periodicals, as will be seen by reference to the section "Periodicals Quoted," contained in the bibliographical index.

Further, the reviewer says that I "put forward the pious belief . . . that cancer is a disease of civilisation," giving the impression to readers that I have drawn upon my imagination. In reality, the fact that cancer is a disease of civilisation is fully proved by the pronouncements of more than a hundred physicians practising among uncivilised nations, whom I have quoted and to whom I have referred. The reviewer's statement that I recommend "eating raw food and roots like the beasts in the field" for preventing cancer is another distortion. I have recommended a diet rich in vitamins and in roughage, a diet consisting largely of wholemeal bread and plenty of raw fruit and salads.

In conclusion, the reviewer states that my book "will do much more harm than good." I have received hundreds of letters from cancer sufferers, both medical and non-medical, informing me that in their case cancer was undoubtedly caused by chronic poisoning and vitamin starvation, and I am receiving every day letters from readers, telling me that their health has been vastly benefited by the adoption of the diet recommended in my book.

J. ELLIS BARKER.

Albion Lodge, Fortis Green,
East Finchley, N.2,
October 13.

I HAVE no desire to embark on a controversy with Mr. Ellis Barker in a scientific journal like NATURE, though I have behind me thirty years' study of new growths. His hymn of hate above is no doubt a relic of the time when, as "Who's Who" informs us, he "devoted his literary career, ever since 1900, to warning England of the danger of a war with Germany and to urging military, naval, and economic preparation." Mr. Ellis Barker may be an authority on the foundations of Germany, British socialism, tariff reform, and the Motherland and Empire, but we must be pardoned if we cannot accept him as the authority on the cause and prevention of cancer. Since the receipt of his onslaught, I have re-read his book and my considered opinion is that it is ridiculous. Mr. Ellis Barker must know perfectly well that the review of his book in NATURE is milk and water compared with the vitamin-free strong potions that have been administered to him on the subject of his book by the *Lancet* (1924, ii. 70), the *British Medical Journal* (1924, ii. 324), *Science Progress* (1924, 328), *American Journal of Public Health* (1924, xiv. 787), and the Journal of the American Medical Association (1924, lxxxiii. 784). I do not, in fact, remember having read in the medical press such wholesale condemnation of any book. THE REVIEWER.

The Choice of Wave-lengths for Achromatism in Telescopes.

MY attention has been directed to Prof. Townsend Smith's letter in NATURE of October 11, p. 536, in which he refers to my paper in the Transactions of the Optical Society. I entirely agree with the very useful curves he has drawn.

It would not be difficult to try the combination of the red lithium line and the F hydrogen line which he suggests, for no new measurements of refractive indices need be made.

In a paper, "The Existing Limits of Uniformity in Producing Optical Glass" (Roy. Soc. Proc. A., vol. 87, p. 190, 1912), a table of the refractive indices of twenty-seven different optical glasses is given, in contiguous columns in the order of their mean dispersions. Indices for both the lithium and the F line run throughout. Since the optical properties of the glasses in adjacent columns very closely resemble one another, interpolation for another glass, the mean dispersion of which lies between them, is easy.

Two later papers with similar tables have been published (Roy. Soc. Proc. A., vol. 91, p. 320, 1915, and vol. 100, p. 624, 1922), and they give a choice of fourteen additional glasses from which to interpolate.

At the end of his letter Prof. Smith refers to 546$\mu\mu$, the mercury line, as being not far from the correct minimum for the D and E curve. This is so, and some years ago I computed an object-glass where focal lengths for D and E were equalised with this mercury line for shortest wave-length, and it was afterwards constructed. Although definition proved

excellent, the greens, blues and violets were distinctly exalted at the expense of the oranges and the reds, the effect being slightly garish.

Later I computed an exactly similar combination with the exception that 561$\mu\mu$ now took the place of 546$\mu\mu$, and the correction of all errors due to curvature was made for that line. This second object-glass was then constructed, and it was found that the defect referred to had been entirely removed.

J. WILLIAM GIFFORD.

Polurrian, Mullion,
S. Cornwall,
October 13.

The "Ship-designs" on Prehistoric Egyptian Vases.

As my friend Dr. Forbes has raised once more a question about the Egyptian ships, without quoting the decisive examples, I would ask to supplement his letter in NATURE of October 4, p. 499.

On the Gebel Arak ivory knife-handle is figured the result of a naval fight between two types of ships ranked opposite to each other, with the drowned men lying between them (*Ancient Egypt*, 1917, p. 27). The Egyptian ships are of the same form as those on the Hierakonpolis wall painting (*Hierakonpolis*, lxxv.), with the two cabins and gangway between, and a top shelter alike in both. The Hierakonpolis painting also shows a black ship with very high prow, like those of the enemy on the ivory, and like one with a square sail on a vase in the British Museum. Each of the Egyptian ships has the painter rope and branch at the prow, like that used to catch the wind on the Swedish and Guinea coasting vessels. At the stern is the steersman holding the large steering paddle. It does not seem possible to deny that these are ships.

Now these vessels are exactly of the type of the ships of the pottery paintings. The same outline, cabins, space between them, and ensign at the hinder cabin, tying-up rope, and branch in the prow. If these are ships, then the sticks projecting below them are oars. The only argument for fixed forts is that the flamingoes indicate lagoons, but then most primitive waterways are bordered with lagoons. So I cannot see how any idea of fixed habitations can accord with all these evidences of shipping, glad as I may be of any explanation by an eminent zoologist about the living forms. FLINDERS PETRIE.

5 Cannon Place,
Hampstead, N.W.3.

Microseisms and Storm Forecasts.

THE value of the seismograph as a detector of the more severe type of cyclonic storm in the Bay of Bengal was recognised some fifteen years ago by Mr. C. W. Peake, then Meteorologist at Calcutta. When I left the Observatory in 1922 it had become regular routine for the Omori charts to be examined for microseisms during the writing of the Daily Weather Report, whenever pronounced symptoms of a serious storm existed in the south of the Bay. Well-marked microseisms invariably confirmed other evidence in the case of the early stages of dangerous cyclones, and were sometimes noticed when the storm centre was so much as 1000 miles south of Calcutta.

I do not, however, recall any instance in which microseisms were associated with ordinary rough weather or with an advance of the monsoon, but possibly a close scrutiny of the charts on the appropriate dates would reveal the phenomenon. The general view in the observatory was that the seismograph ignored anything but a moving area of *exceptionally* low pressure, and for this reason there is some doubt as to whether the obvious explanation that such microseisms are due to ordinary surface waves is the correct one; the large surface wave presumably always caused by the progression of the cyclone as a whole may, however, play a part in the production of the earth tremors. In any case, Dr. Banerji's suggestion (NATURE, October 18, p. 576) that the vibrations he observed may be used in forecasting the date of arrival of the monsoon on the Malabar coast, is very interesting and should prove valuable.

E. P. HARRISON.

H.M.S. *Vernon*,
Portsmouth.

Flight of Birds.

SOME observations which I made on the flight of gulls two years ago on a trip to the Gambia were confirmed lately by observations in the Irish Sea and Atlantic. With the vessel (some 300 tons reg.) proceeding N.N.E. in a steady fresh E.N.E. wind, the gulls flew head to wind, keeping practically the same position in or over the stern of the vessel, apparently on motionless wings and with little or no updraft of air. While keeping head to wind they advanced *sideways* with the vessel going about 9 knots. I noticed the same attitude of gulls when the wind was quite ahead and the birds as usual, flying head to wind. In the latter case the birds seemed to have less difficulty in maintaining both their position and motionless attitude.

In practically identical weather, but with rather less wind force, I was surprised, on another day, to see gulls flap their wings continuously, a difference of behaviour which seems curious.

When up the Gambia River, on a calm day, I noticed a large heron flying along a few feet above the river surface. It gave a few flaps of its wings, then planed along some distance, then a fresh flap and again a plane, and so on for some distance but maintaining the same level. Recently, I constantly observed gannets fly in the same way.

DAVID WILSON-BARKER.

The Fluorescence and Channelled Absorption Spectra of Bismuth Vapour at High Temperatures.

CONTINUING our previous work on the absorption of light by bismuth vapour, we have found that the vapour exhibits, at a temperature of about 1300° C., an absorption spectrum composed of a very great number of bands presenting a fine structure, and extending from λ6500 to λ4500. We have photographed more than 400 bands in this region. These bands shade off towards the red end. At this high temperature, it is found that the vapour emits a fluorescent radiation orange-yellow in colour, and we have succeeded in photographing the fluorescence spectrum of the vapour at this temperature, containing about 24 bands ranging from λ6600 to λ5050. Hitherto bismuth has not been shown to possess either the fluorescence or channelled absorption spectrum in this region. Full details of the experiments, together with the photographs of the fluorescence and channelled absorption spectra of the vapour at this high temperature, will be published shortly.

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Health and Physique through the Centuries.[1]

By Dr. F. C. SHRUBSALL.

IN his presidential address to the Section of Anthropology at the Winnipeg meeting of the British Association, Prof. J. L. Myres asked the question "What happens to Englishmen in city 'slums'?" or, in other words: How are the peoples of Britain adapting themselves to modern conditions? Are these conditions producing modifications in the racial constitution and qualities of the nation? The matter is one of importance to the older country, for more than three-quarters of the population now reside in urban districts, and to the newer, since in the course of time industries must concentrate in favourable localities and close aggregates of population necessarily arise.

The trend of events can be followed in outline from demographic data from about the fourteenth century, though the records are scanty until the nineteenth century. The main factors are urbanisation and industrialism, the combined effects of which can be seen best, though in an exaggerated form, in those individuals who follow certain trades, such as the textile industry, which associate dense aggregation with, even at the best, unhealthy conditions of occupation.

Indoor trades and factory life introduce very different physiological conditions from those under which the young peasant has his being. These factors tend to depress the vitality of the incomer from the country, while those born in the industrial township would be exposed to urban conditions throughout early as well as adult life, and have the further handicap in infancy of the lack of care inevitably associated with the factory employment of the mothers.

In addition, selection may in time sensibly modify the distribution of the various racial elements of the population. Psychological factors, too, come into play, for some types seem to prefer the freer life of the open spaces and leave a district as it becomes more densely settled; while others, who have no love or aptitude for solitude, migrate into the growing towns. The early settlers of the North American continent were drawn largely from areas occupied by Nordic peoples whose early history was that of hunting and fighting communities. As the eastern edge of the continent became settled, it was this type that was largely represented in the pioneers of the West.

The most alarming data in regard to the position in Britain come from the report of the Ministry of National Service on the findings of the recruiting boards during the last years of the War, but a reassuring comment was made by the Commissioner for Yorkshire, who pointed out that grading for military purposes must, in many essentials, differ from grading in respect to fitness for civilian life, which, after all, is the factor of most permanent importance to a nation. No previous data had given any idea of the extent of age changes in efficiency, though it was well known that the period of maximum efficiency in active games was the ages under thirty. It is therefore not surprising that the numbers fit for severe strain should fall off after that age or that relatively few over forty should be fit for effective military service. There is no reason to think that this is in any way a new condition associated with urbanisation, or that a similar census in past centuries would have yielded any better results. Another and more serious criticism of this report as an accurate survey of the whole state of the population of Britain rests on the fact that it was only undertaken after some years of war, when the physical pick of the nation had already voluntarily enlisted.

The more valuable data are contained in the records of youths born in 1900. The proportions of Grade I. varied from 80 to 85 per cent. in rural areas, more than 75 per cent. in mining areas, 72 per cent. in the suburbs around London, down to 49 per cent. in the crowded industrial areas of Lancashire.

There is nothing in the statistics to suggest that the British people have degenerated more than other nations. The German pre-War figures showed 72 per cent. fit or prospectively fit for service and 28 per cent. less fit or unfit for service, with the same contrast between the rural and urban, the agricultural and the textile areas, as is noted in Britain.

Actual data on stature are very sparse in the reports of the recruiting boards. A large number of the adult male population examined as conscripts in 1918 had statures between 64 and 67 inches, but the average figure obtained has little significance as an index of the whole pre-War population, since a large proportion of the tall stock had already enlisted. The lowest statures were found among the casual labourers and the textile workers, who had been subject to bad conditions of environment.

The returns from the School Medical Service show that stature is, on the whole, greater in England and Wales to the south of a line drawn from the Severn to the Wash, with an extension northward to include Lincolnshire and the East Riding of Yorkshire; in addition, scattered areas containing many tall children occur in Westmorland, on the coast of Cumberland, in the far north of Lancashire, in the hilly districts of Staffordshire, and in Merioneth. This line of demarcation clearly marks off the industrial from the rural districts, though it also largely coincides with areas of former Saxon, Danish, and Norwegian occupation. The children in factory towns and mining areas are in general definitely shorter than those in rural districts. The best physique is found in the great public schools, then in order come other secondary schools, the trade schools, and the ordinary elementary schools; these correspond pretty well to the leisured and professional, the commercial, the artisan, and the factory and labouring classes respectively. The stature of the children from the better-class schools, many of whom present Nordic traits and all of whom have been brought up in a favourable environment, is equal to any in the world. The general average for all types of schools is, however, below that of the children of British descent in the Dominion or the Commonwealth. The advantage of the latter supports the opinion that the emigrant stocks from Britain contained a large

[1] From the presidential address to Section H (Anthropology) of the British Association at Toronto delivered on August 7.

proportion of Nordic elements, and also suggests that the children flourish under the new environment.

In neolithic times, so far as can be gleaned from skeletal remains, the average stature of adult males was about 63 inches with a few taller individuals interspersed, who were perhaps of the ruling caste; the Saxons averaged about 66 inches, the Norwegians and Danes were a little taller. Throughout the medieval period, stature remained little affected so far as can be judged from clothes, implements, and armour, which would suit the larger number of the present-day people and would indeed be too small for the better built. In the eighteenth century there were many recruits whose stature was only about 63 inches.

Records of children of Lancashire operative and labouring classes, taken in the second quarter of the nineteenth century, when compared with similar figures at the present day, show little change until the last few years. Since the initiation of the School Medical Service, it has become evident that a gradual improvement is in progress. In London elementary schools there has been a gain of a full half-inch in stature since 1904, while in the public schools average gains of an inch or more are recorded. The changes in weight are even more general and significant.

Comparisons which have been made between children who have suffered from illnesses and those who have had none of importance show the greater stature of the latter class; many children fail to attain their full stature on account of morbid factors which may act on the growing bones directly, as in rickets, or indirectly through malnutrition resulting from infectious ailments, catarrhs, or actual privation.

Taking a more general survey, the health of a people under varying conditions may be measured by the variation in the duration of life, which appears to have increased steadily from the earliest times. The great gain has been that more now live to middle age or beyond. The expectation of life varies from class to class much as does physique, being greater for the professional classes than for the agriculturist, for the agriculturist than for the miner, while the latter in turn is a better life than the tailor or the textile worker. It also seems that there is a greater expectation in those areas which, at any rate until recent times, were occupied by a predominantly Nordic population.

General health has often to be estimated from the records of mortality, though it must be remembered that morbidity is much greater than mortality and that the after effects of injury or disease may long affect the physique of the sufferer. Lethal agencies are sometimes local, sometimes widespread in their action, and may at times exert a selective action on the population affected.

War in early culture might occasionally wipe out a whole population, but more often the skilful and strong survived; in modern war the selection favours those whose physique does not permit of active military service and is thus opposite in tendency. War acts more lethally through the social disorganisation, and the consequent famine and disease, which follow in its train, than through any casualties in the field; from these direct experiences on its own soil, England has been singularly free since the Norman period. Thanks perhaps to the great demand for labour and to the separation allowances, as well as to the seat of action being abroad, the recent War has exerted no obvious harmful effects. The children have been well nourished and there was no great increase of defective children, such as had been anticipated by some, even in the areas most exposed to air raids. There was, it is true, an increase in the number of children who were troublesome and educationally backward, but on examination it was clearly seen that these features were not due to innate characters but to truancy and lack of discipline during the absence of their fathers.

Famine took its toll in Western Europe in the medieval period, but England was the country in which the mass of the people soonest attained to fairly constant comfort. This was a great contrast to France, which repeatedly suffered from long years of famine. Harrison in his "Description of Britain" quotes a Spaniard in Queen Mary's day as saying "These English have their houses made of sticks and dirt, but they fare commonly as well as the king." In general any morbid influences on nutrition arose rather from a seasonal scarcity of certain essential articles of diet than from famine in the ordinary acceptance of the term.

Disease, throughout the historic period, must have been the most lethal of all the morbid agencies; there is nothing to suggest that there are important diseases to-day from which our ancestors were free. On the other hand, certain of the scourges of our ancestors have practically disappeared, especially some of the infectious diseases. Leprosy and plague long ago ceased their ravages, typhus and famine fever vanished, save for isolated cases in later Victorian times, enteric fever has lessened nearly to the vanishing point, and even infantile diarrhœa is becoming less year by year. Most, if not all, of these diseases may be communicated by animal agencies, either by direct inoculation from bites or by secondary contamination. The louse, the bug, and the flea, common until recent years, are succumbing to the newer tradition and meaning of cleanliness which has followed universal education, the medical inspection of scholars, and the action of public health authorities; the fly, an indirect agent, is being eliminated by improved sanitation and the gradual disappearance of horse transport in our cities. As the changes proceed more rapidly in the towns the approximation of their health conditions to those in rural areas follows.

The mortality in early years was very high; thus in 1754 the deaths in London of children under two years of age were 45 per cent. of the deaths. Infant mortality has oscillated around 160 per 1000 until 1900, since when it has fallen to 60 per 1000 in 1923. A great part of the reduction has been in deaths due to infectious diseases and especially to diarrhœa; there has been little or no change in the rates from congenital defects or developmental disorders, which have remained relatively unchanged in all classes of the community, so that this lethal selection against the naturally unfit remains as rigid as ever.

Mortality in the early years of life is greater in the cities than in the small towns and in these than in the rural areas; it is greater in the north than in the south for all classes of the community, but it must be noted that with the great fall during the present century

the gap between urban and rural areas has been closing. This again suggests that education and a higher standard of personal hygiene are important factors, for the country is always more conservative in its actions and beliefs.

The mortality of the infants of agricultural labourers is less than that of those of any other class of manual workers, not only so far as diarrhœal diseases are concerned—here, perhaps, they have better chances of obtaining fresh milk—but also from measles, tuberculosis, and respiratory diseases generally. Some of the difference may be due to the rural child, on the average, being older than the townschild at the time he is attacked by infections; for, whereas infantile infections spread through towns about every second year, in the country districts there may be an interval of five years between periods of epidemic prevalence. The infant mortality among textile workers is especially due to diarrhœa, which may be ascribed in many instances to artificial feeding during the mother's absence at the mills. The children of this class also die notably from congenital malformation and prematurity, which might naturally have been attributed to the mothers working until a late stage of pregnancy, were it not that the mortality from these causes is even higher among the children of miners, whose womenfolk seldom work outside their own homes. On the whole the evidence goes to show that morbidity, and especially infant morbidity, is closely associated with the aggregation of population, but that in recent years improved standards of social or individual hygiene and comfort have done much to neutralise specific causes of ill-health. It may also be taken as proven that such ill-health is the greatest cause of stunting of physique. As in the past the countryside has been freer from these morbid influences; the countryman has been the physical superior of the townsman, comparing class with class.

There are three main ways in which the growth of towns and of the industrial system has prejudiced the health and thus the physique of the nation: adverse conditions of work, which had little influence prior to the eighteenth century, unhygienic housing, and bad feeding, which in varied ways have exerted their effects throughout a large part of human history. Some of these would be peculiar to the town, others would fall indifferently on town and country, and on all social classes save perhaps the very wealthiest, though even they could not entirely escape. The contrast is less vivid than would appear at first sight: the country child can get fresher food, it is true, but less of it perhaps, owing to the lower wages of his parents, though he often eats margarine, the butter being sold in the towns; he gets fresher air outside but not indoors, since the country cottage may be as dark, ill-ventilated, and overcrowded as any in a city court.

The greatest change in the conditions of work was the rise of the factory, involving long confinement in monotonously ventilated rooms, as opposed to work in the open at the door of the home. The early factory was an extension of the home. The introduction of water and steam driven machinery aggregated the populations into the northern towns which arose near the sources of the power, and put a premium on the employment of children who could then do work which formerly required a man's strength. In recent years the general hygiene of the worker, together with the removal of industrial risks, has made enormous strides, the result being apparent in the falling death rate and the healthier children.

In early days the English dwelt scattered through woods and marshes; in medieval times they began to flock to the towns in which the sanitary conditions were bad; during the industrial revolution the aggregation of houses and the pollution of the air greatly increased and produced their well-known evils, though the sanitation of the individual houses was, in some respects, no worse than before.

Sedentary occupations in still warm atmospheres have the effect of lowering the general metabolism and of reducing the desire for food, thus producing a similar effect to actual privation and affecting even the well-paid worker. Acting through long periods during the growing time of life, such factors whenever they arise may stunt growth as well as predispose to illness. Many dietaries which appear satisfactory on a mere caloric basis prove failures owing to the lack of vital elements. The industrial worker is doubly handicapped; he not only loses his appetite and takes scarcely enough to provide the necessary energy for his work, but also, too often, he takes even that in the form of margarines and canned foods which do not supply adequate vitamins. If, as is probable, physique suffered with the concentration of the population in the industrial areas, no small part may have been played by the confinement in a relaxing atmosphere and the substitution of inert for live foods. The worker who emigrates to more rural surroundings reverses these conditions and, if young enough, recovers part of his lost physique, and in any case his children, not being handicapped, fulfil their true potentialities. With feeding as with housing, though the industrial age brought its own defects, yet the contemporaneous increase of civilisation provided the remedy for some of the previous evils, such as those arising from imperfect methods of food preservation. The curing at the best was very imperfect, and the diet of the poorer classes would be the semi-putrid sides of bacon, mutton, or beef. Indeed, it was enacted that such should be given to the outcast by the Scottish Parliament at Scone in 1380. "Gif ony man brings to the market corrupt swine or salmond to be sauld, they sall be taken by the baillie and incontinent without any questions sall be sent to the lepper folke; and gif there be no lepper folke, they sall be destroyed alluterlie."

Modern medical inspection and treatment are fast counteracting the chief causes depressing the health and physique of the children, and are also dealing with contributory secondary factors, such as defective teeth and other foci of chronic sepsis, verminous conditions, and unsuitable clothing. No one who compares photographs of present-day children with their predecessors of the 'seventies can doubt the change. It is significant that the town is now gaining over the country and that London children are now second to none. The treatment schemes did not come into force until just before the War, and affected almost exclusively children who did not reach military age in time to appear before recruiting boards, so that the benefits of the system

could not be brought out in the report of the Ministry of National Service. In this direction the future seems secure.

There remains the gap between the school and adult life. An experienced Scottish recruiting board reported a falling off during adolescence both in the agricultural and the industrial classes. With any extension of facilities for apprenticeship or trade instruction, with opportunities for the further treatment of ailments, even though these be of a voluntary character, much would be gained. Moreover—since the use made of these facilities would depend on the mentality and character of the individual—the youth with the best mind and good will should gain the advantage and be favoured in his prospects of a successful marriage, through which he could transmit these qualities to further generations.

Turning to the genetic aspects of the subject, it is clear that the future of the nation depends on the interaction of two somewhat opposed processes, reproductive and lethal selection. Fecundity is a heritable trait, and parents who themselves are members of large families tend to produce many offspring who, in their turn, are similarly prolific. Lethal selection, on the other hand, counteracts this tendency in that the demands of a large family reduce the chances of the parents protecting themselves or their offspring, since the available care has to be distributed over a larger number. It will be noted that the shorter the intervals between successive births, the higher is the rate of infant and child mortality.

That reduction in fertility has been of long standing is strikingly illustrated by Crum's study of the New England genealogies, in which he finds a progressive reduction in the size of the family and an increase in the proportion of childless marriages. The differential death rate, chiefly due to infant mortality, to some extent modifies the initial differences in fertility; the high fertility of the agriculturist is largely opposed by the low marriage rate, and the relative infertility of the upper classes is exaggerated from the same cause.

There appears to be a general impression that the number of defective individuals, particularly of those suffering from mental defect, is greatly increasing. There is little evidence on this point of a comparable nature, but it may be definitely said that in London no such increase has taken place during the last fifteen years. The stocks from which defective individuals come are certainly often prolific, but the infant mortality is high. Contrary also to popular belief, mentally defective individuals do not mate in nearly so high a proportion as the normal. There is some reason for thinking that there is a great intermarriage between defective stocks, and that the actual number of such stocks is in reality quite limited.

There remains one important factor bearing on physique—namely, emigration. Since the early part of the seventeenth century the British Isles have sent abroad large numbers of the most efficient of their people, agriculturists and skilled workers of all kinds possessed of just the qualities which the nation demands for its own physical good. Where these have come from somewhat isolated areas the result has been a steady loss of the best, with the consequent replacement in the next generation by the offspring of an undue proportion of the next best. This—probably the most serious drain to which the nation has been, and still is, exposed—can only be regarded with equanimity on the ground that England's loss is the gain of the daughter nations. The emigrants have been largely of "Nordic" and "Prospector" stocks, seeking a wider scope for their energies, and the result will in the end seriously modify the racial composition of some parts of the British Isles, particularly Scotland.

Summarising the whole survey I would submit that a pessimistic view of the physical or mental condition of the people of England is unnecessary and unfounded. Stature and weight at least are not less than in earlier days. The War showed the possession of powers of resistance to physical adversity that have never been equalled. The general health of the nation is better and the expectation of life longer than ever before. There are no grounds for thinking the physical conditions of any class are worse than that of corresponding classes at previous epochs, even among those persons and classes on whom the adverse conditions of life associated with urbanisation and industrialism have pressed hardest and have been least opposed. The real increase of the unfit is much less than has been assumed from *a priori* arguments. Reproductive selection, which has a tendency to increase the apparently less valuable stocks, is opposed by a lethal selection which has not been abolished, while emigration, from the eugenic point of view, though a real disadvantage to England, has been a source of strength to the Empire of Associated Nations. The dysgenic tendencies of industrialism are being successfully opposed by the higher level of general culture and the awakening of a national conscience, but more especially by the more intelligent care for the children of the nation, in which the application of preventive medicine to education is playing no mean part. The Education Acts, if they have not revealed every child as a potential university scholar, have proved the best of public health measures; while all available evidence points to the intellectual average being equal to that of any other country. Civilisation may be making greater demands on its bearers, but their qualities are neither diminishing nor deteriorating and more and more are fitted to shoulder the burden.

Periodical surveys are necessary to check the changes in the population. Failing more extensive measures, these may be effected through the records of the medical inspection of school children, though in these anthropometric data are but scanty. The matter is of great importance, since it is only on the basis of careful physical and mental surveys that legislation directed towards social and racial hygiene could properly be introduced and rightly justified. The lack of such information has been a great handicap to the discussion of such measures in Britain, and has allowed a freer play to pessimistic views.

None the less, despite all forebodings, it may confidently be stated that the mother nation has remained true to herself and deserves now, as of yore, the encomiums of the "Polychronicon": "Engelond ful of pley, fremen well worthy to pley, fre men, fre tonges, hert fre, fre helth al the leden."

Why Wireless Electric Rays can bend round the Earth.[1]

By Sir JOSEPH LARMOR, F.R.S.

MYSTERY has remained attached to the transmission of free electric rays a long way round the protuberant curvature of the earth, which has recently developed into the greatest sudden practical evolution in signalling since the telephone. The difficulty was already emphasised by the late Lord Rayleigh, as soon as the first signs of transmission across the Atlantic had been detected by the Marconi operators. The effect has been sometimes supposed to be accounted for by a hypothesis that the rays are turned downward by an upper conducting layer in the atmosphere. But conduction, as usually understood, involves dissipation, and thus loss of energy of the rays by absorption; so that a train of radiation travelling along a layer sufficiently conducting to bend the rays could not go far. In fact, by a well-known dynamical principle, if the absorption is small of the first order, the resulting increase of velocity of the train is small of the second order and so of no account for bending rays in a varying field.

There seems, however, to be a sufficient and rather striking cause available for transmission of long waves horizontally round the earth at great altitudes, though the rays travelling at lower heights would be gradually quenched. For the synchronous oscillations of free ions of small mass go on undisturbed by collisions in very high regions of the atmosphere, and have time owing to the long period of the exciting waves to get up high speed and so become important under the influence of the field; much as the electrons in a triode valve have time during the electric oscillation affecting them, or rather in this case during their passage, to get deflected on to the grid. In an extremely tenuous atmosphere, this free ionic oscillation would be almost the sole conceivable deflecting agency. On the other hand, the absorption that would accompany ionic oscillations in ordinary conduction arises from the shortness of the free path, which leads to dissipation, through collisions with the surrounding molecules, of part of the extra energy acquired in the accelerated motion of the ions and thus abstracted from the electric field. When, as above, the period and amplitude of the oscillatory motions of the ions are much shorter than the time and length of their free path, so that the great majority of the oscillations take place without interference from collisions, this loss of energy will be very much reduced. A rough illustration of this principle is doubtless afforded, at the other extreme, by the remarkable penetration of the very short X-rays into light metals. It is not, of course, that conductance tends to become perfect, for then no waves could travel: the influence must be turned on to the dielectric modulus of the medium.

This cause must operate also for long waves travelling in the extreme limits of the atmosphere where the free path is great. The density aloft may be extremely minute: the long swing of the ions can bend the waves. The region in which the aurora borealis is displayed extends up to a height of fifty miles or more, and there the free atomic path for air would be about two centimetres. For radiation of wave-length of a kilometre, with oscillating field of amplitude one volt per metre and so transmitting $\frac{4}{3} . 10^{-7}$ watts per square cm., the amplitude of the oscillations of free electrons would be about five centimetres, and for heavier ions it would be smaller inversely as their mass; while the time of oscillation for this length of wave is only about a twentieth of the time of the free path, at this altitude, for a molecule of the air, or a quarter of the free time for a hydrogen ion. For an electron moving with the speed of thermal equilibrium this time of oscillation would come to ten times the time of its free path at this height; this would be entirely excessive and the electron would be an agent of strong dissipation, were it not a reminder that the electron passes through the atom each time with but slight derangement of its free motion.

The long free path would in itself tend to augment the degree of ionisation. There must, of course, be as many positive ions present as negative; but though both influence the velocity of propagation of the waves in the same direction, the effect of the massive ones is negligible. It can readily be shown that the result is to reduce the effective dielectric modulus of the medium, the value of which is close to unity, by $N_0 e^2 \lambda^2 / 2\pi m$, where N_0 is the numerical density of the ions of charge e and small inertia m. The amplitude of free oscillation of each ion would be $e\lambda^2 / 4\pi^2 mc^2 . F_0$ in a field of amplitude F_0. The velocity of propagation v is increased relatively by the first of these amounts, which is for the same stratum proportional to the square of the wave length λ. The curvature of the horizontal rays in any stratum is equal to $d \log v/dh$, the rate of relative increase of the velocity upwards, which is here $\frac{e^2 \lambda^2}{2\pi m} \frac{dN_0}{dh}$. The stratum of transmission to great distances is the one for which this is exactly the same as the curvature of the earth, namely, $\frac{1}{2}\pi . 10^{-9}$. For electrons this gives dN_0/dh equal to 10^{-5}, for hydrogen ions 1700 times this; thus if this adaptation of curvature applies to a sheaf of rays extending over the height of as much as a kilometre, N_0 need not mount to more than one electron per cubic cm. for this wave-length of one kilometre, whereas the number of the atoms would still be as much as 10^{14} per cubic cm. at the height of fifty miles, which gives a sufficient free path for material ions. For hydrogen ions, N_0 would have to be increased to $2 . 10^3$ per cubic cm., while the amplitude of oscillation would be reduced 1700 times so that the effective stratum need not be so high; if free electrons also are present in numbers, in thermal equilibrium, they would introduce dissipation of the rays passing at levels considerably higher than this rough illustrative estimate of fifty miles,—were it not that their motion, more potent on account of their smaller mass, is so slightly deranged by passing through an atom as to compensate for the much greater number of such encounters.

These considerations remain valid in a general way when the strata of equal ionisation are not exactly horizontal. If any cause, such as the influence of sunlight on the ionisation, alters the height of this

[1] Abstract of a paper read on October 27 at the Cambridge Philosophical Society.

effective stratum too suddenly, the rays will be bent away upward or downward, and scattered, at the place of dislocation, and may not be able to get adjusted into the new stratum of transmission. If, however, the stratum is thick, the dislocation will be incomplete, extending over only part of it. The stratum may be expected to be of varying height, some function of the local solar time; but it is too high for any merely meteorological derangement. All rays emitted not nearly horizontally are lost: a good local earth would assist the antennas here. We can think of the constituent beam of rays connecting the transmitter with a receiver anywhere along the path: it travels most of the way, without loss except by spreading sideways, in the effective stratum, in which all such beams unite to form a nearly horizontal band of rays, the rough analogue of an optical caustic, in the almost vacuous region above. Each receiver collects from an area around it of the order of the square of the wave-length: it thus appears from numerical estimate that the amount of energy available need not be at all inadequate to account for the now familiar features of free electric transmission round the earth, even to the antipodes and beyond.

Obituary.

DR. J. E. CAMPBELL, F.R.S.

THE sudden death, at sixty-two years of age, of John Edward Campbell has come as a grievous shock to many. It removes from among us, in the height of his powers, a pure mathematician of strong individuality, and of conspicuous achievement in departments of research where few, in the British Isles at any rate, could bear him company. It deprives the small fraternity of mathematical lecturers in Oxford of a recognised leader, both revered and beloved. It means the loss to his College of a tutor no less devoted and successful than distinguished, who also served it in administration as acting head during the last years of its great Principal, Dr. Boyd. It leaves certain causes of philanthropic and religious work in Oxford sadly the worse off for working friends.

Campbell was the son, born at Lisburn, Co. Antrim, in 1862, of Dr. John Campbell. After going through the Belfast College of the Queen's University with distinction he came to Oxford, rather older than most undergraduates, as a scholar of Hertford. Later he became fellow and tutor of the same College, after gaining all the ordinary academical honours. He was also for a good many years lecturer of University College. He became a fellow of the Royal Society in 1905. In the years 1920–22 he was president of the London Mathematical Society; while the University of Belfast made him an honorary doctor of science.

Geometry was the strong point of Oxford mathematics in Campbell's young days, and it was natural for him to choose his line of research with a certain geometrical predilection, but he never became a devotee of the pure geometry of Chasles like others who surrounded him. Prettinesses did not much appeal to him: he wanted to plough broad acres. Looking afield for them, he began the study of the theories of continuous groups and of contact transformations which that master-geometer Sophus Lie had exploited, and with Sophus Lie he stayed long. Most of his earlier writings were contributions to Lie's theories, and presently he wrote a comprehensive book upon them, the first one by a British author, and far from a slavish reproduction of Lie's ideas. The differential geometry of surfaces has for long been another subject of his study and productiveness. More recently he has plunged into the time-space of Einstein in hopes of finding firm ground, as witness his presidential address to the London Mathematical Society.

There was a wonderful charm about Campbell's personality. Transparent rectitude, playful humour, the courage of his opinions, all shone from him to those who knew him. Affectation was as alien to his nature as idleness, and he could not be ungenial. In fact, he was the sort of Irishman whom it is a joy to run against. Some, hearing him for the first time, may have fancied that he had brought his Scotch name and his quaint accent unfamiliar to southern ears from somewhere to the east rather than the south-west of Campbeltown, and perhaps a comparatively remote Scottish ancestry may have had to do with the sturdiness of his principle and the forcefulness of his determination. Patient he was at his work, tolerant of stupidity, kindly in his joking, but there was a fire underneath which showed itself when what he thought wrong was in question. In the middle of 1914 he was a heated Ulster patriot. August came, and the lesser patriotism was submerged by a flood of the greater. A dearly loved son was an early sacrifice. During the War there was nothing else to him that mattered. He lived to serve those who fought for the right.

The War over, Campbell returned to his mathematics and to his tutorial work with young men. Of the latter, another generation or two have learned to be thankful for his precept and example. Of the former, a new book from his pen—one on differential geometry—will shortly speak.

WE much regret to record the death on October 4, at the age of seventy-seven, of Dr. Joseph Moeller, emeritus professor of pharmacognosy in the University of Vienna, and we are indebted to the *Chemiker Zeitung* for the following details of his life and work. Dr. Moeller studied in Vienna and was appointed an assistant in the pharmacological department in 1871. After the publication of his work, "Vergleichende Anatomie des Holzes," he lectured on natural products in the technical high-school at Vienna, and he was awarded the *venia legendi* for pharmacology of the University. In 1886 he was appointed professor of pharmacognosy at Innsbruck, and in 1893 he left that University for Graz. Later he returned to the Medical Faculty of Vienna, where an independent Institute of Pharmacognosy was built for him. Among other publications Dr. Moeller was the author of "Mikroskopie der Nahrungs- und Genussmittel," which has been translated into several languages; "Anatomie der Baumrinde"; and, with Ewald Geissler, of the "Real-Encyklopädie der gesamten Pharmacie."

Current Topics and Events.

IN the leading article of our issue of September 27 we dealt with the question of University Staffs and University Finance. In the course of the discussion we endeavoured to make the point that where the functions and responsibilities of the staff varied continuously from the lowest to the highest of its members, a reasonable case could be brought forward for a similar continuous variation in remuneration. To illustrate the point, the case of the University of Edinburgh was quoted, where this question has recently been raised in an acute form. We stated that the "average salary of the members of the non-professorial staff (248) was about 260*l.* and that for the professorial staff (52) about 1100*l.*" Our authority for this statement was contained in a memorandum issued and signed by a staff committee of sixteen containing names of some eminence. Prof. Barger, of that University, writes querying the accuracy of these figures and suggesting that they are misleading, in that there must have been included "a large number of physicians and surgeons of the Royal Infirmary, professors in the College of the United Free Church, advocates, part-time demonstrators, etc."; that the full-time non-professorial staff is about 123 with an average salary of 433*l.* He does not tell us what would be the average salary of the professorial staff in these circumstances, nor does he quote his authority. We must leave the question to be decided at Edinburgh, but our main contention remains, of course, unaffected.

A CORRESPONDENT writes:—"Our Dutch colleagues have done well to keep green the memory of their distinguished countryman, Van't Hoff, by openly celebrating the jubilee of the conception upon which the modern doctrine of stereoisomerism is based, published independently by Le Bel in France and Van't Hoff in Amsterdam, in the latter part of 1874. Van't Hoff, it may be remembered, was brought up on a strange diet of Burton's Anatomy of Melancholy, Byron, Burns, and Buckle, yet his contribution was so made and so simple that it almost forthwith gave solidity to chemists' speculations as to the character of optically active compounds in particular, and it has prevailed up to the present day. A vast amount of solid work is traceable to the influence it has had. At the public meeting, held on October 25, in the University of Amsterdam, the foreign visitors were first welcomed by a representative of the Netherlands Chemical Society; addresses were then delivered by Profs. Cohen and Walden. Prof. Cohen's speech was an eloquent appreciation of the two men, the section devoted to Le Bel being particularly happy in its allusions. Prof. Walden appears to have prepared a complete account of the development of stereochemistry up to the present day, but could only summarise his conclusions. A reception preceded the meeting, and tea followed it. Unfortunately Le Bel could not be present. The French Chemical Society was represented by M. Delépine, the English Chemical Society by Profs. Armstrong and Lowry, whilst Mr. Woolcock represented the Society of Chemical Industry and the Association of British Chemical Manufacturers. An American wandering in Europe had been captured to appear on behalf of the American Chemical Society. Prof. Walden was the delegate of the German Chemical Society and also appeared for the Russian Society; it may be mentioned that he is now professor in Rostock; he was formerly in Riga. In the evening a banquet was given at the Hotel de l'Europe. The celebration on the whole was immensely successful. A friendly party of men, all understanding one another, united to give pious effect to the feeling of gratitude which all who can appreciate the great gift our science has received from the two men in whose honour we were assembled. Such exchanges of courtesy are of great value. These meetings, however, ever serve to remind us only too forcibly of our linguistic deficiencies."

IN his presidential address to the Institution of Automobile Engineers, delivered on October 14, Dr. W. R. Ormandy reviewed the fundamental work done by Ricardo, and by Tizard and Pye, on the phenomena and principles governing the efficiency of internal-combustion engines, and then dealt mainly with problems awaiting solution. The present method of taxing motor vehicles, by cylinder capacity, has led to the use of engines having very high compression-ratios, in order to obtain a high power with a given cylinder bore; but many engines fail in efficiency owing to pre-ignition of the fuel. Hence ability to withstand high compression is a very important attribute of a motor-fuel. The work of Midgeley and Boyd in America has opened up the possibility of using low-compression fuels in high-compression engines by adding to them traces of compounds of selenium, tellurium, or lead, but such substances are difficult to handle. For engines with more than one cylinder, the problem of distribution from the carburettor to the cylinder needs investigation with the view of finding distributing systems that will enable all types of fuel to be used freely in motor engines. "Cracked" fuels are rich in unsaturated hydrocarbons, and further research is needed on the relation between chemical constitution and performance in the engine. Another desideratum is a fuel which can be exploded in very weak admixture, as a means of improving the efficiency of engines working at light loads; hydrogen and, to a much smaller degree, methyl alcohol, and ether, satisfy this condition, but are ruled out owing to inconvenience or cost. Further progress in the discovery and investigation of new alloys, particularly those containing aluminium and magnesium, will have far-reaching effects on the future of the automobile industry. For these and other researches more money is required. In Great Britain money is fairly easily obtained for new processes that have advanced to a small commercial scale, but it is very difficult to procure for a discovery that needs investigation in the laboratory; in this respect Great Britain is behind Germany, where such work was not

interrupted even during the most stressful periods of the War.

IN his presidential address on "Bretonneau: His Life and Work," delivered at the Section of the History of Medicine of the Royal Society of Medicine on October 15, Dr. J. D. Rolleston said that Bretonneau (1778–1862), by his clinical perspicacity in conjunction with careful post-mortem examinations, did as much for the study of acute infections as Laennec did for chronic diseases. Bretonneau was a remarkable personality whose services to medicine can be summarised as follows:—(1) He established the specificity of diphtheria and typhoid fever; (2) by his doctrine of specificity he foreshadowed the germ theory of disease; (3) in opposition to the physiological school headed by Broussais, who had discarded the materia medica and reduced treatment to bleeding, leeching, and a starvation diet, Bretonneau made several contributions to therapeutics, including tracheotomy for laryngeal diphtheria, a new method of administration of quinine in malaria, the use of belladonna in constipation and enuresis, the resuscitation of purgatives in dysentery and of martial preparations in anæmia, and the introduction of cod-liver oil in the treatment of rickets; (4) his work, especially his researches on diphtheria, by which he showed that the Syriac ulcer, malignant angina and croup were the same disease, illustrated the practical value of the study of the history of medicine.

A SLIGHT earthquake was felt in Birmingham and the surrounding district on the afternoon of October 24. From the information at present received, the disturbed area is about 24 miles long, 16 or 17 miles wide, and contains about 300 square miles, the centre being a few miles to the west of Birmingham. The shock was registered at Mr. J. J. Shaw's observatory at West Bromwich at 4·49½ P.M., the maximum intensity being about four seconds, and the last tremors about four minutes later. This is the fourth undoubted earthquake that has occurred in the neighbourhood of Birmingham. About the first, on November 23, 1769, little is known. The second, on November 15, 1772, disturbed a small area about 8 miles long and 4 miles wide, including Birmingham, but lying principally to the east. Still farther to the east, and extending from Birmingham to Coventry, was the disturbed area of a slight shock on January 31, 1888. A much stronger shock on August 27, 1922, felt over an area of about 650 square miles, has been attributed to the bursting of a meteorite (NATURE, vol. 110, p. 393).

DR. P. CHALMERS MITCHELL delivered the third Benjamin Ward Richardson Memorial Lecture on "Hygiene in Animal Food: Evidence from Zoological Gardens," under the auspices of the Model Abattoir Society, on October 23. Dr. Chalmers Mitchell stated that examination of the intestines of mammals and birds shows that the more primitive types in most classes are adapted to an omnivorous diet, and that the purely carnivorous and the purely vegetarian habits are more specialised. Man, although the most highly specialised in brain, is more primitive in some other organs, including the intestines. Until human beings change their habits, a meat supply will be required. At the Zoological Gardens, meat has to be provided for carnivorous and omnivorous mammals and birds, and the animals chiefly used are horses and goats. These are killed in a modern, hygienic abattoir. The rifle is used, and although on an average three horses are required in two days, in the last twenty years in only two cases has a second shot been required. Dr. Chalmers Mitchell is of opinion that there is little or nothing to choose between the rifle and the humane killer, the poleaxe or the knife, skilfully used under proper conditions, as the instruments of actual death. In his opinion and experience, animals have no presentiment of death, and even the fresh blood and warm offal of their fellows convey no message of fear to their consciousness. But they are readily thrown into panic by being driven into unfamiliar places. Every abattoir should therefore have attached to it proper stables or byres, and the animals should be tended and finally led out by men familiar with the handling of living animals. Particulars of the work of the Model Abattoir Society can be obtained from the hon. secretary, Model Abattoir Society, at the Royal Sanitary Institute, 90 Buckingham Palace Road, S.W.

THE jubilee celebrations of the London (Royal Free Hospital) School of Medicine for Women were held last week-end. On Friday, October 24, a dinner was held at the Guildhall, which had been specially lent for this purpose by the Corporation of the City of London. Mrs. Scharlieb presided, and the toast of "Women's Work" was given by Dean Inge, Dean of St. Paul's. The toast of "The School" was proposed by Prof. E. A. Gardner, Vice-Chancellor of the University of London, and replied to by Miss Aldrich-Blake, Dean of the School; Mrs. Fawcett, Lady Barrett, and Prof. Winifred Cullis also spoke. More than 3000 women, representing all professions and callings in which women are engaged, gathered in St. Paul's Cathedral on Saturday afternoon to give thanks for "the opportunities for training, work, and service opened to women in the past fifty years." Of special interest, in view of the Jubilee Endowment Fund which is being raised to endow three chairs in memory of the three women pioneers in medicine, was the presence of the three nieces of Sophia Jex-Blake, founder of the School; and of Dr. Louisa Garrett Anderson, daughter of Mrs. Garrett Anderson, who was Dean of the School for 20 years. On Saturday, October 25, a party was held at the School, when past and present students and friends of the School were entertained. In this connexion there were some interesting scientific exhibits. Mr. Gardner, lecturer in organic chemistry, gave demonstrations with liquid air. An exhibit of crystals and crystal formation included some beautiful specimens lent by the Gas Light and Coke Co., Messrs. Burroughs and Wellcome, and the British Drug Houses, Ltd., as well as specimens made in the School laboratories. The physiology exhibits included optical illusions, tests for colour-blindness, the Sanborn apparatus for investigating respiratory exchange, measurement of

blood pressure, and microscopic specimens of various normal tissues. The Endowment Fund, headed by a donation from the Queen, has now reached a total of more than 26,000*l.*, including a reversionary gift of 10,000*l.* from a woman doctor in Harley Street.

THE Ramsay Laboratory of Chemical Engineering at University College, London, will be opened by Prince Arthur of Connaught on Wednesday, November 12, at 5 P.M. After the opening ceremony, the new building will be open for inspection.

THE Thomas Vicary lecture of the Royal College of Surgeons of England for the present year will be given at the College by Sir Arthur Keith on Wednesday, November 12, at 5 o'clock. The subject will be "Sir Richard Owen as Conservator."

APPLICATIONS are invited by the Zoological Society of London for their newly instituted Aquarium Research Fellowship, particulars of which were given in NATURE of August 30, p. 324. Applications for the fellowship must reach the Secretary of the Society, Regent's Park, N.W.8, by November 18 at latest.

APPLICATIONS are invited from members of the Royal College of Veterinary Surgeons with, if possible, experience in research work, for an assistantship in the Animal Disease Research Division of the Ministry of Agriculture of the Government of Northern Ireland. The latest date for the receipt of applications by the Secretary of the Ministry, Belfast, is November 8.

PROF. C. F. MARVIN, professor of meteorology since 1891 and chief of the United States Weather Bureau, has been appointed acting-secretary of agriculture for the United States, the secretaryship having fallen vacant through the death on October 25 of Mr. Henry Wallace, of Iowa.

THE Royal Airship Works, Cardington, require a skilled calculator, of either sex, with a university degree in science or engineering, who has taken higher mathematics in the degree examination. Experience in stressing of complicated braced structures is essential, preferably in connexion with the design of aircraft. Candidates with a knowledge of aerodynamics will be given preference. Applications should be sent to the Secretary, Royal Airship Works, Cardington, Beds.

THE Report on the Hunterian Collections of the University of Glasgow for the year 1922–23 is noteworthy for the large number of type-specimens included among the fossils presented to the geological department. These comprise plants from the Mepale Oil Shale of South Burma; Daunichthys, a new genus of fishes, with other fossils from the Dawna Hills, South Burma; corals, stromatoporoids, and brachiopods from Yunnan. Prof. J. W. Gregory also records the donation of a fine series of lead ores, calcite crystals, and other minerals from Wanlockhead and Leadhills mines by Mr. G. B. Findlay.

THE most recent annual Report of the Castle Museum, Norwich, records the gift by Mr. Gerard H. Gurney of the collection of British birds formed by his father, the late John Henry Gurney. The collection comprises 1500 bird skins and 49 glazed cases of mounted birds, and is of particular value for its examples of different stages of plumage. The report also tells of successful co-operation with the Norwich Education Committee. That body has appointed a museum demonstrator, who gives four demonstrations daily to a class of 25 senior boys or girls in their fourteenth year. The scheme allows of 500 scholars attending a full course of twelve consecutive demonstrations in natural science. A good feature is that the children have the opportunity of handling duplicate specimens.

WE have received the tenth annual Report for 1923 of the International Health Board, Rockefeller Foundation, reviewing the activities of the Board in all parts of the world. Its work includes propaganda, money grants in aid of public health education and for travelling and research fellowships, and campaigns against hookworm, malaria, yellow fever, and other diseases. The total expenditure of the Board for 1923 amounted to 2,452,728 dollars. The Report is characterised not only by the lucid and interesting text, but also by the number of excellent illustrations, charts, and maps. Short papers on the spleen index in malaria, the use of fish for malaria control, and the eradication and diagnosis of hookworm disease are included in an appendix.

WE learn from the *Lancet* that after the delivery on St. Luke's Day, October 18, of the Harveian Oration before the Royal College of Physicians of London, the president, Sir Humphry Rolleston, presented the Weber-Parkes Prize and Medal to Prof. A. Calmette, formerly of Lille, now sub-director of the Pasteur Institute, for his researches on tuberculosis. The president referred to him as the foremost authority on this subject, at the same time alluding to his researches into other aspects of bacteriology. He then presented the Moxon Gold Medal to Sir Leonard Rogers for his distinguished researches in clinical medicine. In doing so, he remarked that there were few tropical diseases in regard to which Sir Leonard Rogers had not laid the medical profession under debt by his investigations. He mentioned especially dysentery, kala-azar, cholera, and leprosy, and wished him success in his present researches into the treatment of tuberculosis.

THE New York correspondent of the *Times* states that the late Mr. Henry R. Towne, a manufacturer and engineer, has bequeathed the bulk of his estate, amounting to several million dollars, to establish museums in New York which shall be a "permanent exposition of American achievement in the peaceful arts." In case the trustees deem it inexpedient to establish such museums, the fund is to be divided equally between the Metropolitan Museum of Art and the American Museum of Natural History. A sum of 50,000 dollars (10,000*l.*) has been left for an educational campaign to bring before the American

public the essential facts in regard to the great industrial museums of Europe.

PLASTER casts of the Deinosaur eggs found by the Mongolian Expedition of the American Museum of Natural History (see H. F. Osborn, NATURE, October 4, p. 504) have been presented to the Trustees of the British Museum and are now on view, with elucidatory labels, in a special table-case at the entrance to the Geological Department. Beside them have been placed for comparison certain fossil eggs of reptiles, some of which have been in the Department since 1864. In this table-case it is proposed to show the more interesting recent acquisitions, changing them from time to time. There are also exhibited in it some remarkable fossil frogs and a salamander, in bituminous shale, of Oligocene (?) age, from mines at Libros, in the province of Teruel, Spain, the gift of Dom Longinos Navás, S.J., who recently described a new fauna from that locality, including also birds, beetles, spiders, and molluscs.

MESSRS. Wheldon and Wesley, Ltd., 2 Arthur Street, W.C.2, have just circulated another of their special scientific catalogues, namely, New Series, No. 14, which is devoted to "Zoology, Part 1—Vertebrata." Upwards of 1500 works are classified under the headings: Bibliography, Biography and History, General Systems and Iconography, Evolution, Heredity, Biology, Anthropology and Ethnology, Mammalia, Aves, Reptilia and Batrachia, Pisces, Domestic Animals and Poultry, Game Animals and Sport, Palæozoology, Miscellanea.

THE new list of announcements of Messrs. Longmans and Co. contains the titles of many books of scientific interest, among which are vol. 5 of Dr. J. W. Mellor's "A Comprehensive Treatise on Inorganic and Theoretical Chemistry"; "Glucoproteins," Prof. P. A. Levene, and "The Action and Uses of Digitalis and its Allies in Medicine," Prof. A. R. Cushny ("Monographs on Biochemistry"); and "Elements of Mechanism," Profs. F. S. Carey and J. Proudman.

MESSRS. C. Baker, of 244 High Holborn, London, W.C.1, have sent us a copy of their classified list (No. 82) of second-hand scientific apparatus. This differs slightly from the well-known quarterly lists previously issued by the firm in that the section dealing with photographic apparatus has been omitted. This is now issued separately. The catalogue still contains plenty of material, however, which is well worthy of consideration by scientific workers. Section I., dealing with microscopes and accessories, is particularly full, while there are also long lists of surveying instruments, telescopes, spectroscopes, and other physical apparatus. Surveying instruments are let out on hire for various periods by the firm.

Our Astronomical Column.

PLANET OR COMET?—A very interesting object, which was evidently stellar in aspect, but the motion of which is suggestive of a comet, was discovered by Dr. Baade at Bergedorf on October 23. The following positions have been telegraphed from the I.A.U. Bureau at Copenhagen.

	G.M.T.	R.A.	N. Decl.	Mag.
Oct. 23	$7^h\ 25{\cdot}5^m$	$21^h\ 5^m\ 16^s$	15° 28′ 0″	10·5
25	8 59·0	21 15 31·0	14 7 9	9·5

Deduced daily motion, $+4^m\ 57{\cdot}8^s$, S. 39′·15.

If the object is a planet, it would seem to belong to the Eros type, with a perihelion far inside the orbit of Mars, so that it is of importance to obtain observations. Photography offers the readiest means of identifying it by its trail. The increase of a magnitude in brightness in two days should not be stressed, as it is difficult to estimate the magnitude of a trail.

On November 1 the estimated position is R.A. $21^h\ 50^m$, N. Decl. 9½°, some 3° east of ϵ Pegasi. The object souths about 7 P.M., and is thus in a favourable position for observation.

TELESCOPES IN THE SOUTHERN HEMISPHERE.—An extract received from the *New Zealand Evening Post* contains an account of the inauguration of a 9-inch telescope at Kelburn, Wellington, under the auspices of the Wellington City Council. It is at present housed in a temporary wooden shed, in order to allow work on Mars to be undertaken, but a more suitable building is promised in the near future. The object glass is a photo-visual one, and it may be presumed that the mounting is equatorial, though details are not to hand. This interest of a City Council in pure science deserves grateful recognition.

From the *Observatory* for October we learn that Yale Observatory is accepting the invitation of Dr. Innes to set up a 26-inch photographic telescope in the grounds of the Union Observatory, Johannesburg, so as to continue the parallax studies of the American observatory in the Southern Hemisphere.

Dr. Innes has also organised a scheme of interchange of observers between Leyden and Johannesburg, under which Dr. Hertzsprung is at present at Johannesburg on a 15 months' visit; he will be followed by Mr. Van den Bos.

Dr. Innes makes a suggestion that every observatory should send annually to the International Astronomical Union a report on its work. Such reports would make it easier to decide on a programme of work without needless overlapping, and would help to keep observatories in touch with each other.

FINSLER'S AND ENCKE'S COMETS.—Finsler's Comet was followed at Heidelberg until October 6, but was then lost from its proximity to the sun. Dr. Kobold gives the following orbit in *Astr. Nachr.* 5326, using observations on September 20, 26, 30.

$$T = 1924\ \text{Sept.}\ 4{\cdot}3370\ \text{G.M.T.}$$
$$\left.\begin{aligned} \omega &= 66^\circ\ 31'{\cdot}18 \\ \Omega &= 80\ \ 2\ {\cdot}54 \\ i &= 120\ \ 9\ {\cdot}36 \end{aligned}\right\} 1924{\cdot}0$$
$$\log q = 9{\cdot}60855.$$

Encke's Comet was followed until October 22, being then of at least the fifth magnitude and visible in considerable twilight. The observations indicate October 31·437 G.M.T. for the time of perihelion passage.

Research Items.

A SKULL OF PAPUAN TYPE FROM COLOMBIA.—In *L'Anthropologie*, T. xxxiv., No. 5, Dr. R. Verneau directs attention to a close resemblance between the skull of a Tunebo Indian and Papuan skulls, particularly skulls from the island of Mallicolo (New Hebrides). Not only is the general morphological resemblance remarkable, but the absolute measurements are extremely close. The cranial index in each case is 69, and both are hypsicephalic. The maximum transverse diameters vary by three millimetres only, the vertical diameters by one millimetre, and the maximum antero-posterior diameters are identical. In both cases the frontal region is narrow. The chief difference is that the Tunebo skull has a higher cranial capacity, 1775 c.c. as against 1550 c.c. in the Mallicolo crania, probably an individual variation. Where in other respects it varies from the Mallicolo characters, it approaches those of other Papuan crania. Notwithstanding the danger which attaches to conclusions drawn from a single specimen, it appears reasonable to conclude that the Tunebo skull belongs to the Papuan type. Ten Kate and Rivet have demonstrated that traces of the early type of S. American man represented by the Lagoa Santa skulls are to be found from Southern California to Patagonia, while de Quatrefages and, later, Rivet pointed out the close resemblance of this type to the hypsistenocephalic type of Melanesia and Australia. The importance of the Tunebo skull is that it is the first of the type to be found in the Eastern Andes and supplies a link hitherto missing between examples of the type on the Atlantic and Pacific sides of the continent.

SURVEYS IN BHUTAN AND SOUTHERN TIBET.—In the *Geographical Journal* for October, Maj. F. M. Bailey describes a journey which he took for political reasons into Bhutan in 1921 and a subsequent journey through hitherto unexplored parts of that country and Tibet. His route was from Chumbi (Yatung) across the foothills of the Himalayas by Paro to Bumtang, where unexplored ground began. From Bumtang he passed northward into Tibet by the Mönlakarchung Pass to the lake known as Yamdrok Tso and thence westward by Talung to Gyantse. Capt. H. R. C. Meade with a survey party accompanied Maj. Bailey, and a map of their surveys is published with the paper. An area of 9493 square miles, including 6589 original survey and 2904 revision, was mapped on a quarter-inch scale, the work being based generally on triangulation carried out during the journey. Of this area, more than half consists of accurate plane tabling and photo-survey, and the rest of reconnaissance work. The whole of the Mo Chu basin in North Bhutan is still unsurveyed, though several prominent snow peaks were fixed, and the map between Bumtang, where touch was lost with the Assam triangulation, and Lhunbushö (on the Yamdrok Tso) is more or less in the air, and adjusted by astronomical work. The work in the *Geographical Journal* is on a scale of 1 to 750,000.

GONAD AND SOMA IN THE FOWL.—Pézard, Sand, and Caridroit (*C.R. Soc. Biol.* v. 89, 1923) describe on p. 1271 a case of feminisation of an adult Brown Leghorn cock which was castrated at the age of 3 months, and a year later received two implants of ovaries from hens of the same breed. The head furnishings and plumage are now henny. On p. 1103 the authors describe how in plucked ovariotomised hens, as the ovary regenerates, the growing feathers of the lumbar region mirror exactly the various phases of the process. In vol. 90, p. 623, they discuss the results of ovarian implantation into a castrated Brown Leghorn × Silver Dorking F_1 male, and of implantation of ovarian tissue without castration. In both instances there is a swing to the plumage of the female and the appearance of new pigmentation which differs according to whether Leghorn or Dorking ovary was implanted. They suggest that there is a racial specificity of ovarian secretion apparently ignoring sex-linked inheritance. On p. 676 they discuss the phenomenon of pœcilandry: the existence of two sorts of males in one and the same breed. Cocky-feathered Sebright Bantam cocks are to be found in France. From experiments in which the testes from henny-feathered Sebright cocks were implanted in a cock of a cocky-feathered strain, they conclude that the testes of the henny-feathered cock exercise the same effect as an ovarian implant. On p. 737 they describe briefly certain experiments on gonadectomy and implantation, and conclude that castration results in a neuter form, which they designate "the species type," since they consider it to represent the common heritage of both sexes of the same breed, the base upon which the end-result is built.

THE FOOD OF THE WILLOW-GROUSE IN NORWAY.—To *Bergens Museums Aarbok* for 1922–23, Dr. Jens Holmbœ contributes a detailed study of the food of *Lagopus lagopus* in the various parts of Norway in every month of the year, based on material collected during 1921–23. So long ago as 1753, Pontoppidan remarked on the difference between the summer and winter diet, the latter consisting mainly of birch-twigs. It has also been recognised that the young eat insects, but these are soon given up and the birds live mainly on seeds, berries, and leaves. Dr. Holmbœ's researches show that there is also a considerable difference of food in the different regions, especially as between the coast and the inland districts, and this is chiefly manifest in winter. The reason clearly is that the snow renders the upland vegetation more or less inaccessible, so that the birds are driven to eat the twigs and buds of birch and other trees, or else to migrate to more favourable districts, whereas along the coast the snow does not lie so long and is swept away from the moors. Birch-twigs can be regarded as at best a substitute food, whereby the grouse can stay the pangs of hunger and live through the winter, but it would scarcely be satisfying in the long run. The Norwegian willow-grouse has until now been free from the parasite *Trichostrongylus pergracilis*, which is so dangerous to British grouse. This may be because the Norwegian birds do not eat much ling (*Calluna vulgaris*), which, as Leiper has shown, harbours this parasite. It now appears, however, that in the coast districts of Norway, Calluna does often serve as food for the grouse, so that increased effort should be made to prevent the introduction of British birds.

A SPECIES OF MONILIA ASSOCIATED WITH SEVERE ANÆMIA.—European residents in the tropics frequently suffer from a chronic or intermittent intestinal disturbance, in which amœbæ or dysentery bacilli are not found, to which the sufferers give the name "sprue." If this is a true infectious disease, an active agent is still to be sought, and therefore considerable significance attached to the work of Ashford in Porto Rico, in which it was suggested that the micro-organism *Monilia psilosis* was responsible for the symptoms. Lawrence Weld Smith, of the Department of Pathology and Bacteriology, University of the Philippines, now publishes in the *Philippine Journal of Science* (April 1924, vol. 24)

notes upon eight cases of severe anæmia associated with the sprue syndrome in which *Monilia psilosis* Ashford has been isolated.

A BIOCHEMICAL BASIS TO DISEASE RESISTANCE.—In Œnothera, resistance to mildew disease is inherited as a unit factor. Marañon has therefore used this species mainly in an investigation, described in the *Philippine Journal of Science* for April 1924 (vol. 24, pp. 369-441), in which a preliminary comparison is made of the biochemical constitution of disease resistant and susceptible strains. The conclusion is reached that the resistant strains are characterised by higher tannin content and more water-soluble acid, whilst immune forms are comparatively high in total nitrogen and total ash, the nitrogen increase being mainly in amino-acids and nitrogenous compounds of non-basic character, the ash increase in calcium and sulphur. Examination of disease resistant and susceptible strains of *Syringa vulgaris*, *Desmodium canadensis*, and *Solidago canadensis* is said to give concordant results.

AN EXPLOSIVE FRUIT.—The beautiful purple flowers of the South European species of toothwort, *Lathræa clandestina*, must have been noticed by many visitors to the London parks; parasitic on elm or other trees and flowering freely in May, it is to be seen in Regent's Park, in the Bedford College grounds, at Kew, and at the Royal Botanic Society's garden. In the Quarterly Summary of the last body (for October 1924) the Curator, Mr. J. L. North, has an interesting note upon the seed dispersal of the plant, which fruited freely in the Royal Botanic Society's garden this summer. He was surprised to notice the force with which the seeds were scattered by the explosion of the capsule when squeezed between finger and thumb. Although the capsule is born at ground level, the seeds are shot out so violently that when, with the assistance of Prof. Gates, their flight was followed and distances measured, some of the seeds were found to have travelled 27 feet. This may throw some light upon the dispersal of the plant in the garden; originally planted upon the root of a beech tree, it has now spread to the roots of other plants to a distance of 40 yards on either side.

A NEW VIEW OF SOIL FERTILITY.—Prof. W. F. Gericke of the University of California certainly seems to have developed a refreshingly novel point of view in relation to the problem of soil fertility, to judge from a preliminary note published in *Science* for April 4, which has just been brought to our notice. Pointing out that the rapid growth of a crop often produces a temporary depletion of some essential soil constituent, he investigated by the water culture method the effect upon the growth of a plant of a period in which the salt supply provided lacked one essential element. The striking result was obtained that after plants had grown for one month in complete nutrient solution, a great enhancement of growth, increase in weight, and advance in date of maturity resulted from the transfer to solutions *devoid of potassium*. In the light of these experiments Prof. Gericke attempts a reinterpretation of the results obtained by Stewart (Journ. Agr. Res. 12, 311-368, 1918), in which it was shown the barley crop very rapidly depleted the soil of nitrogen in the cases where large crops were obtained. From other water culture experiments Gericke had reached the conclusion that the presence of the nitrate ion materially affected the availability of the potassium ion to the plant, and he therefore inclines to associate these large yields in soils early depleted of nitrate with these new experiments in which lack of available potassium after the first few weeks of growth favours increased growth and yield. Needless to say, potassium, and indeed the full supply of nutrients, proves to be essential during the first few weeks of the plant's growth. Prof. Gericke reports similar improved development and yield in plants transferred, after four weeks in full mineral solution, to media devoid of phosphorus (*Science*, September 26).

THE PATHS OF CYCLONES.—The *Monthly Weather Review* for June contains an article by J. W. Sandström on "Investigations relative to the Polar Front," translated from *Meteorologische Zeitschrift* for February by Mr. W. W. Reed. It deals chiefly with "cyclonic families," and an attempt to apply the theory to practical weather service work. The theory asserts that after the passage of a cyclone, each succeeding depression has its path somewhat to the south of that of the preceding one until the cyclones move tangentially to the tropical belt of high pressure. The first members of the family appear in high latitudes. The theory is a consequence of the polar front conception put forward by Prof. J. Bjerknes. When the path runs in the vicinity of the tropical "high," a new cyclone family, it is said, appears in the north and behaves in the same way as the disturbances of the earlier family. The author, on the basis of this law, sought to draw in advance the paths of coming storms; he soon found that the storms followed quite different paths. An investigation was made on the basis of Hoffmeyer's charts. The first test failed to show that the succeeding cyclone lies more often to the south than to the north. The tracks of disturbances from Hoffmeyer's charts showed that the paths often intersect the paths of earlier disturbances in all kinds of ways. The author is of opinion "(1) that cyclone families in the Bjerknes sense do not exist, (2) that the behaviour of cyclones is not regulated by a polar front, and (3) that the discontinuity, which is called the polar front, appears, in general, only with the cyclones and is a result of their activity."

HISTORY OF OPTICAL GLASS.—In any historical appraisement of the makers of optical glass one name alone stands proud of all others—that of Pierre Louis Guinand. Endowed neither with riches nor education of a conventional kind, he converted a haphazard process of selection, which failed to satisfy the cravings of opticians, into a definite industrial art, the essentials of which constitute the universal practice of the present day. At the request of the German optician Utzschneider, Guinand in 1805 left his home in Switzerland to establish at Benediktbeuren an optical glass works, upon the success of which the fame of Utzschneider's firm and its productions quickly extended. According to the investigations of Dr. M. v. Rohr, published in the issue of *Die Naturwissenschaften*, September 26, it would appear that Joseph Fraunhofer, a young artisan in the glass-grinding shop, who had already won the good opinion of his employer, was transferred to the glass works in order that he might master the methods of Guinand. Two years thereafter he was placed in complete control—Guinand, the old experienced and renowned man of sixty-three, was made subordinate to the ambitious youth of twenty-five. Guinand returned to his old home in Le Brenets, and after the termination of his agreement with Utzschneider recommenced the labour of his life. His process was established by the Guinands and their associate, Bontemps, in France and Britain, where the manufacture has flourished and endured. In Germany the industry ultimately declined and entirely disappeared. Thus the ascendancy passed

from Germany until, in 1884, works were established by Abbe and Schott in Jena, where the process of Guinand is once more practised.

THE PHOTOELECTRIC EFFECT WITH MINUTE MERCURY SPHERES.—Dr. E. Wasser, in the *Zeitschrift für Physik*, September 12, describes an investigation of the photoelectric effect, using submicroscopic mercury spheres produced by evaporation and subsequent condensation in dry nitrogen and carbon dioxide. The particles were observed in an electric field with an Ehrenhaft condenser, the field being so adjusted that the observed particle remained suspended in the gas. Light of wave length $\lambda = 275\mu$ was employed to produce the photoelectric effect, and it was found that, up to about $1{\cdot}2 \times 10^{-5}$ cm. radius, the spheres were negatively charged, or there was an inverse photoelectric effect. From this radius up to $1{\cdot}9 \times 10^{-5}$ cm. some particles are charged positively and some negatively, while above $1{\cdot}9 \times 10^{-5}$ cm. radius all are charged positively. The magnitudes of the charges which the spheres acquire seem to depend on the radius; with small spheres charges of $0{\cdot}6 \times 10^{-10}$ electrostatic units, or about one-eighth of an elementary quantum, are much more frequent than charges equal to that of an electron; above 3×10^{-5} cm. radius, charge alterations down to about half the charge of an electron were observed. It is shown that these effects are not due to ionisation of the gases. The question whether the photo-effect has its origin in the adsorbed gas on the surface of the mercury, or in the interior of the metal, can only be answered when it is possible to investigate the same test particle with different gas pressures.

ELECTRIFICATION DUE TO BUBBLING GASES THROUGH FLUID METALS.—Messrs. A. Coehn and E. Duhme describe a series of experiments in which hydrogen, nitrogen, carbon dioxide, oxygen, and ammonia are bubbled through pure mercury and dilute amalgams (*Zeitschrift für Physik*, September 17). All these gases behave alike, and leave pure mercury negatively charged, while weak amalgams of "non-noble" metals (sodium, zinc, cadmium) are positively charged; "noble" metals (tin, copper, silver, gold) do not produce this reversal of sign. Lenard has concluded that, in the case of non-metallic fluids, the function of the bubbling gas is to break up the electrical double layer at the surface, and to carry off the charge which is least firmly held by the fluid. It appears that with pure mercury the electrons are held by the metal which remains behind more firmly than the positively charged mercury particles, which are carried off by the gas as a fine dust, giving it a positive charge. The effect with amalgams depends on the position of the metal employed in the electric tension series; a sodium atom, for example, gives up an electron to the mercury; and it must be assumed that the Na^+ ions bind Hg atoms, forming large $Na^+(Hg)_n$ complexes, which are less easily carried away by the gas bubbles than the corresponding negatively charged mercury particles. Thus the fine dust carried away by the gas must consist mainly of pure mercury; this is not necessarily the case with amalgams of the "noble" metals.

THE DOPPLER EFFECT AND CANAL RAYS.—When the light from canal rays is observed spectroscopically, the spectral lines are seen to be widened, owing to the different velocities of the radiating atoms. Dr. H. Krefft has photographed the β line of hydrogen under different conditions, and has measured photometrically the blackening throughout the band (*Annalen der Physik*, Aug.). He finds that the Doppler band is separated from the line which comes from atoms having small velocities; and that the intensity curve of the band has in general two maxima. The velocities corresponding to these are related, when the discharge voltage is above 40,000, not as $\sqrt{2} : 1$, as is the case with the spark lines of oxygen and nitrogen; the ratio being larger than 2 : 1, and increasing with the voltage. Previous observers have found a limit for the Doppler effect when the voltage is raised sufficiently; but Krefft, who has used voltages from 1400 to 70,000, finds for the higher voltages that the effect increases regularly, proportionally to the square root of the discharge voltage. The difference between the velocity distribution, as determined by the Doppler effect, and the curve for that of the positive H atoms, as determined by electromagnetic analysis, is shown to be a necessary consequence of the facts that the carriers of the Balmer lines have no charge, and that the ratio of the numbers of positive and of neutral atoms depends on the velocity. With the spark lines of oxygen and nitrogen, where the "carriers" are the positive atoms, the two curves are nearly the same; and the two maxima of blackening indicate a velocity ratio of $\sqrt{2} : 1$, which is consistent with the assumption that the lower velocity is produced by the movement of a molecule with positive charge through the same voltage drop that produces the higher velocity in the positively charged atom. The oxygen spark line $\lambda = 4591{\cdot}6$ indicates extra high velocities, which must be due to the fall of doubly charged oxygen atoms through the discharge space.

MOBILE COMPONENTS OF CRYSTALS.—In Band 18, Heft, 1 of Eucken's *Fortschritte der Chemie, Physik und physikalische Chemie*, 1924, Dr. Hüttig contributes an essay with the somewhat curious title: "Über Gitterbestandteile die im Kristallgitter vagabundieren." It is pointed out that in some cases the particles in a crystal lattice, besides oscillating about positions of equilibrium, may move through the lattice, and the rapidity with which this motion takes place will influence the pressure-composition curves when a volatile constituent is withdrawn from a system. A selection of such curves based on very recent experiments is given, and these are divided into three groups. In the first group, *e.g.*, $H_2O/LiCl$, the solid residue consists of a mechanical mixture of definite compounds, and the phase rule applies in the simplest form. When a single compound is present, the pressure curve drops vertically towards the composition axis. In the second group, *e.g.*, H_2O/WO_3, H_2O/Sb_2O_5, H_2O/SiO_2, the behaviour is intermediate between those of the first and third groups. In the third group, *e.g.*, O_2/UO_2, H_2/Li, and H_2O/Al_2O_3, the curve sinks continuously without any steps or changes of direction. The laws of solution can be applied to the examples in the third group, and the whole curve covered by an equation $\log(p_0/p) = k/n$, where p, p_0 are the vapour pressures of the solution and of the pure volatile constituent, respectively, n the simple molecular weight of the volatile constituent, and k a constant. It is mentioned incidentally that X-ray experiments have shown that some so-called "colloidal hydrates" contain definite compounds. Thus, white tungstic acid does not show the spectrum of WO_3, and is presumably not a mere colloidal association of H_2O and WO_3.

ERRATUM.—We regret that in our reference to Early Christian legends in India (NATURE, October 4, p. 515) by a slip Malabar was substituted for Mylapore in the last sentence. Mr. Frederick Fawcett, who writes to point out the error, states that while the legend of St. Thomas is very much alive at Mylapore and on the west coast, it does not occur in the Malabar district of British India. He adds that the legends of St. Thomas on both the west and the east coast agree in a remarkable manner.

Lake Level in Relation to Rainfall and Sunspots.

By Dr. F. DIXEY, Government Geologist, Nyasaland Protectorate.

VARIATIONS IN THE LEVEL OF LAKE NYASA

THE present investigation was commenced towards the end of 1923 as a result of inquiries made as to recent variations in the level of Lake Nyasa; the information was required in connexion with proposed constructional work at or near the southern end of the lake. At the time the only information readily available was a record at the Marine Transport Department of the rise and fall of the lake level at the Bar, Fort Johnston, since 1916; the additional data now presented have been collected from many sources, and especial thanks are due to several past and present officers of the Marine Transport Department, as well as to residents and missionaries stationed on the lake.

The results of the investigation indicate that the lake level varies in close sympathy with the sunspot numbers. This relation is apparently due to the dependence of the lake level upon evaporation as well as upon rainfall, and to the fact that evaporation is very largely controlled by solar conditions. The researches of W. Köppen and others have established beyond doubt that there is a close connexion between sunspots and tropical temperature, the latter being 1·1° F. higher at sunspot minima than at sunspot maxima. It is reasonable to conclude that evaporation proceeds at a greater rate during the periods of higher temperature; hence at sunspot minima evaporation will be increased and the level of a lake suitably situated will consequently fall, whereas at sunspot maxima evaporation will be decreased and the level of the lake will rise. In the case of Lake Victoria, for example, this relationship has been found to be so intimate that it yields correlation coefficients of between 0·8 and 0·9; recent work has shown, however, that, for this lake at least, rainfall is also an important factor. The variations observed in the levels of Lakes Victoria and Albert and in that of Lake George in New South Wales, and shown to be closely associated with the eleven-year periodicity of sunspot phenomena, have now been found to occur in the case of Lake Nyasa also.

Lake Nyasa, the third largest lake in Africa, is the southernmost of the Rift Valley lakes; it is 10,200 square miles in area and 360 miles in length, and it lies at an altitude of about 1645 feet. It is exceptionally deep, so that in places its floor extends down to about 670 feet below sea level. The area of the territory drained by the affluents of the lake is about three times that of the lake itself. The evidence of raised beaches shows that the level of the lake has fallen several hundred feet within late geological times. Until within the last few years the lake was drained by the Upper Shire river, which has now, however, become more or less completely silted up.

The curve depicting the variations in the level of Lake Nyasa is shown in the accompanying diagram (Fig. 1), together with those for Lakes Victoria and Albert and also those representing the rainfall of Uganda and the monthly sunspot numbers. It will be seen that Curve 3, showing the rainfall variation in Uganda according to figures available at the time, indicates that the level of Lake Victoria is undoubtedly dependent upon the rainfall, although the connexion is apparently small. Later work, however, has shown that the relation existing between the lake level and the rainfall of the whole of the surrounding area is much closer than would be supposed from this curve,

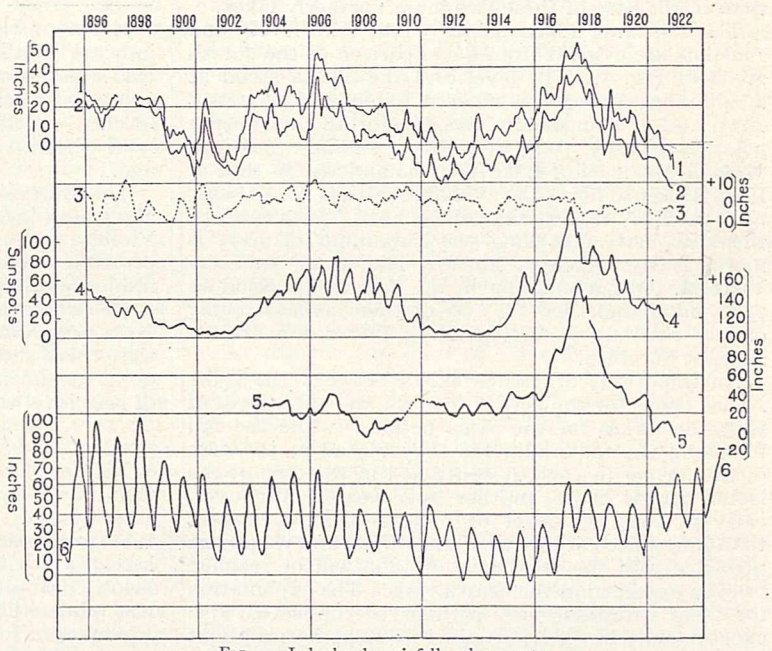

FIG. 1.—Lake levels, rainfall and sunspots.
Curve 1. Maxima, Lake Victoria.
Curve 2. Minima, Lake Victoria.
Curve 3. Rainfall in Uganda. Deviations from normal summed up in overlapping periods of six periods.
Curve 4. Monthly sunspot numbers.
Curve 5. Lake Albert.
Curve 6. Lake Nyasa: zero on the curve corresponds to 90 ft. mark on Lake George at the Bar, Fort Johnston.
Curves 1-5 are from Geophysical Memoir No. 20 (Meteorological Office, 1923). "Variations in the Levels of Central African Lakes Victoria and Albert," by C. E. P. Brooks.

Mr. P. Phillips, Director of the Meteorological Service, Cairo, has recently pointed out that there is actually a very high correlation (0·915) between the rainfall of the "Lake Plateau," which includes parts of Kenya Colony and Tanganyika Territory as well as Uganda, and the change in the level of the lake from year to year.

It is of interest to note that for the period under review the annual variations in the level of Lake Nyasa appear to have decreased, so that while they exceeded six feet in amount between 1895 and 1899, they have only attained about three feet since 1915; nevertheless, observations made at Cape Maclear for the few years succeeding 1875 show that at that time the variations were again only about three feet. These variations are all much greater than the corresponding changes in the levels of Lakes Victoria and Albert, and they are large also even as compared with the greater variations associated with the sunspot effect.

The curve of the Lake Nyasa levels has been compiled from observations made at different periods and at different stations as follows:

1895–1914, Nkata Bay; 1914–1916, Monkey Bay;

1916–1924, The Bar, Fort Johnston. Fortunately, the Monkey Bay records overlap those of the other two stations. The first part of the curve, due to Captain E. L. Rhoades, is based upon observations representing for the most part only the approximate maximum and minimum readings for the year, whereas the last part is plotted from readings taken upon the sixth day of each month; nevertheless the relation of the lake levels to sunspot maxima and minima is clearly indicated. In view, however, of the imperfection of the data available, and also of the greater ratio of the annual variation to the "sunspot variation" as compared with Lakes Victoria and Albert, the correspondence between lake level and sunspot numbers is perhaps less satisfactorily indicated than in the case of these two more northerly lakes.

The following relationships as to lake levels and sunspots are evident from a comparison of the curves given in Fig. 1. The level of Lake Nyasa stood at a minimum during the sunspot minima of 1902 and 1913, and at or near a maximum during the sunspot maxima of 1895, 1906, and 1917; similar variations occur in the level of Lake Victoria and also in that of Lake Albert so far as the available records go. Owing to the slightly longer range of the Lake Nyasa records, the sharp rise preceding the maximum of 1895 is more clearly indicated for this lake than for Lake Victoria. Minor maxima in the lake levels occur in 1898, 1900, and 1910–11, two of them at least being clearly related to corresponding minor maxima in sunspot numbers.

An important difference exists between the Lake Nyasa curve for the period 1920–23 and the curves of the other lakes for the same period; while the fall following the maximum for 1917 ceased in the case of the former in 1920, it continued in the case of the latter for at least another two years. Moreover, early in 1924 the level of Lake Nyasa was higher than it had been at any time since 1898, and it appears probable that the maximum of 1898 will be reached or even exceeded in the near future. The explanation for these variations may perhaps be connected with exceptionally low level attained by Lake Nyasa about the end of 1914, during the last minimum, when it was lower than it had been for at least twenty years. The accompanying period of depression so much affected the Upper Shire river, which normally formed the outlet of the lake, that it became too feeble to remove not only the silt usually carried by it but also the detritus carried in by its tributaries; consequently, its bed became more and more silted up until coarse reeds and other forms of vegetation were firmly established upon it. Although the mean annual level of the lake stood more than four feet higher in 1923 than in 1914, and was still rising, the Upper Shire river remained impassable. Moreover, when the river begins to flow again with the first rains of the year, its direction of flow is now reversed, so that from a point about forty miles south of Fort Johnston the water actually flows towards instead of away from the lake. Since the gradient of this part of the valley of the Upper Shire has been given as about six inches per mile, this reversed flow indicates the rising of the river bed through a considerable height. The accumulation of sediment and of vegetation along the course of the river thus acts as a barrier impeding the discharge of water from the lake, and to this barrier may be ascribed the otherwise inexplicable rise of 1920–23 and afterwards. Further reference to the history of the Upper Shire river will be made in a later paragraph.

The conclusion already drawn from the Lake Nyasa curve that the lake level varies in sympathy with the sunspot numbers receives support from the general statements of early pioneers prior to the commencement of the actual measured record in 1895. The available data may be summarised as follows:

Date.	Lake Level.	Sunspots.
1830	Very low.	
1857–63	Very high.	Maximum about 1860.
1873	High.	Maximum about 1872.
1875–8	Falling; annual variation about three feet.	
1882	High.	Maximum 1883–4.
1890	Very low.	Minimum 1890.
1892–5	Rising rapidly.	Maximum 1895.

Marks on the rocks at Monkey Bay and elsewhere indicate that at some early period of unknown date the level stood six feet nine inches higher than in 1897, which otherwise constitutes the highest recorded level. According to native information, this old high-level period occurred not less than one hundred years ago.

The diurnal variations of level to the extent of about four inches, similar to those recorded from Lake Victoria, occur also on Lake Nyasa, and they may probably be ascribed to the same cause, namely, the influence of the land and lake breezes.

Recording piles have now been established at Kota Kota and Nkata Bay as well as at Fort Johnston, so that there should be available for the future a more detailed and more complete record of the variations of lake level than has been possible in the past.

The Upper Shire River.

Reference has already been made to the changes that have taken place in the Upper Shire river during recent years. In the early history of the Protectorate the river formed an invaluable highway from the lake down to Matops, a distance of about ninety miles; below Matops almost as far as Chikwawa the river was rendered impassable by the Murchison Cataracts. Navigation for the larger lake steamers, drawing up to 6 feet of water, persisted at least until about 1900, apart from occasional periods of low water during which it was restricted to the upper reaches of the river. From 1905 onwards, owing to a steady fall in the mean annual level of the lake, navigation on the river became more and more difficult, and the lower limit of navigation receded slowly up-stream; about 1910 the river became too shallow even for small craft, and from then until the present day the Upper Shire has been entirely useless as a waterway. As the river fell and the accumulating silt enabled vegetation to become established and this in turn induced a more rapid deposition of sediment, large portions of the river-bed become swampy and ultimately dry. Of late years, as has already been stated, when the river begins to flow with the first heavy rains of the year, it actually carries water for about forty miles into the lake instead of away from it. The accumulations in the river bed have proved so firmly established and so difficult of removal that the steady rise of the lake of the last few years has failed to give the river sufficient power to clear them away; this is the more remarkable when it is considered that not only has the level of 1905 been exceeded, but also that of 1898, when the river traffic was at its height, is being rapidly approached.

The remarks made as to the silting up of the Upper Shire apply also to the old Lake Malombe, through which the river passed. The lake is now little better than a large swamp, which is diminishing in area from year to year.

While an essential cause of the present silted-up condition of the Upper Shire was thus in all probability the steady fall of the level of Lake Nyasa from 1905 to 1914, other factors have probably acted as contributory causes. For example, during the last 60 years or more the Upper Shire valley, in common with other parts of the Protectorate, has been very largely deprived of its natural covering of vegetation; this has of course led to the rapid erosion of soil and even of sub-soil, particularly on the steep hillsides that form the valley walls. The streams flowing swiftly down from the hillsides have carried with them this eroded soil; on reaching the broad flat floor of the Upper Shire Valley, they have been forced to deposit their load in the main river and its larger tributaries. In this way the Upper Shire might well have received more detritus than it could dispose of, even apart from the added difficulty of diminished outflow from the lake. While it is true that the run-off from the hillsides has probably increased in speed and in amount, and should thus have helped to clear the débris, the combination in the main valley of a wide flat floor and steep walls has more probably overcome this factor and led to increased aggregation.

To whatever factor the blocking of the Upper Shire may be due, it is clear that it must bring about a raising of the level of the lake, although from the few figures at present available it appears unlikely that a rise of more than one foot per year at the most would result from this cause alone. In view of the larger variations of lake level due to other causes, however, it is practically certain that earlier or later an unusually high level of the lake would give the Upper Shire river a temporary advantage over the obstructions in its course. Once this advantage were gained the river would in all probability be able for a time to keep its course clear and thus assist in lowering the level of the lake; this process would gradually place the river in danger of becoming silted up again, when the cycle already outlined would begin afresh. It is of interest to note in this connexion that according to native tradition, as I am informed, the upper part of the Upper Shire valley is subject to periodical flooding on a large scale.

One other complication in tracing the history of the Upper Shire river is the possibility of the level of the land along the course of the river, or in the lake basin, having been slowly raised or lowered even within historical times. Certainly, within very late geological time, as proved by the existence of raised beaches, the lake stood several hundred feet above its present level; from the information at present available, however, it would be difficult to say whether the barriers that held the lake up to this great height have been removed by a tilting of the land or by some process of erosion similar to that described in the preceding paragraph. Attempts are now being made to determine how far available historical records indicate the existence of any such tilting. Certain it is that the strip of country along the line of the lake and the Upper Shire valley is in an unstable condition as compared with the country bordering it; this is evident from its late geological history and the frequent occurrence of earthquakes there even to this day.

Summary and Conclusions.

An examination of available records of the rise and fall of Lake Nyasa indicates that the level of this lake, in common with the levels of Lake Victoria and Lake Albert, varies in close sympathy with the number of sunspots; moreover, certain minor variations associated with sunspot phenomena are also common to all three lakes so far back as the records for each can be traced. While the rainfall records of the Lake Nyasa area are not sufficiently complete to be of value in this connexion, it has recently been shown that, in the case of Lake Victoria at least, a very high correlation exists between lake level and the rainfall of the surrounding plateau; thus the rainfall of the plateau is also closely related to the number of sunspots. Accordingly, in view of the sympathetic variation in the levels of Lake Nyasa and Lake Victoria, and the relation of the level of the latter lake both to sunspot maxima and to rainfall, it is more than possible that the level of Lake Nyasa and the rainfall of its catchment area as a whole may both attain to maximum values in parallel with the eleven-year periodicity of sunspot phenomena. It is of great interest in this connexion to observe that the great drought of 1921–22 affecting this part of Africa occurred in a period of sunspot minimum, that during this time the levels of Lake Victoria and Lake Albert were both falling at a considerable rate, and that the drought of 1911–12 also occurred in a period of sunspot and lake level minimum. Again, the Lake Nyasa maxima of 1896–8 and 1917 were immediately preceded by periods of exceptionally heavy rainfall. Finally, it has been observed by the older residents of Nyasaland that famines similar to those of 1912 and 1922 have occurred at intervals of ten or eleven years over a considerable period in the history of the country; thus it is not unreasonable to assume that famines will recur in the future at similar intervals, unless due precautions are taken to avert them.

As regards the level of Lake Nyasa, however, it appears that the condition of the Upper Shire river and its capacity for carrying off excess waters from the lake must act as an additional but irregular factor. The very low level attained by the lake in 1914, combined with certain other factors, led to such an extensive silting-up of the bed of the river that the succeeding maximum failed to give the river sufficient power to scour out its course. Consequently on passing the maximum the lake level fell but slowly; furthermore, it began to rise again, and rise rapidly, about three years before the anticipated minimum. By the early months of 1924 this rise had brought the level almost up to the high maximum of 1896–8 when river traffic was at its best, but even so the river remained practically dry and totally unfit for navigation. Hence during the next few years the lake may be expected to rise again at least to the highest level on record; if this rise enables the Upper Shire to remove the obstruction from its bed, the river may begin to assist again in bringing about a lowering of the lake level, and incidentally to become fit for navigation once more. The unexpectedly early and rapid rise of the lake that commenced in 1920, and even persisted through the drought of 1921–22, may thus be ascribed very largely to the virtual damming-up of the lake outlet by the prolonged accumulation of sediment and vegetation in the bed of the Upper Shire.

While fluctuations of considerable magnitude have occurred in the level of the lake during historic time, there is no evidence to show that any progressive rise or fall has taken place. This is in accord with the findings of a Commission recently appointed in South Africa to inquire into the cause of the disastrous droughts of recent years; it was found that there was no evidence for any progressive increase or decrease in the rainfall of the Union during historic time, and that the desiccation observable in many parts of the country was due, not to diminished rainfall, but to failure of the land to absorb the rain as it fell. The failure was regarded as due largely to the destruction of natural vegetation, to the consequent erosion of soil, and to the hardening of the surface of the land by sun-baking and the trampling of cattle.

A New Loop Galvanometer.

A NEW loop galvanometer made by the firm of Messrs. Carl Zeiss, of Jena, possesses several novel features. Although with its most insensitive arrangement it is capable of detecting a microampere, it is not easily damaged mechanically, and with a suitable field stand (Fig. 1) it can be used for taking out-

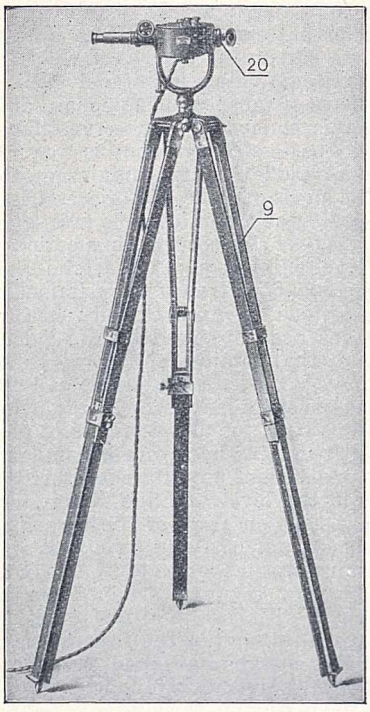

FIG. 1.—Galvanometer on field stand for outdoor observations.

door observations. In principle the instrument utilises the action of a magnetic field acting on a current carried by a light loop of metal foil. The magnetic field is produced by two strong permanent magnets the unlike poles of which face one another (Fig. 2).

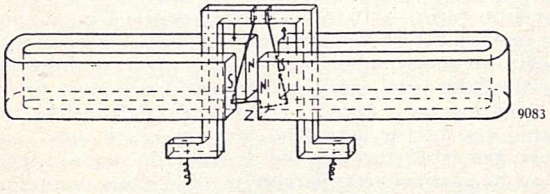

FIG. 2.—Diagram showing the arrangement of the magnets and the loop in its hanging position of stable equilibrium.

The sensitivity is therefore twice as great as when one magnet only is used. The internal resistance of the galvanometer is only about eight ohms.

The general appearance of the galvanometer is shown in Fig. 3. The deflexions of the loop are viewed through a microscope, having in its field of view a scale divided into 100 parts. For ordinary purposes, daylight can be used to illuminate the loop. When, however, greater sensitivity is required, a supplementary microscope and a small electric lamp are employed.

The entire galvanometer casing is mounted on trunnions, and by turning the whole instrument round, the loop can be used either in its stable position, where the sensitivity is least, or in its unstable position, pointing vertically upwards, where its sensitivity is about six times greater. The greatest sensitivity is about the hundredth part of a micro-ampere. The loop is enclosed in a small glass box, and is thus protected from currents of air. When the current exceeds about the thousandth of an ampere, the loop may cling fast to the glass sides. In this case tapping with the hand usually sets it free. A

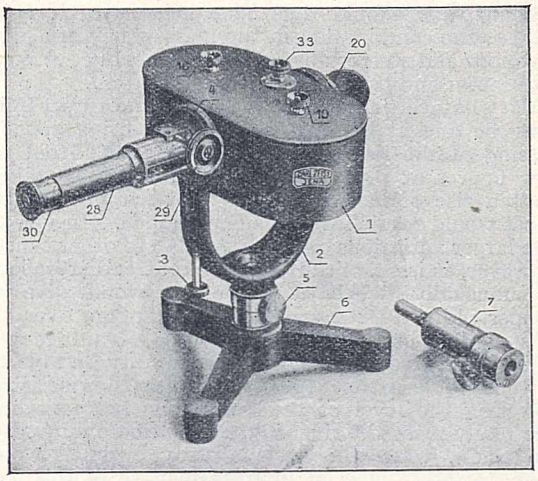

FIG. 3.—Loop galvanometer with microscope magnifying 80 times, for general laboratory and outdoor use. Sensitive to about 3×10^{-7} to 6×10^{-8} amp.

small spring hammer, however, is provided outside the box when more vigorous tappings are required. When the loop is twisted up by an excessive current it can be untwisted by a polished non-magnetic needle.

All the optical arrangements for this instrument are most interesting. The phenomena of interference bands are utilised; but this necessitates keeping the free surfaces of the optical parts very clean.

To the same degree of accuracy as with a mirror galvanometer, the deflexions are proportional to the strength of the current and they are aperiodic. As the internal resistance is very small, it is very sensitive when used as a voltmeter. This type of galvanometer, however, is not so sensitive as a mirror, or as a string, galvanometer. In our opinion, its great advantages lie in its robust construction, and in the fact that its internal resistance is small. It should prove useful for pyrometric and similar work.

Messrs. J. W. Atha and Co., of 8 Southampton Row, W.C.1, are the London agents for Messrs. Carl Zeiss.

Some Aspects of Russia's Contribution to Chemistry.

PROF. W. P. WYNNE, in his presidential address to the Chemical Society (1924, 125, 997-1013), gives an extremely interesting account of the work of Russian chemists up to 1914, dealing mainly with the Kazan University school of chemistry. The history of this school begins with the appoint-

such as the preparation of aniline, α-naphthylamine, *m*-phenylenediamine from the corresponding nitro-compounds by reduction with ammonium sulphide, as also the production of azoxybenzene, azobenzene and benzidine by modification or development of the above process.

Butlerov, who succeeded Zinin, is remarkable, not only for his far-reaching researches in the field of structural chemistry and for the introduction of numerous fundamental conceptions now universally employed in the theory of organic chemistry, but also for his influence in forming an entire school of chemists who, up to the present day, have actively followed up and enlarged upon his work. Butlerov's first paper deals with the preparation of trioxymethylene and hexamine, and it was in the course of this work that the first clue to the possible mechanism of sugar synthesis in plants was found, namely, the preparation of a mixture of hexoses from trioxymethylene. In the course of his next investigation on isomerism and isomeric changes, Butlerov suggested the possibility of the phenomenon of tautomerism which was later to occupy so prominent a place in organic chemistry, and incidentally explained the nature and the importance of the zinc methyl reaction, which, as a result of this work, occupied a prominent place in processes of synthesis, until superseded by the Grignard reagent. A further consequence of this work was the demonstration of the possible stability of compounds possessing two hydroxyl groups attached to the same carbon atom, and this was further substantiated by the synthesis of pinacolin from trimethylacetyl chloride. The explanation of the course of reactions of polymerisation in the olefine series must also be attributed to Butlerov, and it is noteworthy that in his investigation on the di*iso*butylenes he again puts forward the idea of tautomerism.

Among the numerous workers who received their inspiration from Butlerov, perhaps the best known is Markovnikov, the enunciator of the well-known rule which bears his name. His work on the naphthenes is, however, no less important to chemistry than the above rule, and furnishes a classic example of the perseverance and capability of overcoming difficulties so characteristic of Russian chemists. This research, together with those of Wreden at Petrograd and Kijner at Moscow, were instrumental in placing the study of the alicyclic compounds on the same level as that of other hitherto better known substances.

Markovnikov was succeeded in 1871 by A. N. Saytzev, who remained as professor of chemistry at Kazan until his death in 1909. Much of Saytzev's work was a continuation of his predecessors', dealing with the systematic synthesis of alcohols by the zinc alkyl process. G. Wagner is probably the most brilliant of Saytzev's students. This worker extended Saytzev's method for the preparation of secondary alcohols from ethyl formate by substituting for the latter various aldehydes, thereby obtaining ketones, which served as material for the testing of Popov's rule as to the oxidation of ketones. As a result of this work, Wagner was able to show that this rule did not hold good in all cases, but had to be modified according to circumstances. Following up this research, he next studied the progressive oxidation of compounds possessing ethylenic bindings and showed the importance of oxidation reactions in locating the position of unsaturated linkings in olefinic chains. In this way he was able to assign to oleic acid the structural formula now accepted. A consequence of this work was the view that oxidation of fatty acids occurs in the β-position, thus anticipating by sixteen years Knoop's theory of β-oxidation. The application of these oxidation methods to the study of the terpenes occupied the last twelve years of Wagner's life, and enabled him to assign to pinene, terpineol, dipentene, bornyl chloride, bornylene, and camphene their respective formulæ.

Similar work to that of the Kazan school was in the meantime also being carried out at Petrograd, Moscow, and Kiev, where Ipatiev, Zelinski, Favorski, and others studied the reactions of unsaturated hydrocarbons. Ipatiev was the first to synthesise isoprene by a method which gave clear evidence of its structure, and is also known for his work on the structural changes occurring in the unsaturated hydrocarbons obtained by the catalytic dehydration of alcohols. Zelinski investigated the *cyclo*-paraffins and olefines, whilst Favorski was the discoverer of the change which the homologues of allylene undergo on heating with alcoholic caustic alkalis. Kutcherov was the discoverer of the catalytic conversion of homologues of acetylene into aldehydes and ketones, thus opening the way to the production of acetic acid from carbide.

Mendeléeff is undoubtedly the best known of Russian chemists, and his paper on the periodic classification of the elements is too well known to require description, and the same may be said of the work of Beilstein and Menschutkin.

Prof. Wynne closes with a plea for a better appreciation of the value of the Journal of the Russian Physical-Chemical Society, and suggests that a study of this journal would amply repay the trouble incident on acquiring a sufficient knowledge of Russian.

The Kerr Effect in Optically Active Liquids.

WHEN polarised light passes through an optically active liquid in an electrostatic or a magnetic field the phenomenon of double refraction observed with a non-active substance is complicated by the optical rotation, and the only method employed to study the birefringence has been to mix equal quantities of right- and left-handed samples of the compound to be investigated, so as to obtain a non-active liquid. M. R. de Mallemann, in the *Annales de Physique* for July-August, making use of the Airy-Gouy principle that on the element of path *dl* the double refraction and the rotation act independently of one another, and that the resultant effect can be calculated by compounding the elementary vectors representing the two effects, derives formulæ by means of which the true double refraction of the liquid can be derived from the observations. Measurements are described on pinene, turpentine, ethyl tartrate, carvone and camphor, in which Panthener's method of instantaneous charge was used, which, in spite of certain difficulties, gives fairly satisfactory results in all cases, and enables the birefringence of imperfect insulators to be determined.

In almost all cases the Airy-Gouy principle gives, qualitatively, the relation between the phenomena; and, in general, there is quantitative agreement even with bodies like carvone, which have very large birefringence, the calculated ellipticities not differing in the majority of cases from those observed by amounts exceeding the limits of precision of the measurements. For the rotation of the axes, however, the differences in the case of carvone are more systematic.

M. de Mallemann considers the theories of Stark,

Oseen and Born, in connexion with his own previous work, which explained optical activity in terms of the asymmetry of the molecule; he does not, like the above authors, assume resonance, but uses the single idea of the asymmetry of the field of force, taking into account the experimental data. The theory indicates, in apparent agreement with observation, that the rotary power should increase when the number of atoms is large, when the masses and atomic volumes are large, and when the atoms are arranged very unsymmetrically. It also shows that the rotary dispersion is related to the refractive dispersion; and the specific rotary power should, in general, diminish with increase of temperature, and should increase with the pressure. There are, however, certain discrepancies in passing from the liquid state to that of vapour. Modifications of the molecular structure due to lack of rigidity of the molecule, which would not affect the refractive index, may produce marked changes in the optical activity, and the rotary power must be a very delicate index of molecular phenomena. This accounts for the difficulty of finding simple laws connecting the phenomenon as observed in different substances. The theory indicates that the Airy-Gouy formula can no longer hold rigorously for high refractivity; apparently this commences to be true in the case of carvone.

Engineering and Shipbuilding.

IT is not easy to state reasons for the present depression in the engineering and shipbuilding trades without touching upon political matters, and both Mr. J. Howden Hume and Mr. Tom Westgarth found this difficulty in their presidential addresses to the Institution of Engineers and Shipbuilders in Scotland and the North-East Coast Institution of Engineers and Shipbuilders respectively. Still in both addresses there is much of interest and several valuable suggestions.

Mr. Hume attributes the depression to (*a*) the loss of our export trade; (*b*) the Washington Treaty, which has seriously affected not only workmen engaged in engineering and shipbuilding, but also those on the technical and scientific staffs, and those connected with allied trades, besides the artisans in districts where warship building was carried out; (*c*) the world's market on the merchant shipping side has partially collapsed, and there was over-production of merchant ships during and immediately after the War.

Mr. Hume suggests (i.) that the whole question should be taken out of the political field and placed in the hands of a representative body, chosen, say, by half-a-dozen of the leading judges, and comprising equal numbers of manufacturers, workmen, merchants, and professional men. Such a body would arrive at the truth, and a plan could be devised and acted upon by the Government in power. (ii.) A complete and friendly understanding between employer and employed. The Shipping Federation and the National Sailors' and Firemen's Union have worked together for thirteen years, and in that time there has been no strike in the shipping trade. Other bodies might follow this lead.

The subject of Mr. Westgarth's address was waste. Of all sources of waste in industry, the greatest is that caused by strikes and lockouts, by demarcation difficulties between trades, and by people of all classes not doing a fair day's work for a fair day's pay. Many disputes are the result of neglect and delay in dealing with difficulties as they arise, and something of the old-fashioned discussion between master and workmen immediately a difficulty appears should be revived. Such discussion should be informal and not binding on the official representatives of either side. By this method a great many disputes would probably never be taken outside the works. In 1921, 85,872,000 working days were lost through disputes, and 10,642,000 in 1923, according to the Ministry of Labour Gazette. Nearly all this waste is preventable, and could be prevented by friendly conference. Sir Robert Hadfield's suggestion that an endeavour should be made to arrange an industrial truce is worthy of the most serious consideration.

Mr. Westgarth referred to a fruitful cause of unrest: wages in the so-called protected trades do not compare reasonably with those in the highly skilled and competitive trades. If competition in the open markets of the world makes it impossible to pay skilled workmen a certain wage, it is in the highest degree wasteful to pay considerably higher wages to unskilled men just because a stoppage of their work would be an inconvenience to the public. This really amounts to a kind of blackmail, and the public should be assisted in resisting such claims by their governing representatives.

In reference to technical waste, Mr. Westgarth says that the engineering industries can only be successfully conducted nowadays by helping to make possible the discovery of new methods of manufacture and fostering the advancement of new ideas in engineering science—as distinct from teaching engineering science—and then by giving commercial expression to the best of such methods and ideas. Has such a policy been characteristic of British engineering? The future of British engineering will be good or bad according as the spirit of scientific progress develops or flags.

Electrical Precipitation.[1]

THE two kinds of electrical precipitation dealt with were the natural and the artificial. Artificial precipitation began with the well-known experiment which Sir Oliver Lodge showed to the British Association at Montreal in 1884 on the electrical deposition of smoke or steam; an observation which has now been applied on a large scale in Great Britain, by his sons and by Dr. Cottrell in the United States, to the recovery of metallic fume, and to the freeing of blast-furnace gas from solid material before combustion. The theory of the action is like that of the coherer, and was considerably elucidated by the late Lord Rayleigh's experiments on the cohesion of liquid jets and drops, under slight electrical stimulus.

The natural kind of electrical precipitation is what occurs in the atmosphere when clouds turn into rain; and also when, as shown by Dr. G. C. Simpson, large water-drops break up in a column of ascending air, giving rise to separation of electricities and the phenomenon of thunderstorms. This mode of generating electricity is somewhat surprising. A theory of it is suggested by the coherer and water-drop experiments; since the breaking-up of a drop may be regarded as the converse action to the cohesion of two drops. Electrical influence stimulates cohesion: it is possible that absorption may give rise to electrical separation. Not that the two fragments become oppositely electrified, but because the uniting electronic layer is blown away by the air, thus carrying away a negative charge and leaving the residual water positive. Calculation applied to this phenomenon seems to give results of the right order of magnitude, making use of Dr. Simpson's measurements of the charge which can thus be imparted to the fragments

[1] Abstract of an address by Sir Oliver Lodge, F.R.S., delivered on Wednesday, October 29, to the Institute of Physics.

of a drop of water of known size, falling through or in to a blast of air.

Returning to the artificial electrification of solid or liquid particles, Sir Oliver emphasised the engineering skill which had enabled very high-tension electricity to be applied, in difficult circumstances, continuously without break throughout the year; and mentioned the economical value of the results. He then proceeded to ask whether the natural operations occurring in the atmosphere would always remain beyond human control; or whether precipitation of moisture could not be taken in hand and managed—in ways which seemed no more difficult or unmanageable than the modern theory and treatment of disease; a subject which, like the weather, was at one time left to pious resignation or appeal, without any adequate effort being made to take it in hand and control it.

University and Educational Intelligence.

CAMBRIDGE.—Lady Teall has presented to the Sedgwick Museum the very valuable collection of rocks and rock-slices made by her late husband, Sir Jethro Teall, St. John's College.

Dr. M. B. R. Swann, Gonville and Caius College, has been reappointed demonstrator of pathology.

Mr. F. P. Ramsey, Allen student and scholar of Trinity College, has been elected to a fellowship at King's College.

The Henry Sedgwick Memorial Lecture will be given at Newnham College by Sir J. J. Thomson, Master of Trinity College, on Saturday, November 29, at 5 o'clock. The title of the lecture is "Radiation."

LONDON.—A University chair of anatomy, tenable at the Middlesex Hospital Medical School, has been instituted as the result of a munificent gift of 20,000*l.* by Mr. S. A. Courtauld; the title of the chair will be "The S. A. Courtauld Chair of Anatomy"; and Dr. Thomas Yeates, at present University professor of anatomy at the School, has been appointed as the first occupant.

The Sir John William Lubbock Memorial Prize in mathematics, of the value of 30*l.*, has been awarded to Miss E. M. Jones, of the Royal Holloway College.

The following doctorates have been conferred: D.Sc. (*Physics*): Mr. W. N. Bond (University College and the Imperial College—Royal College of Science), for a thesis entitled "The Flow of Fluids treated Dimensionally"; D.Sc. (*Chemistry*): Mr. G. E. Foxwell, for a thesis entitled "Collected Researches into By-Product Coking," and another paper; and Miss F. M. Hamer, for a thesis entitled "The Synthesis of an Azocyanine," and other papers.

Prof. H. B. Baker has been appointed representative of the Faculty of Science on the Senate for the remainder of the period 1921–25 in succession to Prof. A. N. Whitehead, who has accepted a chair in the Faculty of Philosophy at Harvard University.

APPLICATIONS are invited for the Wernher Beit chair of pathology in the University of Cape Town. The applications, eight in number, should be sent by, at latest, November 18 to the Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2.

A LECTURER in mechanical engineering is required at the University of Cape Town for twelve months dating from March 1 next. Candidates must be qualified to give instruction on machine drawing and design and the theory of machines. Applications should be sent by November 7 at latest to Prof. Sillick, Royal College of Science, South Kensington, S.W.7.

APPLICATIONS are invited for the principalship of the Wigan and District Mining and Technical College in succession to Mr. S. C. Laws, recently appointed principal of the Northampton Polytechnic Institute, Clerkenwell. The latest date for the receipt of applications is November 29. They should be sent to the chairman of the governing body of the college.

THE council of the Royal Horticultural Society has decided to contribute 105*l.* to the fund which Lord Milner is raising for the Imperial College of Tropical Agriculture. This is a gratifying indication that the premier horticultural society in the world recognises the value of the work that the College is doing for agriculture in the tropics.

A LECTURER in psychology and philosophy will be required in February next at the Rhodes University College, Grahamstown, South Africa. Particulars may be had from the Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2. Applications for the post should be sent not later than November 5 to the Master, Balliol College, Oxford.

THE North of Scotland College of Agriculture Calendar for 1924–25 includes reports on the past year's work, showing that the county extension classes were well attended. The rapid development of the work is shown by the record of attendances during each of the past five years at the systematic classes in agricultural subjects in the extension area of the College: 3035, 13,166, 18,786, 23,436, 33,849. The Central Class report, on the other hand, shows a decrease in the enrolments for degree courses in all subjects except agricultural botany and agricultural zoology. The Edinburgh and East of Scotland College of Agriculture also shows a decrease in the number of students attending Central Classes under each of the heads: day classes, evening classes, rural schools' course, and farmers' class. The College has now entered into possession of its experimental farm of 600 acres at Boghall, and the publication of college reports and leaflets, which has for some time been discontinued, will, one may surmise, be resumed. The list of appointments held by former students shows that appointments were obtained in 1923 in Scotland (2), England (2), Ireland, Hungary, West Africa, Tanganyika, India, Singapore, and Argentina.

HONOURS courses have been established recently in many American universities and colleges with the object of releasing the more highly gifted undergraduates from the trammels of a system designed to meet the needs of the average student. The National Research Council collected material in the shape of reports and suggestions and turned it over to President Aydelotte, of Swarthmore College, who has prepared a critical summary, published by the Council as Bulletin No. 40. In thirty colleges and universities, honours candidates are now required to undertake specific extra tasks, a special course, a thesis, or a comprehensive examination, in addition to doing substantially the same amount of work in regular courses as is done by the pass-men. In nine there are, or will shortly be, in operation schemes for honours based on work superseding the regular requirements during a part, generally the third and fourth years, of the undergraduate course, following a creditable record in the work of the first two years. The honours student has his work outlined for him, not, like the pass-man, in terms of what he must do, but in terms of what he must know. Instead of taking courses he studies a subject. In nearly all cases provision is made for individual supervision and instruction by competent teachers, but not for any great number of special honours lectures or classes.

Early Science at the Royal Society.

November 2, 1664. Dr. Wilkins related that Sir John Cutler had declared to him, that he was firm in his resolution to settle upon Mr. Hooke 50*l.* per annum for such employment as the Royal Society should put him upon.—A letter of Mons. Huygens to Sir Robert Moray was read, containing a relation of his having seen with wonder at Paris a glass of twelve foot of the workmanship of Divini, which bore the aperture of two inches Parisian measure; upon which occasion he recommends it as a matter worthy of inquiry, to know what may be the right aperture in each glass, of such and such a distance from the focus.

1671. Mr. Oldenburg presented to the Society from Mr. Hobbes his "Rosetum Geometricum," printed at London, addressed by him to the Royal Society for their judgment thereon: Which pieces were referred to the consideration of the professors of Astronomy and Geometry in Gresham-college, and Mr. Collins.

November 4, 1663. The history of whale-fishing, and of the making of whale-oil, was delivered in by the secretary from Mr. Gray of the Greenland Company, who had been in those parts, and was present at the killing of whales and the making of oil.

November 5, 1667. It was mentioned by Mr. Oldenburg, that Sir Paul Neile had spoken to him, that Mr. Adrian May had desired, that the society would give order for a good thermometer for the use of the Queen.—Dr. Wilkins moved, that Mr. Collins might be declared exempt from the payment of admission-money and the weekly payments, he having but a small revenue, and being capable and willing to do the Society very good service. He was declared exempt accordingly.

November 6, 1672. Mr. Hooke mentioned that among Mr. Guericke's experiments there was one which he thought deserved to be tried before the Society, viz., that of a sulphur-ball having a considerable attractive power, and representing the properties of the earth. Mr. Locke intimated that himself had made some experiments with such a ball.

1673. The earl marshal, who was present was acquainted by the council with their thoughts of removing their weekly assemblies to Gresham College, and of beginning to meet there again upon the next anniversary election-day; as also by the solemn invitation of the city of London, and the professors of Gresham College. To which was added, that though this Society should thus remove their meetings, yet they were full of hopes that his lordship would be so far from removing his favours and kindnesses from them, that he would preserve them in the same degree that he had done all along, and especially during the many years he had entertained them under his roof. Whereupon the earl marshal very obligingly and generously declared that though they had been a great honour to his roof, he could not but give up his reason to the reason of the council.

November 7, 1666. Sir Robert Moray proposed, that the directions for seamen, and the inquiries of tides, might be printed separately, and the instruments mentioned in the printed papers concerning these particulars provided both at the society's expence; and promised, that he would endeavour to procure an order from his Royal Highness the duke of York to Trinity-house, importing, that every captain and master of a ship should take with them in their voyages a copy of such printed books, and make observations and trials accordingly; of which they should at their return give one to Trinity-house, and another to the society.

Societies and Academies.

LONDON.

Royal Meteorological Society, October 15.—Mr. C. J. P. Cave, president, in the chair.—L. F. **Richardson**: The brown corona and the diameters of particles. As a result of experiment the following variety of Airy's formula has been found to be in rough agreement with measurements on various holes and spheres:

$$\text{(diameter of obstacle)} = \frac{5{\cdot}3 \times 10^{-5}\ \text{cm.}}{\sin\left\{\text{(radius of chestnut-brown corona)} - \tfrac{1}{2}\text{(radius of source)}\right\}}.$$

In view of Ray's work this will not be applicable to the smallest cloud-droplets of 2 microns diameter; but is more likely to apply to drops of ordinary size of, say, 5 to 20 microns diameter.—L. F. **Richardson**: Photometric observations on clouds and clear skies. With an improved instrument made at Benson, it was shown that the difference-of-brightness at the moon's-limb, as measured by the instrument, is independent of the glow of the sunlit sky. It was also shown that the transparency of blue sky alters during twilight. Observations on clouds enable one to compute the rainfall equivalent to the cloud on those occasions when a corona reveals the size of the droplets; a certain very dark thunder-cloud was like a rain-factory holding in stock only one hour's output.—L. J. **Sutton**: Notes on haboobs. Haboobs are severe sandstorms of a type apparently confined almost entirely to the Sudan, where they are most frequent in the central region. Nearly all of them occur during the rainy season, *i.e.* May to October, and at Khartoum, for example, they are experienced more than once a week during this period and last about three hours on the average. Haboobs probably owe their origin to the heating up of a large region for four or five days, but owing to the wide distances between meteorological stations in the Sudan, it has not been possible to discover where any particular haboob originated or to follow its track.

MANCHESTER.

Literary and Philosophical Society, October 21.—G. **Senn**: The change of position of the chlorophyll grains in the plant cell. Green chlorophyll grains show positive and negative phototactic reactions to red and green light, if it is strong enough or if the sensitiveness of the grains is raised by lower temperature. The various colouring substances appearing in the chlorophyll grains of different Algæ (yellow in diatoms, brown in Brown Algæ, and red in Red Algæ) generally do not influence their phototactic irritability. A Red Alga was only slightly more sensitive to green light of diffuse intensity. In high intensities of direct sunlight the red rays induce a very strong effect on the grains of the majority of Brown Algæ (five of six species) and of the only Red Alga studied. But as the yellow light with its shorter rays produced much weaker effects, the strong action of the red rays must have been produced by a damaging action on the protoplasm which transported the grain by its streaming. In this case the grains are passive during their movement like those of Elodea and Vallisneria during the rotation of the protoplasm. It seems that it is only the colourless protoplasmic strands of the envelope of the green chlorophyll grains which execute their normal movements.

PARIS.

Academy of Sciences, September 29.—M. Louis Bouvier in the chair.—Mme. Sylvia **Creanga**: The cyclifying developable surfaces of a curve and

their application to the theory of curves traced upon a surface.—Th. **Varopoulos**: The differentials of multiform functions.—A. **Foch**: The use of Recknagel's disc as an indicator of velocity and direction. A redetermination of the constant for a Recknagel's disc and suggestions for possible applications.—L. G. **Stokvis**: Conversion of the energy of a triphase system or a constant energy to a pulsatory energy.—André **Léauté**: The propagation of electric waves along perfectly insulated iron wires, taking account of the skin effect.—H. **Gault** and H. **Klees**: Contribution to the study of the condensation of acetoacetic esters with malonic esters. Preliminary results of the products of the interaction of α-chloracetoacetic ester with the sodium derivatives of cyanacetic ester and of malonic ester.—G. C. **Georgalas**: The geological constitution of the Phourni Islands (between Nikaria and Samos).—**Munerati**: The running to seed of beetroot in the first year. The conditions under which the beetroot may behave as an annual or a biennial are not known with certainty and are not under control. Examples are given of the slight changes in external conditions which may cause the change from annual to biennial.—Jacques **Benoit**: Experimental endocrinian hypomasculism in the domestic cock.—Jean **Bathellier**: The development of *Macrotermes gilvus* compared with that of *Eutermes matangensis*.—**Parat** and J. **Painlevé**: Vital observation of a glandular cell in activity. The nature and rôle of Golgi's internal reticular apparatus and Holmgren's apparatus.

October 6.—M. Louis Bouvier in the chair.—P. **Villard**: The experiments at Courtine. The dominant waves produced by a very powerful explosion are, even at a short distance, of very low frequency, well below the audible limit: the sound is the result of a secondary phenomenon of relatively negligible importance. It is quite certain that the mechanical effects, such as breaking windows, observed in the neighbourhood and up to several kilometres distance from a powerful explosion, must be attributed to waves much longer than the ear can perceive.—G. **Sagnac**: The mechanism of light projection in double stars.—A. **Grumbach**: The rôle of ionisation in cells with fluorescent liquid.—Charles **Lafon**: The utilisation of the grapho-mechanical combiner for numerous everyday problems in physics.—W. **Kopaczewski**: The effects of dilution on colloids. In determining the physico-chemical constants of blood serum, it has been found that the diluted sera possess a conductivity sensibly higher than would be expected from the law of electrical dissociation. Other colloids (hæmoglobin, collargol, electrosol of dialysed silver and gold, Paris violet, etc.) have now been examined and have proved to show the same phenomenon. Some consequences in physical chemistry, biology, medicine and therapeutics are deduced.—E. **Darmois** and A. **Honnelaitre**: Some properties of ammonium dimolybdomalate. This salt is a reagent for substances capable of combining with molybdic acid: these produce considerable variations in the rotatory power.—A. **Lassieur**: The electrolytic separation of copper, antimony, and bismuth from lead. The separation is effected in hydrochloric acid solution, with or without addition of hydrofluoric acid, in the presence of hydroxylamine hydrochloride, and using the method of graded potentials.—Mme. Pauline **Ramart**: The action of hydrobromic acid on some tertiary alcohols. Alcohols of the general formula $(C_6H_5)(OH)(Ar) . C . CR_1R_2R_3$ are readily transformed into unsaturated hydrocarbons by the action of HBr in glacial acetic acid solution.—**Fosse** and A. **Hieulle**: A colour reaction, hitherto supposed to be characteristic of formaldehyde, produced by glyoxylic acid.—Marcel **Mirande**: The states of liliosterin in the course of the life of the bulbar scales of the white lily.—P. **Reiss**: Remarks on the internal P_H of the cell nucleus and its experimental variations.

ROME.

Royal Academy of the Lincei.—Papers received during the vacation.—Giacomo **Albanese**: Conditions for the rationality of the variety of pairs of points of two distinct or coincident algebraic surfaces.—Luigi **Fantappiè**: The nth prime number as the asymptotic value of a function $\psi_n(s)$ deduced from the $\zeta(s)$ of Riemann.—Oscar **Zariski**: Algebraic equations containing linearly a parameter and resolvable by means of radicles.—Bonaparte **Colombo**: An extension of Lamé's problem regarding the distribution of temperature in an ellipsoid having three unequal axes.—Washington **Del Regno**: Relation between the elastic tension and the magnetic behaviour of nickel steels in the neighbourhood of the transformation point. The relationship between the elastic and the magnetic behaviour shown by nickel is found also with three nickel-iron alloys, two of these being reversible and the other irreversible.—S. **Berlingozzi** and G. B. **Capuano**: 3-Hydroxyquinoline-4-carboxylic acids.—F. **De Carli**: Reducibility of certain metallic halides by means of hydrogen.—Remo de **Fazi**: A new reaction of aldehydes.—G. **Malquori**: Electrolytic preparation of ozone by means of an alternating current superposed on a continuous current.—Emilio **Papasogli**: Derivatives of diphenylamine.—Mario **Passerini**: Reaction between pernitrosocamphor and potassium cyanide. This reaction is one of direct addition of a molecule of each of the reacting compounds, the result being a potassium salt, the potassium of which may be replaced by other elements, such as copper or silver.—Ubaldo **Sammartino**: Studies on insulin: II. Action of insulin on zymase. The experimental results obtained lead to the conclusion that the active principle of the pancreas exerts no appreciable influence either on the fermentation of sugars by Saccharomyces or on glucolysis by zymase.—V. **Tognazzi**: Chalkones and hydrochalkones.—Mario **Ferrari**: Datolite from Monte Campotréra (Reggio Emilia).—Roberto **Savelli**: Transmission of mutations through inter-specific hybridisations.—Livia **Garofolini**: Utilisation of *Triton cristatus* for the destruction of the larvæ of Anopheles. *Triton cristatus* destroys, but is not a specific enemy of, Anopheles larvæ.—Luisa **Volterra**: Variability of the pelagic Daphnias of the lakes of Albano and Nemi.—G. **Amantea**: Periodic and cyclic modification of the uterus of Canis, independent of pregnancy.

Official Publications Received.

Ministry of Health. Final Report of the Departmental Committee on the Use of Preservatives and Colouring Matters in Food. Pp. 84. (London: H.M. Stationery Office). 1s. 6d. net.

The Newcomen Society for the Study of the History of Engineering and Technology. Transactions, Vol. 3, 1922–1923. Pp. xii+140+21 plates. (London: Science Museum, South Kensington.) 20s.

Department of Scientific and Industrial Research. Report of Test by the Director of Fuel Research on Parker Low Temperature Carbonisation Plant installed at Barugh, Barnsley, at the Works of Low Temperature Carbonisation, Ltd. Test carried out July 22nd to 24th, 1924. Pp. iv+24. (London: H.M. Stationery Office.) 9d. net.

Empire Cotton Growing Corporation. Report of the Administrative Council of the Corporation to be submitted at the Third Annual General Meeting on October 23rd, 1924. Pp. 22. (Manchester.)

Report of the Council of the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne, intended to be presented at the Annual Meeting of the Society, 7th November 1924. Pp. 34. (Newcastle-upon-Tyne.)

The University of Leeds. Calendar, 1924–25. Pp. xxxii + 573. (Leeds.) 4s.

County Borough of Warrington: Museum Committee. Report of the Director of the Museum for the Two Years ending 30th June 1924, with a List of the principal Additions to the Museum Collections. Pp. 20. (Warrington.)

The Institution of Civil Engineers. Engineering Abstracts prepared from the Current Periodical Literature of Engineering and Applied Science, published outside the United Kingdom. Supplement to the Minutes of Proceedings of the Institution. Edited by W. F. Spear. New Series, No. 21, October. Pp. 19d. (London: Great George Street.)

Dominion Museum. Monograph No. 7: A Bibliography of Printed Maori to 1900. By Dr. Herbert W. Williams. Pp. xvi+198. (Wellington, N.Z.: W. A. G. Skinner.)

Diary of Societies.

SATURDAY, NOVEMBER 1.

GILBERT WHITE FELLOWSHIP (at Queen Square, W.C.), at 3.—Sir A. Daniel Hall: The Countryside in English Literature (Presidential Address).

MONDAY, NOVEMBER 3.

ROYAL SOCIETY OF EDINBURGH, at 4.30.

ROYAL INSTITUTION, at 5.—General Meeting.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—Capt. W. J. Liberty: Underground London.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at Public Library, Swansea), at 6.—R. G. Isaacs and others: Discussion on Power Factor Improvement.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—H. H. Harrison: Chairman's Address.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street, W.C.), at 8.—Prof. A. D. Lindsay: What does the Mind construct? (Presidential Address).

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—W. J. U. Woolcock: Experiments in Protection.

LEICESTER LITERARY AND PHILOSOPHICAL SOCIETY (at Leicester Museum), at 8.—Prof. H. H. Swinnerton: Man 100,000 B.C.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—Presidential Address.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Sir Aurel Stein: Innermost Asia: Its Geography as a Historical Factor (First Asia Lecture).

TUESDAY, NOVEMBER 4.

ROYAL HORTICULTURAL SOCIETY, at 4.—Lecture.

MINERALOGICAL SOCIETY (at Geological Society), at 5.30.—Anniversary Meeting.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—C. M. Hunter: The Oilfields of Argentina.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Sir A. Smith Woodward: Exhibition of a Plaster Cast of a Fossil Egg of a Dinosaur.—D. Seth-Smith: Exhibition of Rare Amazon Parrots from Dominica and bower of Australian Regent-Bird.—S. Hirst: Three new Acari belonging to the Superfamily Trombidioidea (Erythræidæ and Teneriffiolidæ).—I. Montagu: (1) The Remains of Feu-Beaver in the Sedgwick Museum; (2) The Burrows of the Rodent Spalax.—R. Gurney: The Larval Development of some British Prawns (Palæmonidæ). II. *Leander longirostris* and *Leander squilla*.—W. E. Le Gros Clark: The Brain of the Tree-Shrew, *Tupaia minor*.

INSTITUTION OF CIVIL ENGINEERS, at 6.—B. Mott: Address.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Midland Hotel, Manchester), at 7.—H. C. Lamb: Chairman's Address.

INSTITUTE OF METALS (Birmingham Section) (at Chamber of Commerce, New Street, Birmingham), at 7.—A. R. Page: Brazing.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. D. Johnston: Presidential Address.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Section) (at Broadgate Cafe, Coventry), at 7.15.

INSTITUTE OF METALS (North-East Coast Section) (at Armstrong College, Newcastle-on-Tyne), at 7.30.—W. E. W. Millington: The Structure of Metals in its relation to Elastic Failure. Part II.

RÖNTGEN SOCIETY (at British Institute of Radiology, 32 Welbeck Street, W.), at 8.15.—Dr. A. E. Barclay: The Growth of Radiology: Has the Röntgen Society kept pace with it? (Presidential Address).

WEDNESDAY, NOVEMBER 5.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. F. X. Schaffer (of the State Natural History Museum, Vienna): History of the Vienna Basin (Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—E. H. Shaughnessy: Address.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Engineers' Club, Coventry Street, W.), at 7.—E. S. Shoults: The Heating and Ventilation of Glass Houses from the Grower's Point of View.

SOCIETY OF CHEMICAL INDUSTRY (Nottingham Section) (at University College, Nottingham), at 7.30.—C. E. Pickard: The Testing of Bates in the Laboratory.

ROYAL MICROSCOPICAL SOCIETY (Biological Section), at 7.30.—W. S. Hoseason: Notes on the Malaria Parasite.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—Dr. H. E. Cox: Certain New Methods for the Estimation of Arsenic and its Occurrence in Fish and Urine.—A. T. Etheridge: The Estimation of Cadmium in Brass.—N. C. Wright and J. Golding: The "Hoyberg" Method of Milk and Cream Testing.—Dr. S. G. Willimott: An Apparatus for the Catalytic Dehydrogenation of Alcohols.

ROYAL SOCIETY OF ARTS, at 8.—Senatore G. Marconi: Address.

INSTITUTION OF CHEMICAL ENGINEERS (at University College), at 8.—Dr. M. W. Travers: The Water Gas Process.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

THURSDAY, NOVEMBER 6.

ROYAL SOCIETY, at 4.30.—Prof. T. R. Merton: Ultraviolet Spectrophotometry.—Prof. W. L. Bragg and Prof. S. Chapman: A Theoretical Calculation of the Rhombohedral Angle of Crystals of the Calcite Type.—Prof. O. W. Richardson and T. Tanaka: (1) The Striking and Breaking Potentials for Electron Discharges in Hydrogen; (2) On A, P, Q, and R Combination in the Many Lined Spectrum of Hydrogen.—J. D. Bernal: The Structure of Graphite.—*To be read in title only*:—C. N. Hinshelwood and R. E. Burk: The Homogeneous Thermal Decomposition of Nitrous Oxide.—C. N. Hinshelwood: The Kinetics of the Interaction of Nitrous Oxide and Hydrogen.—Dr. A. T. Doodson: Perturbations of Harmonic Tidal Constants.—K. R. Ramanathan: The Structure of Molecules in relation to their Optical Anisotropy. Part I.—Prof. R. W. Wood: Controlled Orbital Transfers of Electrons in Optically Excited Mercury Atoms.

LINNEAN SOCIETY OF LONDON, at 5.—E. G. Baker: A Remarkable Tropical African Leguminous Plant.—Prof. E. B. Poulton: Exhibit of Lantern Slides illustrating Mimicry among Fijian Butterflies.—Dr. H. A. Baylis: Cestodes from Whales.—W. H. Pearsall and Dr. W. H. Pearsall: Phytoplankton of the English Lakes.—Dr. B. M. Griffiths: Studies in the Phytoplankton of the Lowland Waters of Great Britain: the Phytoplankton of Shropshire, Cheshire, and Staffordshire.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Sir St. Clair Thomson: Tuberculosis of the Larynx and its Significance to the Physician (Mitchell Lecture).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—R. Johnson: Some Clinical Aspects of Carcinoma of the Breast (Bradshaw Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—J. D. Cockcroft, R. T. Coe, J. A. Tyacke, and Prof. Miles Walker: An Electric Harmonic Analyser.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at Watergate House, Adelphi), at 7.30.

SOCIETY OF CHEMICAL INDUSTRY (Bristol Section) (Joint Meeting with the Institute of Chemistry) (at Bristol University), at 7.30.—E. J. Holmyard: The Present Position of the Geber Problem.

CHEMICAL SOCIETY, at 8.—J. Kenyon, H. Phillips, and H. G. Turley: Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part XXIV. Further Experiments on the Walden Inversion.—Prof. T. M. Lowry: Studies of Valency. Part V. The Mechanism of the Walden Inversion.—H. J. Emeléus and W. E. Downey: A Spectroscopic Study of the Luminescent Oxidation of Phosphorus.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—Joint Discussion with the Section of Epidemiology and State Medicine, and the Society of Medical Officers of Health, on The Notification of Puerperal Sepsis.

INSTITUTION OF MECHANICAL ENGINEERS (Glasgow Section) (at Glasgow).—Prof. J. H. Andrew: Steels and their Selection.

INSTITUTION OF MECHANICAL ENGINEERS (Manchester Section) (at Manchester).—Prof. W. T. David: (*a*) The Missing Pressure in Gas-Engines; (*b*) Heat Loss in Gas-Engines.

FRIDAY, NOVEMBER 7.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Geophysical Discussion: The International Geophysical Congress at Madrid. Chairman—Col. H. G. Lyons. Speakers—Sir G. P. Lenox-Conyngham, A. R. Hinks, Dr. C. Chree, R. G. K. Lampfert, Prof. H. H. Turner.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Vice-Admiral Sir George G. Goodwin: The Trend of Development of Marine Propelling Machinery (Thomas Hawksley Lecture).

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (at 16 St. Mary's Parsonage, Manchester), at 7.—Sir William Willcox: The Influence of Chemical Research on Medicine and Forensic Medicine.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—J. C. Dollman: Light.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—H. C. Jones: History and Construction of the Fire Engine.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Graduates' Section) (at Cleveland Institution, Middlesbrough), at 7.30.—R. W. Dickinson: Toothed Gearing.

PHILOLOGICAL SOCIETY (at University College), at 8.—Papers on The New Liddell and Scott.

PUBLIC LECTURES.

SATURDAY, NOVEMBER 1.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Some Famous Pharaohs.

MONDAY, NOVEMBER 3.

KING'S COLLEGE, at 5.30.—Prof. E. W. Scripture: The Psychoanalysis of the Poet.

GRESHAM COLLEGE, at 6.—Sir Robert Armstrong-Jones: Physic. (Succeeding Lectures on November 4, 6, 7.)

THURSDAY, NOVEMBER 6.

ROYAL SOCIETY OF MEDICINE (1 Wimpole Street, W.), at 3.—Dr. D. Guisez: Malignant Disease of the Gullet (in French) (Semon Lecture).

FINSBURY TECHNICAL COLLEGE (Leonard Street), at 4.—Julian L. Baker: The Chemist and the Fermentation Industries (Streatfeild Memorial Lecture).

ST. THOMAS'S HOSPITAL MEDICAL SCHOOL, at 4.30.—Prof. J. Mellanby: Enzymes. (Succeeding Lectures on November 13, 20, 27.)

FRIDAY, NOVEMBER 7.

KING'S COLLEGE, at 5.30.—Prof. E. W. Hobson: The Ideal Aim of Physical Science.

UNIVERSITY COLLEGE, at 5.30.—R. H. Hooker: The Weather and the Crops: Part II. Economic Effects (Jevons Memorial Lectures). (Succeeding Lectures on November 14, 21, 28.)—At 8.—Prof. G. Dawes Hicks: German Philosophy in the XIXth Century. (Succeeding Lectures on November 14, 21, 28; December 5, 12.)

SATURDAY, NOVEMBER 8.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—E. Lovett: The Amulets of Ancient Egypt and of Modern London.