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"To the solid ground
Of Nature trusts the mind that builds for aye."—WORDSWORTH.

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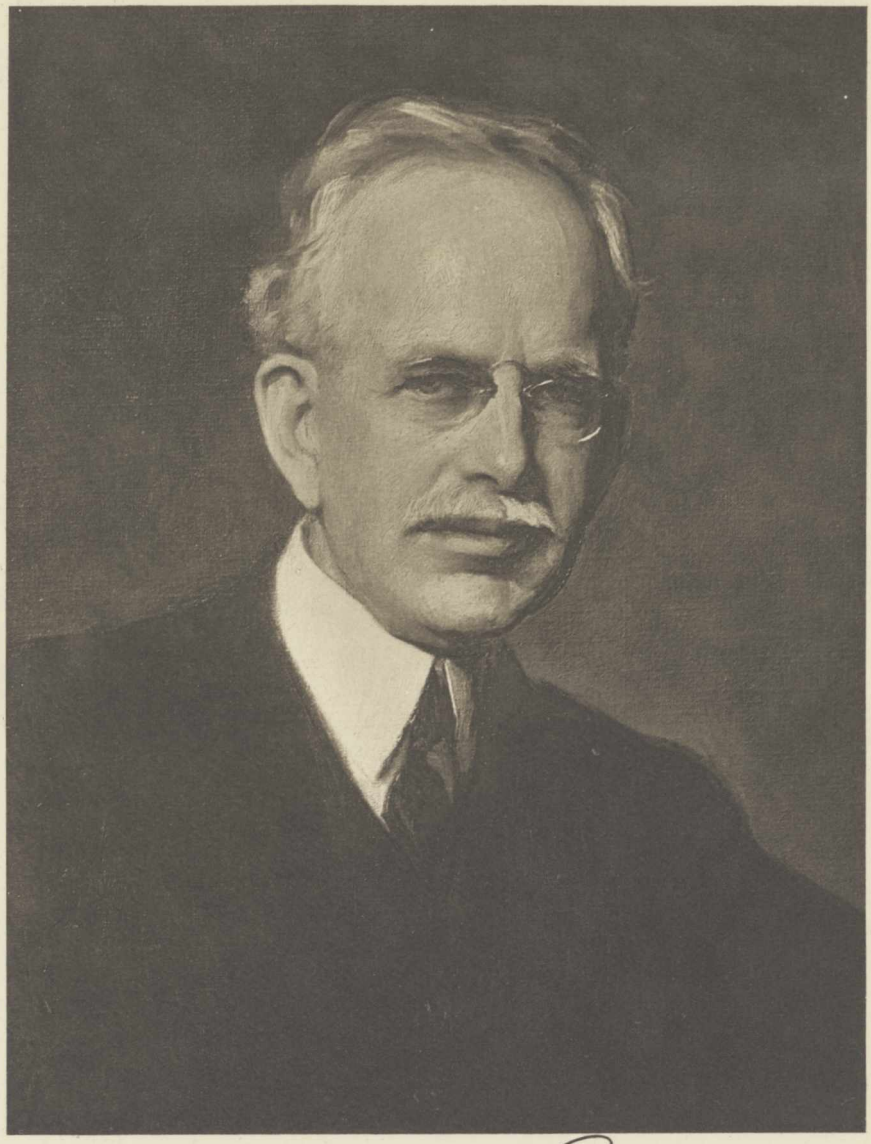

George E. Hale

From a painting by S. Seymour Thomas.

NATURE

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SATURDAY, JULY 1, 1933

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Scientific Worthies

XLVII. George Ellery Hale

THE advance of science is sometimes described as taking place by leaps and bounds. This mode of expression serves to indicate the rapidity of general progress, but it scarcely suggests the existence of the long intervals in which stagnation was the notable feature in the advance of special branches of scientific investigation. Advance in one branch is frequently at a standstill, until some discovery in another subject has been made and found to be available in wider fields.

This has been markedly the case in the study of solar phenomena. The invention of the telescope in 1610 led to the observation of sunspots, but it needed the passage of two centuries before the periodic variation in the frequency of sunspots was discovered by the apothecary Schwabe, from his personal observations assiduously recorded during many years. Wollaston's and Fraunhofer's study of absorption lines in the solar spectrum had to wait for half a century before explanation was forthcoming at the hands of Foucault and of Stokes, and of Bunsen and Kirchhoff. Yet another half-century was to pass before the advance of astrophysics could be said to have arrived at the exciting time of leaps and bounds, when a multitude of contributors had found the technique of studying the complex phenomena which gave promise of disclosing the nature of the systematic differences between one star and another, with a

unique specimen—the sun—to provide us with means of detailed study.

Helmholtz had suggested that the processes of gravitation in the sun itself must be the source of the continual emission of heat and light from the sun, and so probably from the stars also; but radioactivity had not then been discovered. Dry-plate photography had displaced the tedious processes of the wet plate, and the range of sensitiveness to light of different colours had to be extended by the use of special sensitisers. Janssen and Lockyer had shown how the extensive prominences round the limb of the sun could be seen visually with the aid of the spectroscope. Lockyer had directed attention to the importance of enhanced lines in spark spectra. Huggins had fathomed the secret of the gaseous nebulæ and had led the way, which was so splendidly followed by Vogel, Keeler, and Campbell, in measuring the radial motions of the stars.

It was into this exciting time that George Ellery Hale emerged from boyhood, with an unusual eagerness for the study of natural objects with home-made appliances. He was born in Chicago in 1868. Three years later the great fire destroyed most of his native city and left those who, like Hale's father, had property there, involved in heavy losses. William Ellery Hale was an energetic optimist, and whilst carrying on his business of manufacturing hydraulic elevators, he recognised the constructive ability of his son and developed it with true wisdom and understanding. Improved tools and microscopes were to be earned by successful work spent in making full use of make-shift apparatus and in devising and improving methods and instruments to special ends.

Whilst the father rewarded industry by the gift of a lathe or a Beck binocular microscope and tried to control undue eagerness by a remonstrance that his son was always "wanting to do it yesterday", the mother saw to it that her son gained a lively interest in good literature both ancient and modern. Grimm's "Fairy Tales", "Don Quixote", translations of Homer's "Iliad" and "Odyssey", were supplemented by Cassell's "Book of Sports and Pastimes", and later by Darwin's "Origin of Species". There was a possibility at one time of his boyhood that Hale should become a zoologist, and even to the present day it is no easy matter to get him to pass a woodland pool without his wishing to search for a *Cyclops* or a branchiopod or a *Vorticella*. But the joy of making, using and designing instruments for special purposes carried the day, and by the time his boyhood was completed he had himself constructed his own private workshop and a spectroscopic laboratory.

These details may seem out of place in an article like the present, but they have a high interest as bearing on the development of breadth of outlook, justification of bold enterprise by full use of experience, and single-hearted desire to contribute to the welfare of a generation by personal stimulation of co-operation in the multifarious lines of human endeavour. These qualities have been marked features in Hale's life.

It was clear that the Massachusetts Institute of Technology was likely to satisfy Hale's desires as a place of directed study, and in 1889, before the completion of his courses, he had made trials, at the Harvard College Observatory, of the first model of the spectroheliograph, the instrument which he developed later to great perfection step by step.

The choice of the subject of a life's work is a very arbitrary and chancy affair, and Hale's choice was made when he was at the beginning of his studies (1886–1890). Probably the proximity of the Harvard College Observatory, and the stimulating influence of E. C. Pickering, and of C. A. Young at Princeton helped to confirm his devotion to what is now known as astrophysics; but he was a confirmed amateur spectroscopist and solar observer before he went to Boston. The work of Secchi, Huggins and others had shown how one star "differeth from another" and how a system of stellar types was disclosed by the study of the details of the spectra of hundreds of stars. To a young mind that was already moved enthusiastically by Darwin's ideas of natural evolution in the gradual development of the various forms of living objects, the way seemed open to still wider application of evolutionary ideas in the interpretation of celestial phenomena.

It was not that Hale was a lonely pioneer in this appreciation of the vastness of the field of research thus opened out. But it afforded him the motive power to the great endeavours which have marked his life's work.

Hale finished his courses at the "Mass. Tech." in the summer of 1890. A visit to California and to the Lick Observatory, with his wife (married two days after his graduation), made a lasting impression on his mind. Holden was then director of the Observatory, and Keeler was on the staff in charge of the spectroscopic observations. Hale had great difficulty in resisting Holden's offer of the 36-in.

refractor for use in developing the spectroheliograph. The greater freedom for work with a smaller instrument of his own weighed strongly with Hale, and he returned to Chicago to talk the matter over with his wise father. The result of the consultation was an order for a 12-in. refractor with a suitable mounting incorporating Hale's designs. Thus the Kenwood Observatory was founded, on the same site as Hale's spectroscopic laboratory, about a mile north of the buildings of the University of Chicago.

A most notable feature in Hale's work has been the regular succession of advances based on successive experiences and leading to constantly increased power of instrumental equipment on novel lines.

It was a fortunate chance that led him to his first choice of study in spectroscopic observation of solar prominences. His recognition of the marked brilliance of the *H* and *K* lines of calcium in those prominences led him to concentrate his efforts first in obtaining photographic records of the prominences at the sun's limb, and then in the systematic search for signs of such phenomena over the whole visible disc of the sun. The observations of Janssen and of Lockyer during the total eclipse of the sun in 1868 had shown the way to detect prominences at the limb in full uneclipsed sunshine, but the delineation of them in visual observations was a tedious process, involving as it did the building up of a picture by recording in their drawings the successive changes in the distribution of bright points in the monochromatic image of the slit of the spectroscope, as the suspected prominence was allowed to move across the primary slit. Even Huggins's method of widening the primary slit had its drawbacks; for though it served to reveal the form of the brighter parts of a prominence, the more delicate parts were lost in the increased brilliance of the background.

Hale's invention of the spectroheliograph achieved what was required by the simple expedient of retaining a narrow primary slit and introducing a narrow secondary slit in a chosen part of the spectral image in the camera, to allow only the light of a chosen monochromatic image of the primary slit to pass through. A photographic plate, placed behind the secondary slit, was moved across that slit with equable speed, and so was made to record the instantaneous impressions whilst the primary image of the prominence on the primary slit moved equably across that slit. The photographic plate necessarily recorded the form of the prominence in the monochromatic light transmitted by the secondary slit, and when that light was that of the *H* or *K* lines of calcium, the form of the prominence was depicted in terms of that kind of light, and it was found that the form was in most respects similar to that depicted when one of the bright spectral lines of hydrogen was employed. The utilisation of the *K* line had a great advantage, namely, that in the solar spectrum the *K* line is a very broad absorption line (K_1) with a narrow emission line (K_2) at its centre, this emission line having a dark reversal (K_3) at its middle point. Hale's interpretation of these features was immediately helpful; he regarded K_1 as ascribable to calcium vapour seated low in the solar reversing layer under considerable pressure; the bright K_2 as being due to vapour higher in the solar atmosphere, and he ascribed K_3 to the absorption produced by the calcium vapour high above that producing the K_2 line.

Success, achieved in the Kenwood Observatory, in photographing isolated prominences, was followed at once by success in obtaining record in a single photograph of all the prominences round the whole limb of the sun. It was then found by photographic spectroscopic observations that the bright K_2 line could be detected here and there even on the bright disc of the sun. This suggested that masses of calcium vapour might be observed not only projecting edgewise from the limb of the sun but also passing over the bright disc of the sun. Spectroheliograms of the disc of the sun were accordingly undertaken, and disclosed the existence of great regions where the calcium vapour was glowing in huge clouds, clustering in general over and about sunspots. Hale recognised that the phenomena thus disclosed required a new terminology, and he later coined the word *flocculi* to distinguish these from *faculæ*, which was the name then in use to describe the bright areas of the sun's surface, such as are disclosed for example in Janssen's large-scale direct photographs of the solar surface in integrated sunlight.

At the Kenwood Observatory, this new study of the sun's surface was carried out by Hale in the years 1891–93, and with the help first of his brother and sister and later of his devoted assistant Ellerman, some three thousand photographs were obtained of these novel phenomena, disclosing as they did the close relationship of the floccular zones with the sunspot zones.

Then followed a period of great activity for

Hale. He learnt of the existence of two 40-in. discs of glass in the hands of Alvan Clark, and set himself the task of finding means of securing them for an observatory to be connected with the University of Chicago, a task that was made practicable by the munificence of Mr. Charles T. Yerkes. The site was chosen at Lake Geneva, near the southern boundary of the State of Wisconsin, at a height of more than eleven hundred feet above sea level, and at a distance of about sixty miles north-north-west of Chicago.

While the observatory was being built and the 40-in. refractor was being constructed, Hale carried on his observations at Kenwood and took steps to found the *Astrophysical Journal*. Later he developed the Rumford spectroheliograph—an instrument weighing about 700 lb. and capable of securing photographs of the sun's disc on a scale of about $6\frac{1}{2}$ in. to the diameter of the image. His mind being set also on the study of stellar spectra on lines of the evolution of stars, the stellar spectrograph was constructed and utilised specially in the study of the spectra of stars of Secchi's fourth type. He had secured the co-operation of Barnard, Burnham and of E. B. Frost; and the work at the Yerkes Observatory went forward for ten years under Hale's directorship.

Then came the possibility of large financial assistance from the Carnegie Institution for the foundation of a Solar Observatory, and Hale was encouraged to seek better conditions of astronomical seeing and more congenial climate in Southern California, where admirable sites had been found. Hale decided to go to the site of Mount Wilson which, after careful observations made by Hussey and others, had been found to offer much better conditions than were available for astronomical work at the Yerkes Observatory. He realised that better results for solar observations could be obtained by the use of a beam of sunlight directed in a fixed azimuth by heliostats or cœlostats, so that more massive spectroheliographic apparatus could be utilised on fixed platforms than could be manipulated at the eye end of an equatorially mounted refractor. The work accomplished at Lake Geneva with the Snow telescope served to show the advantages of that form of instrument, but it ended tragically in a fire started by the fusing of electric mains and resulting in the destruction of a large part of the optical equipment. The instruments were rebuilt through a gift from Miss Snow and afterwards were lent to Hale by the new director, Frost, and Miss Snow made further contributions to enable Hale to complete the trials on the new site on Mount Wilson.

It was characteristic of Hale's thorough method of procedure, that, in order to find out whether atmospheric tremor diminished appreciably when the required optical beam of sunlight was caught several feet above the surface of the ground, he made observations of the sun at different heights up an available fir tree, and they convinced him that definite improvement in the seeing was gained even 30 ft. above the ground, and still better results were obtained at 75 ft. So the site for the new Snow telescope was chosen on ground sloping downwards to the north, so that the cœlostat system could be placed on a lofty pier at the south end, directing the optical beam northwards, sloping downwards at an inclination of 15°. Soon another experiment was tried, in the form of a tower telescope, a lattice-girder structure carrying cœlostat and a 12-in. object glass at the top, forming a 6 in. image of the sun at ground level 60 ft. below, whilst the massive spectrographic apparatus was sunk vertically downwards into a dry well which served to keep equable temperature.

The successes achieved with these arrangements completely justified the large expenditure involved. The more powerful instruments enabled Hale to study spectroheliograms taken in the light of the much narrower hydrogen lines, and they disclosed the facts that the hydrogen flocculi appeared to require description as if they were dark masses in large regions where the calcium flocculi were usually bright, and, most important of all, that vortical structure was exhibited in the arrangement of the hydrogen flocculi round sunspots. This work was in large measure rendered possible in 1908 by the advances made in sensitising photographic plates in such a way that the flocculi could be studied in the light of the red hydrogen line ($H\alpha$).

Then followed the bold enterprise of a search for evidence of the existence of magnetic fields in the vortices round sunspots. Zeeman's discovery of the peculiar structure elicited in the bright monochromatic lines in the spectra of various chemical elements when they are made to glow in a strong magnetic field, provided Hale with the means of discovering that sunspots were seats of strong magnetic fields. He had to work with absorption lines in the solar spectrum, and to recognise in them the Zeeman fine structure with the aid of delicate polariscopic apparatus.

Here came in the immense importance of Hale's policy of linking the astronomical work with investigations in fully equipped physical laboratories connected with the Observatory; and Hale's remarkable faculty of organising teamwork resulted in the development of a very beautiful technique in studying the Zeeman effect in a multitude of selected lines in the spectra of various elements, chosen by reason of the marked prominence of those lines seen to be affected by widening and enhancement in the spectra of sunspots. By the use of a compound quarter-wave mica plate and a Nicol prism, placed over the slit of the 30 ft. spectrograph in the dry well beneath the 60 ft. tower telescope, Hale succeeded in obtaining proof of the existence of intense magnetic fields in sunspots. Moreover, by the beautiful technique which he had devised for gaining complete information about the intensity of the magnetic field in different parts of a group of spots, he discovered that most groups could be classified as bipolar in the sense that the preceding spot had a polarity opposite to that in the following component. Furthermore, he discovered, in the passage of time in the eleven-year cycle of frequency of sunspots, that the relative polarities of bipolar groups of spots changed in passing through the years of minimum frequency of sunspots, thus indicating that the sunspot cycle should be regarded as involving a periodicity twice as great as that hitherto generally accepted.

The success of this achievement provided Hale with a beautiful instance of bold enterprise to be based on the utilisation of the experience gained in the use of the 60-ft. tower telescope. He planned a tower telescope 150 ft. in height, capable of giving an image of the sun 16 in. in diameter at ground level, to be examined with a spectrograph 75 ft. long, placed in a dry well sunk vertically below the tower, and provided with a diffraction grating, which in the third order of spectrum gave dispersion sufficient to show the Zeeman effect that could be attributed to a general magnetic field over the whole surface of the sun. The observations have justified the conclusion that the sun is a magnet with its poles lying at or near the poles of rotation.

It may well be imagined that a dome large enough to shield the cœlostat and object glass at a height of 150 ft. above ground would be exposed to great shaking from the winds at that height over the mountain. These risks and difficulties were surmounted by the device of mounting the mirrors and lenses on a skeleton tower, with each member (leg or cross bracing) encased in a corresponding hollow member of another lattice-girder tower with clearance enough to prevent contact.

Hale's policy of arranging a fully equipped machine shop in connexion with the Observatory provided him with the means of supervising the construction of instruments devised to meet the requirements of research. Thus the mirror of the 60-in. reflector was begun by Ritchey in the workshops of the Yerkes Observatory and was worked and figured at Pasadena. Similarly the 100-in. mirror, provided by the munificence of John D. Hooker, of Los Angeles, was worked and figured in the workshops of Mount Wilson Observatory at Pasadena. This splendid instrument has already more than justified its construction by providing Hubble with the means of studying the spectra of the remote spiral nebulæ, which are now regarded as island universes far beyond the limits of our immediate galactic universe. These spectra disclose radial motions of the spiral nebulæ far greater than the motions within the galaxy, and they are interpreted as indications of expansive actions tending to lead to dispersal of the super-universe with ever-increasing velocities.

The same 100-in. reflector has also provided, in virtue of its massive mounting, means of applying Michelson's interferential method for gauging the diameters of giant stars. The results help to encourage us with increased confidence not only in the previous theoretical estimates of these enormous extensions of isolated stars, but also in the correctness of our views of the nature of stellar evolution. The results obtained in the extension of our knowledge of the outlying parts of the universe have been such as to justify a further increase in the light-gathering power of even larger instruments, and much thought and exploratory work have been expended on the problems of building a reflector of 200-in. diameter, with the help of subsidies from the Rockefeller Funds, to be attached to the California Institute.

Throughout the development and utilisation of the observational equipment, Hale has found energy and time to devote to fostering co-operative schemes not only in his own country but also among the leading nations. It was at his instigation that the International Union for Co-operation in Solar Research was suggested about the year

1904, resulting in meetings, first at Oxford in 1907, then at Meudon in 1907, and at Mount Wilson in 1910. At the last-named meeting, it was decided to extend the scope of the Solar Union, and thus finally arose the International Astronomical Union, which has met triennially and embraces a multitude of commissions charged with the organisation of observations for accelerated research. Largely under Hale's instigation, too, the National Research Council was established in Washington under the auspices of the National Academy of Sciences.

It is in no way surprising that the demands of such activity should result in the impairment of strength of one so deeply engaged as Hale has been through the whole of his life. Still his indomitable spirit enables him not only to carry out further extensions of observational investigations with his novel instrument, the spectrohelioscope, but also to devote much energy to such varied matters as the organisation of the very valuable Huntington Library and Art Gallery for the purposes of research in literary and artistic subjects, the active participation in town planning in Pasadena, and furthering the extensive aims of the California Institute of Technology under Professors Millikan and Noyes and others and, particularly, stimulating co-operation between that Institute and the staff of Mount Wilson Observatory in investigations contemplated in the Institute's Astrophysical Observatory, which is to contain the 200-in. reflector.

All his many colleagues and friends over the wide world join in congratulating Hale on his great achievements and in wishing him health and strength to continue to completion his present tasks in his observations with the spectrohelioscope and in his intensive search for new methods of studying the general magnetic field of the sun.

H. F. NEWALL.

African Ethnology

The Tribes of the Ashanti Hinterland. By Capt. R. S. Rattray. With a Chapter by Prof. D. Westermann. Vol 1. Pp. xxxii+292+15 plates. Vol. 2. Pp. xi+293–604+69 plates. (London: Oxford University Press, 1932.) 2 Vols., 45*s.* net.

IN his work on the tribes of the Ashanti Hinterland, Capt. Rattray has brought to light a mass of material for which all anthropologists must be grateful, while as an administrator, he has been at pains to investigate those aspects of native thought and organisation that must be understood if 'indirect rule' is to be put into operation successfully.

The area in question has suffered no important northern migration or other alien influence, and except for a relatively small enclave, there has been no attempt to form a centralised government. Only in the north-east, among the Dagomba and Mamprusi, are there important territorial chiefs, with court officials and regular ceremonies of 'enstoolment' similar to those of Ashanti. Here Capt. Rattray was able to trace this organisation to the settlement of Akan mercenaries, the Chakosi, who, called in by the Mamprusi, remained to conquer the neighbouring tribes. The mass of the territory forms a cultural unit, with tribal grouping and totemic clan organisation under 'priest-kings', there being a strong tendency for territorial grouping of the clans. It may be questioned whether 'priest-king' was a wise translation of *ten'dana*, which the author shows clearly to mean 'owner of the land'. The 'owner' is not the possessor but the spiritual trustee, on whose duties the prosperity of the land depends. He is not a 'divine king', as the king of the Shilluk or the Dinka rain-maker, but more closely resembles the 'father of the land' among the Bari or Lotuko, or the *dugutigi*, 'master of the soil', of the Banmana in French territory, one difference being that in the Sudan the clans are usually scattered, so that the 'father of the land' is not the head of the clan and has little authority. The *ten'dana* has, or had, considerable power and social distinction. Capt. Rattray tells us little about his actual duties, but they are in the main religious, disputes being settled by the head of the clan section, though the *ten'dana* will sit with the elders in council.

It must not be thought that religious duties are less important than legislative duties to these tribes. No peoples have been described in closer and more continual contact with their spirits. By means of soothsayers the spirits are consulted on all occasions, and their wishes made known to their descendants; but even without the mediation of the soothsayer, close touch is kept with the spirits by means of shrines, which every householder possesses. Besides the spirits of parents and ancestors, every individual has a guardian spirit, *segere*. For every child the soothsayer indicates at a certain time which spirit has become its *segere*; it is frequently found to be

that of some individual in the child's mother's family. Sacrifices are made to the *segere*, and henceforth the child learns to observe his *segere's* totem taboos as well as his own. This as well as the adoption and occasionally the inheritance of personal 'totems' opens up interesting problems in the succession of totem ties, which cannot be discussed here.

There is a sky-god and an earth-goddess. Capt. Rattray tells little about the latter, but the former, *Yini*, is no "otiose high-god". His place in the ideology of these people is extremely complicated; the word means the sun, but it is used in very many senses. Any shrine to *Yini* is simply called *yini*. The soothsayer may reveal that a tree, a stone, a pot or any animal, wild or domesticated, may be *yini*. A man killed by an arrow is *yini* to his son, a guardian spirit of any shrine may become *yini*, and sacrifice will be made to them all. The elder of twins is *Ayini*, while the younger is called after the earth-goddess and sacredness is attached to both.

Space forbids me to mention any of the features of social organisation, which are of the utmost interest. Here I must express regret that Capt. Rattray has not adhered to any definite system of terminology adopted by social anthropologists. His meaning is generally clear from the context, but it is a pity in a work of this importance to find "inheritance" and "succession" used indifferently; "brothers in a classificatory sense" when the meaning is obviously brothers, ortho-cousins, or members of a single lineage not a clan; "kindred" without any precise definition, etc.

The work is necessarily survey work, and especially in the domain of social organisation numerous interesting features are indicated which require fuller investigation. Notes on the numerous languages and dialects of the district are given, and a commentary is added by Prof. Westermann. The main body belong to the Gur (Goor) group of the West Sudanic languages; a characteristic feature is the division of nouns into classes by means of suffixes, this system being less rigid than the prefix system of the Bantu languages.

It is greatly to be hoped that someone may follow up this fascinating survey with intensive work on the social organisation of one or two of the tribes sketched by Capt. Rattray.

BRENDA Z. SELIGMAN.

Groundwork of Physics

(1) *The Classical Theory of Electricity and Magnetism.* By Max Abraham. Revised by Prof. Richard Becker. Authorised translation by Dr. John Dougall. (The Student's Physics, Vol. 5.) Pp. xiv+285. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1932.) 15*s*. net.

(2) *A Textbook of Physics.* By E. Grimsehl. Edited by Prof. R. Tomaschek. Authorised translation from the seventh German edition by Dr. L. A. Woodward. Vol. 1: *Mechanics.* Pp. xii+433. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1932.) 15*s*. net.

(3) *Physics: for Students of Science and Engineering.* Edited by A. Wilmer Duff. *Mechanics and Sound*, by A. Wilmer Duff; *Wave Motion and Light*, by E. Percival Lewis, revised by R. T. Birge and E. E. Hall; *Heat*, by Charles E. Mendenhall; *Electricity and Magnetism*, by Albert P. Carman and C. T. Knipp. Seventh revised edition. Pp. xiv+681. (London: J. and A. Churchill, 1932.) 18*s*.

(1) IT is now thirty-eight years since the first edition of Föppl's "Introduction to Maxwell's Theory" appeared in German, and it is twenty-eight years since the second edition, completely revised by Max Abraham, was issued. Seven other editions followed in the succeeding years, which bears convincing testimony to the high regard in which "Abraham-Föppl" was held by students and teachers. In view of this striking and well-deserved success, it is surprising that an English translation has not appeared earlier. The highly speculative nature of modern physical theory and its disconnectedness render it the more desirable that the works dealing with classical physics should be rigorous and consistent in treatment. In this respect the new "Abraham" sets a high standard. Experimental physicists who are unable to read Maxwell's "Treatise" in the original would be well advised to master the contents of the present volume.

It has come to be recognised that there is a definite need for books which, while not soaring too far into the realm of higher mathematics, yet cover the essential ground of theoretical physics and enable students to read any branch of their subject without undue difficulty. Examples of such books are the series by W. Wilson and that by Max Planck, and the isolated volumes by

Leigh Page, Madelung and, in a higher sense, Courant and Hilbert.

This translation is from the new edition of Abraham, revised very efficiently by Prof. R. Becker of Berlin. The number of diagrams has been increased more than five-fold, as compared with the preceding German edition. In some sections it has been found desirable to lay greater emphasis on the concrete physical content. There are new sections on electrostriction and thermodynamics of the field. In the exposition of the theory of alternating currents use is made of the method of vector diagrams. The first two chapters give an excellent account of vectors and vector fields. There is an important note in the preface on the different systems of units in use by physicists and engineers. For purposes of reference, a synopsis of formulæ and notation is appended. Acting on the precept: "But be ye doers of the word, and not hearers only, deceiving your own selves", the compilers have added a selection of 137 examples, followed by answers and hints for solution.

On the whole, the translation has been reasonably well done. There are occasional lapses, however, such as at the bottom of p. 6, where there is an ungrammatical rendering of the method of testing whether a physical quantity is a vector or not. It is to be hoped that Abraham's book will take a regular place in the curriculum for honours degrees.

(2) Dr. E. Grimsehl, the original author of the compendious textbook of physics of which the present book forms the first volume, is claimed to have been a pioneer in the teaching of experimental physics in German schools and universities. He was *Rektor* of the Heinrich Hertz Realschule in Hamburg-Uhlenhorst for many years, and like many of his colleagues among the teachers of that progressive and stimulating city on the Elbe, he found time during his hours of leisure to devise original experiments and demonstrations, and to write didactic works on his subject. In addition to an unusual gift for clear thinking, he possessed personal qualities of a high order and enjoyed the respect of physicists generally. At the outbreak of the War, Dr. Grimsehl, then fifty-two years of age, enlisted as a volunteer; he was killed in action in 1915.

The appearance of Dr. Grimsehl's book in English will be welcomed by teachers of physics of almost every rank, as it is the first time that an elementary treatise of such wide scope and encyclopædic magnitude has been made accessible: the standard lies between that of the London intermediate and a good pass degree. The task of revising and amplifying the work has fallen to Prof. Tomaschek of Marburg. One of the future volumes (the present is only the first of five) will be devoted exclusively to atomic physics.

Special features of this first volume (on mechanics) are the excellent and detailed treatment of motions of rotation, and of the problem of flight (kites, gliders, airships, aeroplanes, boomerangs all come under survey). The diagrams have been replaced wherever possible to conform with the outlook of the English reader (for example, the aeroplane depicted on p. 404 is an Armstrong-Whitworth 'Argosy' passenger-carrier). The theoretical discussion is elementary throughout and the calculus is used only where necessary. The experimental aspect is always stressed and many useful demonstration experiments are described. More difficult questions, such as Coriolis forces, are also included and treated in a simple manner. A pleasing innovation is the addition of footnotes giving the etymology of many technical expressions; there are also short biographical notes. We would suggest that certain eminent English physicists (such as Cavendish, p. 177) who have been treated a little scantily in this volume compared with some of the Continental physicists, might well receive an additional note in one of the succeeding volumes.

A large collection of questions and problems taken from university examination papers has been added by Dr. C. F. Powell, who has also accepted the responsibility of supplying the answers. Dr. L. A. Woodward is to be congratulated on the excellence of his English rendering.

(3) The distinctive feature of this volume, regarded as an elementary textbook of physics, is that the various branches of the subject have been allotted to teachers with a particular experience in their own section. The standard approximates to that of the London intermediate. Reference is made to very recent work, even to the neutron. But the section on atomic structure, if it should be included in a book of this type at all, would gain by having a short account of the Bohr atom rather than of the Lewis-Langmuir model which is here given. The book has been carefully written. Useful sets of examples (with answers) are given at the end of each chapter, and also references to the important sources and more advanced treatises. H. L. B.

A Human and Humorous Geography

The Home of Mankind: the Story of the World we Live In. Written and pictured by Hendrik Willem Van Loon. Pp. 506+32 plates. (London, Sydney and Bombay: George G. Harrap and Co., Ltd., 1933.) 12*s.* 6*d.* net.

THIS is an amazingly clever and stimulating book. The author, who won fame by a short "Story of Mankind", is a much-travelled journalist who, born in Holland, has made America his home and English his most familiar tongue. In this brilliant volume he has much improved on his first performance, for his knowledge of the world is made vivid by his travels, while the actuality of his history is a little dogmatic and tendencious from the same cause. Nationalism, for example, finds no more mercy at his hands than it does at those of Mr. H. G. Wells. But on the objective, geographical side of his subject he is well informed, well balanced and most instructive. His account of the evolution of the map and the calendar, and of the effects of climate and natural resources on the evolution of nations, could scarcely be bettered within its limits. There are, of course, lapses; a very curious one represents, in a picture, the English Channel as a sort of Colorado cañon; but on the whole the zest, vivacity and humanity of the book are irresistible.

Either for an intelligent child, or for an adult, as a preferable substitute for a novel, this geographical story of mankind should have a world-wide circulation. It is written from that point of view, as a lively homily on the text that "the importance of any given piece of land depends entirely upon the sum total of the contributions the inhabitants of that particular territory have made to the sum total of human happiness in the form of science or commerce or religion or one of the arts". The illustrations are delightfully crude and arresting. Every one of them contains some point to be remembered, and they are drawn as a bright child might draw them who wished to visualise something in the text. The whole thing is fascinating; in its way a work of genius; and, in the sanity of its internationalism, its pathos for the inhumanity of the past and hopefulness for the future, very much a sermon for the times.

F. S. MARVIN.

Short Reviews

(1) *The Principles of Electromagnetism.* By E. B. Moullin. Pp. viii+279. (Oxford: Clarendon Press; London: Oxford University Press, 1932.) 17*s.* 6*d.* net.

(2) *Electric and Magnetic Fields.* By Prof. Stephen S. Attwood. Pp. xi+314. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1932.) 21*s.* 6*d.* net.

THESE two books are of similar type and are intended for the use of electrical engineers. Both lay stress on the calculation and representation of fields in a great variety of cases and are characterised by the excellence of their diagrams.

(1) Mr. Moullin's book is intended as a preliminary volume and companion to a more technical book on the dynamo. The electromagnetic theory is developed along classical lines, but the need of the electrical engineer is always kept in view. Thus, the chapter on induced electromotive force ends with a detailed discussion of eddy currents and energy losses under various conditions. The usual account of iron in the magnetic field is continued into a discussion of the effects of various gaps, and of the forces between the magnetic poles which occur in dynamos and motors. Magnetic shielding is treated, and the current in the neighbourhood of faces of masses of iron. The last chapter deals with Maxwell's theory, retarded functions and radiation from oscillators.

(2) The field of Prof. Attwood's book is wider than that of the former, the magnetic field not being introduced in the first half of the book, which deals at great length with electrostatic fields and their plotting. The British student will find the nomenclature peculiar, as the names of the practical units are taken, with various prefixes for the absolute and electrostatic units. The word 'potential' is used where we use electromotive force, and magnetic potential is called magnetomotive force.

The Catalytic Oxidation of Organic Compounds in the Vapor Phase. By L. F. Marek and Prof. Dorothy A. Hahn. (American Chemical Society Monograph Series No. 61.) Pp. 486. (New York: The Chemical Catalog Co., Inc., 1932.) 9 dollars.

AN impressive idea of the extensive studies and applications of catalysis in recent years is afforded by this volume. In it the authors have summarised and reviewed critically an enormous range of literature and patents dealing with the special field of catalysis concerned. The main sections are arranged under such headings as the catalytic decomposition of alcohols; reactions involved in the synthesis of hydrocarbons and alcohols from water gas; the production of hydrogen from methane; surface combustion; the cause and suppression of knocking in internal combustion engines; the oxidation of alcohols, saturated and unsaturated aliphatic hydrocarbons, petroleum

oils, benzene and its derivatives, naphthalene, anthracene, and miscellaneous polynuclear compounds. A final chapter deals with apparatus. "The various reactions have been carried through historic sequences from laboratory scale experiments to technical developments wherever possible. When sufficient data were available, industrial practice has been discussed."

The text is fully documented, and there are sixty illustrations. Although modestly described as a monograph, the book partakes rather of the nature of a comprehensive treatise. In producing it, the authors have accomplished a very laborious and useful piece of work, for which they deserve the thanks of the numerous workers in this important field of modern chemistry.

Handbuch der Geophysik. Herausgegeben von Prof. Dr. B. Gutenberg. Bd. 2, Lief. 2: *Der geologische Aufbau der Erde.* Von Prof. Dr. A. Born. Pp. v+565–867. 69 gold marks. Bd. 4, Lief. 3: *Erdbebengeographie.* Von Prof. Dr. A. Sieberg. Pp. iv+687–1005. 84 gold marks. Bd. 9, Lief. 1: *Der Aufbau der Atmosphäre*, von Prof. B. Gutenberg; *Die Schallausbreitung in der Atmosphäre*, von Prof. B. Gutenberg; *Wärmehaushalt der Stratosphäre*, Teil 1, von Prof. J. Tichanowski; *Wärmehaushalt der Stratosphäre*, Teil 2, von Dr. R. Mügge. Pp. v+171. 36 gold marks. (Berlin: Gebrüder Borntraeger, 1932.)

IN the first of the recently issued parts of this 'handbook', Prof. A. Born carries out a geological description of the earth as a whole. In the second, Prof. A. Sieberg gives a detailed account of the geography of earthquakes. We learn that Great Britain is a moderately active country seismically; but the Channel Islands seem to have escaped mention. The third deals with the structure of the atmosphere and its heat balance. This is by Profs. Gutenberg, Tichanowski and Mügge. Decent burial is given to geocoronium. Astronomers will, however, have something more to say about the explanation of the zodiacal light as a phenomenon of the upper atmosphere. All the accounts are very thorough.

Practical Microscopy. By Prof. L. C. Martin and B. K. Johnson. (Blackie's "Technique" Series.) Pp. vii+116+10 plates. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1931.) 3*s.* 6*d.* net.

THE notion underlying this series—evident enough from the general title—is an admirable one, and the volume under review is a most useful addition to the series. The microscopist, in some instances, adopts an attitude towards his instrument not very remote from that of certain car drivers, whose mood of cheerful assurance, so long as all is well, changes to one of very helpless bleating for assistance when difficulties arise. This book is designed to give the microscopist an idea of the constructional details and the potentialities of his instrument, and, without entering into over-fine detail, the authors have given a very full account of the instrument from the practical point of view. They deal with the subject from most sides, treating, *inter alia*, lens and illumination problems, questions connected with the stand and with mechanical parts generally, the preparation of specimens, polarised light and photomicrography. As one would expect, there is a section dealing with ultra-violet microscopy.

The book is well produced and illustrated, and will be found helpful in a measure much exceeding that to be expected from its very modest price.

A. F.

Induction Coil Theory and Applications. By Prof. E. Taylor Jones. Pp. viii+244. (London: Sir Isaac Pitman and Sons, Ltd., 1932.) 12*s.* 6*d.* net.

PROF. JONES gives in this volume an account of the induction coil, which is more descriptive than his "Theory of the Induction Coil" of eleven years ago. The chief departures from a simple action are caused by the distribution of capacity in the secondary circuit, and the decay due to causes other than resistance, namely, eddy currents, hysteresis and leakage. Equations for the primary and secondary voltage and current are thus obtained and it is shown how coupling affects these quantities. The calculated curves are well in accord with those obtained experimentally and throw an important light upon the action of the induction coil. The forms of oscillograph for secondary voltage and primary current are described and a series of excellent oscillograms illustrating the wave forms is given.

A chapter is devoted to the diffraction of electrons by thin films, in which the author's results are described, and the book closes with a valuable chapter on spark ignition.

Admiralty Compass Department. *Admiralty Manual of the Sperry Gyro Compass, 1931.* (B.R. 9.) Pp. viii+136+43 plates. (London: H.M. Stationery Office, 1931.) 4*s.* 6*d.* net.

THE first gyro compasses tried in the Royal Navy were those of Anschutz, several being fitted in 1910–11. Two years later, in 1913, Sperry gyro compass outfits were fitted in H.M.S. *St. Vincent* and Submarine *E.*1., and tests were carried out at the Royal Naval College, Greenwich. As a result of these experiments, during 1914–15 Sperry gyro compasses were supplied to all capital ships, cruisers and the larger submarines, and after the War to all ships. Magnetic compasses are still provided as a useful check on the gyro compasses and for use in the event of electrical failure. To meet the needs of officers navigating ships, in 1925 the "Admiralty Manual of the Gyroscopic Compass" was issued. This has now been cancelled by the publication of the present volume. It is a work of the utmost value to navigating officers, containing as it does a series of chapters on the theory, construction, adjustment and maintenance of gyro compasses, all illustrated by photographs and diagrams.

Crystals of the Living Body*

By SIR WILLIAM BRAGG, O.M., K.B.E., F.R.S.

IT is obvious that the atoms and molecules of a living body are not thrown together in a haphazard fashion. There is in the first place a certain preferential disposal of the various kinds of atoms. While carbon, oxygen, hydrogen are widely and plentifully distributed throughout the body, the bones and teeth are comparatively rich in phosphorus and calcium, the hair contains sulphur and nitrogen, and so on. But these and other special occurrences are not enough to serve the body's purposes. There is a greater differentiation in the distribution of the molecules into which the atoms are grouped. There are, for example, many kinds of protein molecules which have their several parts to play as constituents of the different organs, and help to endow each organ with its peculiar function. But again this is not enough. There is a further requisite, namely, order in the arrangement of the molecules; which gives directive action to the various composite masses. A hair, for example, is largely composed of a species of the proteins known as the keratins. These are long, narrow, molecular arrangements which we shall presently consider more in detail. The molecules are fastened together, somewhat loosely it would seem, into little bundles, in which the molecules all point nearly in the same direction. The bundles are so disposed that this direction is nearly the same as that of the axis of the hair.

This order in the arrangement of the long molecules would seem to us, now that we have discovered it, to be in accordance with what we might have expected. The long molecules are an important part of the hair, and indicate a disposition of its components which must give to it directional properties. The hair grows in a particular direction to which also its various mechanical properties are related. If the molecules lay in all directions, there would be no reason why the hair should be long, narrow, flexible and yet strong.

All growth in Nature implies extensions in particular directions. Function is connected with orientation, and there can be no orientation without method in the molecular arrangements; for it has never yet been found that a process in a living body moves in contradiction to the laws of physics and chemistry as observed in the laboratory. This does not, of course, imply that any artificial arrangement of atoms and molecules has ever been endowed with life. A mass of molecules so indiscriminately arranged that no particular direction can be distinguished from any other, cannot be expected, even though it is part of a living body, to extend and grow in one direction more than in another.

We have taken a hair as an example, but other parts of the body would have served equally well. Nerves, muscles and tendons all possess arrangement; the bones are not merely shaped externally as an engineer would shape them, but show also in the internal arrangement of their molecules an orientation for a definite purpose which the engineer must envy.

Clearly, if arrangement of the molecules is so necessary to enable the body to function and to live, the actions of the body cannot be fully understood without taking it into account. The new methods of analysis by radiation of very short wave-length, including, we may now say, electrons as well as X-rays, have provided us with means of examination of structure which are of much greater power than any that we possessed previously. These latter have been indeed very few and indirect. Furthermore, catalytic actions depend on the arrangements of the atoms and molecules on the surface of the catalysing solid; but though this fact may have been appreciated, the details of the arrangement have been out of reach. In fact the new methods open up possibilities which are also new.

Our chemical methods, it must be pointed out, do not reveal the nature and details of molecular arrangements. When we employ them for the analysis of a material, we begin by pulling the material to pieces and so destroying that very arrangement of molecules which we should be glad to examine. We knock the house down, and discover the numbers and natures of its components; so many bricks, so many slates, so many planks and so on; but we have lost the plan of the house. We must differentiate between the arrangement of atoms in the molecule, and of the molecules with respect to one another. The former has long been the study of the chemist, and especially of the organic chemist. In such studies the molecules are free and approachable from all round, being either the constituents of a liquid or in solution in a liquid. A liquid has no permanent directional properties except, possibly, at its surface. On the other hand, the mutual arrangement of the molecules in the solid is fundamentally concerned in those directive properties which are characteristic of the solid; it is this arrangement which is now open to our examination.

As illustrations of the effects of mutual arrangement among the molecules, we may first consider the case of two soap bubbles, which may be rubbed together—not too violently—without coalescing. The material of the film is contained between two surface borders of long chain molecules which are arranged so as to present their methyl (CH_3) terminals to the outside of the film. Thus a 'methyl face' of one bubble rubs against a similar

* Friday evening discourse delivered at the Royal Institution, January 20.

face on the other. There is very little action between methyl groups, and so the films remain separated. The active ends of the molecules are all turned inwards, and so are kept out of each other's reach.

The solid crystal naturally gives the readiest examples of molecular arrangement, since the arrangement is the cause of the crystalline form.

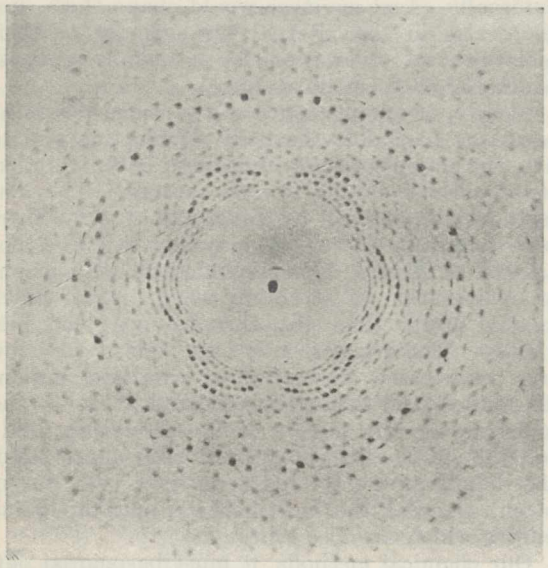

FIG. 1. Diffraction photograph of kaliophilite.

Every face presents only some selected part of a molecule to the external world. Zinc-blende may be looked on as an assemblage of molecules composed each of one atom of zinc and one of sulphur, all lying parallel to one another. Two opposing faces, both perpendicular to the direction in question, and forming parts of the crystal boundaries, differ in their behaviour because one is associated with zinc atoms in the same way as the other with sulphur. It is well known that if the crystal is heated, one such face is electrified positively and the other negatively. There are four such directions in each crystal of zinc-blende and four corresponding methods of picturing the assemblage of molecules.

Resorcinol possesses the same property to a high degree. The molecule is unsymmetrical, being a benzene ring in which two of the hydrogens at points 120° apart are replaced by hydroxyl (OH) groups. The arrangement of the molecules in the crystal has not been determined exactly, but we know that it is at any rate insufficient to give the crystal a high order of symmetry. The symmetry is certainly higher than that of the molecule itself, as is usually the case. There still remains a strong polarity which is revealed by the form of the crystal. The upper end of the crystal is very different from the lower; the faces that form naturally at one end are not those which form at the other. The polarity can be very simply demonstrated by suspending a couple of crystals in liquid air, whereupon they develop opposite electrical charges at their ends, so strong that the two behave to one another like small magnets. The strong electrification of resorcinol and similar bodies is sometimes used to clear liquid air of foreign particles.

The behaviour which is thus exhibited is the behaviour of the unit of pattern in the crystal. The unit can be shown by the X-ray methods to contain four molecules: arranged in a way which, as the term 'unit of pattern' implies, is repeated indefinitely in the structure of the crystal. Mere multiplication cannot alter the properties of the crystal: whatever is true of the crystal as a whole is true of the single unit as it lies embedded in the crystal. That does not mean, necessarily, that the single unit would behave in the same way as it does in the crystal if it were free of its environment.

This is an extremely important point. We obtain from observation on the crystal information respecting the properties of a certain small company of molecules, generally not more than two, three or four. These properties are various: magnetic, electric, optical, thermal and so on. If we determine the arrangement of the molecules in the unit, and of the atoms in the molecule, we may correlate properties and arrangements and so contribute to the solution of one of the great

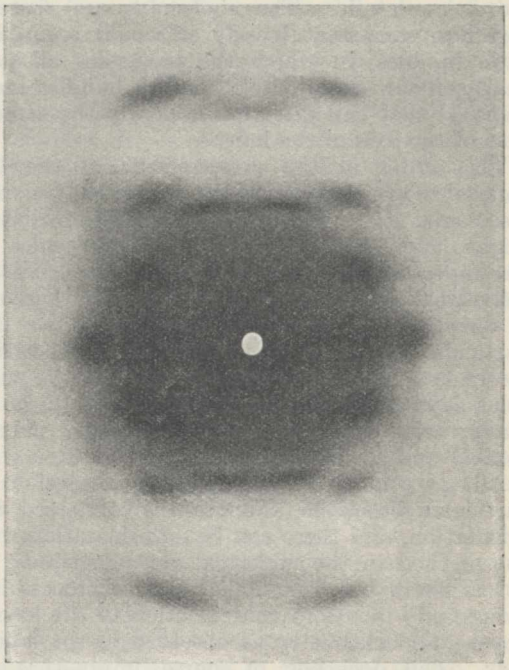

FIG. 2. Diffraction photograph of silk.

problems of physics, namely, the connexion between the properties of a substance and the atoms of which it is built. Conversely, knowing relations between the properties of one or more unit and the details of their structures, we may use our knowledge for the determination of the structures of other units by the examination of

the properties of the crystals of which such other units form part.

To sum up what I have said so far, the positions of the various atoms in the molecule determine the characteristic of the molecule: this is well known and has been widely studied. The positions of the molecules in the solid are equally important, especially if there is any regularity in their arrangement, in other words, if there is any attempt at crystallisation. In a living body there must be arrangements of various kinds to various extents. We want to know what these arrangements are and their effects.

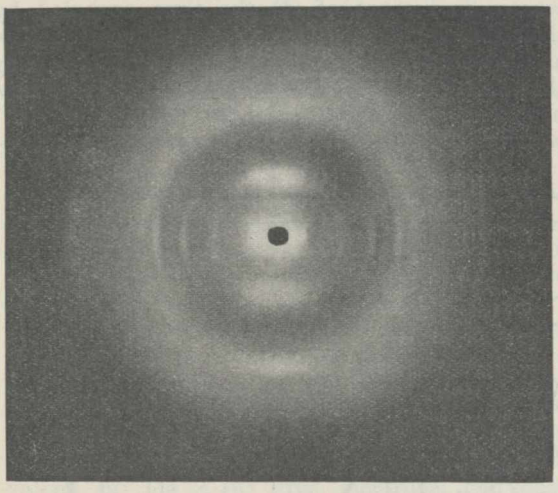

FIG. 3. Diffraction photograph of sea-gull's quill.

The X-rays demonstrate to us any such arrangements. It is now well known that a pencil of X-rays which passes through any substance where molecular arrangement exists gives some sort of diffraction pattern, which may be examined photographically or electrically. From the character of the pattern, information can be obtained as to the nature of the arrangement. When there is much arrangement and great regularity, the pattern is sharply defined. As an example, we may take the photograph of the mineral kaliophilite (Fig. 1) obtained by F. A. Bannister of the British Museum (Natural History). When the arrangement is less regular, the photograph is less definite. When the first photographs were obtained from silk and wool, nerve and muscle, they were in comparison exceedingly vague and it seemed that it would be difficult to make any useful deductions from them. However, both technique and skill in interpretation have increased materially and conclusions can now be drawn which are of great interest. The two photographs of proteins in Figs. 2 and 3 were obtained respectively from silk and from the quill of a sea-gull's feather. These are due to W. T. Astbury and Miss Marwick. The detail is sufficiently pronounced to give valuable information to the experienced observer.

In the first place, it is clear that there must be quite a considerable amount of arrangement in both cases. The silk is largely composed of a protein known as fibroin. It is remarkable that similar photographs are obtained from a great number of proteins, drawn from different sources; there is in fact a characteristic protein photograph which implies that there are elements of structure common to protein forms. Fig. 3 is an example of the diffraction pictures obtained from a peculiar class of proteins known as the keratins; their connexion with the main body has recently been beautifully demonstrated by Astbury.

(To be continued.)

The Ionosphere

By R. A. WATSON WATT

SINCE Teisserenc de Bort established the fact that at heights of the order of 10–15 km. the more or less regular fall of air temperature with height ceases, and that for some distance above this change point the temperature is substantially independent of height, it has become customary to treat our atmosphere as divided into two shells. The inner shell, in which convective motion and turbulence are recognised as the dominant physical characteristics, is now called the troposphere, and is separated from the outer shell by the tropopause, the surface at which this well-defined change of the lapse-rate of temperature occurs. So far as the older meteorological means of measurement were concerned, the outer shell, the stratosphere, must—by mere defect of evidence—be regarded as comprising the whole remainder of the sensible atmosphere.

More recently, however, it has become convenient to admit a not very sharply defined division of the stratosphere into an inner shell, retaining the name of stratosphere, and an outer, probably beyond a height of about 35 km., called the ozonosphere. This third shell, the dominant characteristic of which is its content of ozone, is, despite the incompleteness of data and the small absolute magnitude of the ozone content, of extreme importance in the radiation balance sheet of the earth, and thence in determining the physical conditions of human existence or non-existence on earth. The most recent addition to this systematic group, troposphere, stratosphere, ozonosphere, is the ionosphere, a shell extending from a height of some 80 km., and having, as its dominant physical characteristics, the special electrical properties which result from a relatively high degree of ionisation in the low-pressure gases which constitute the atmosphere at these considerable heights.

It is now well known that the necessity for

an ionosphere was recognised by the magnetician long before the radiotelegraphist required it in explanation of his experimental results, that, in fact, Balfour-Stewart anticipated Kennelly and Heaviside by nearly a quarter of a century. But of the three means of investigation which are capable of giving the readiest information on the state and structure of the ionosphere, the newer tools of the radiotelegraphist have proved more manageable than those of the magnetician or the student of the aurora. This special success of the radiotelegraphic geophysicist is due to two special factors, his ability to stimulate from the earth's surface ionospheric responses which propagate an interpretable message back to the surface, and which it experienced at lower levels, and none as to the state of the ionosphere at higher levels—are far less stringent than these, especially in view of the wide spectrum of radio frequencies to which can be entrusted the task of bringing back data from different levels.

The radiotelegraphic geophysicist usually finds it convenient to project his exploring waves vertically upwards, and to examine them, on their return, in respect of (1) the time occupied by their double journey, (2) their relative intensity, and (3) their state of polarisation. By multiplying the time of travel by the velocity of light *in vacuo*, he obtains a quantity called the 'equivalent path', which must be scrutinised with considerable care—

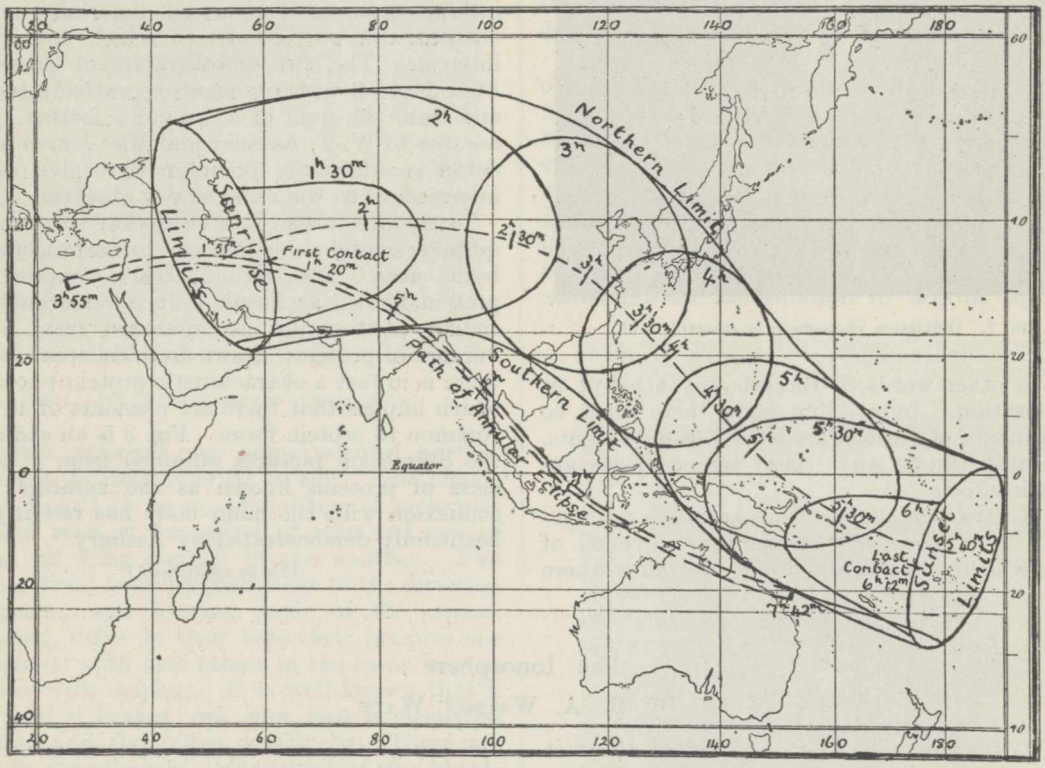

FIG. 1. Track of corpuscular eclipse of August 21, 1933, for an assumed corpuscular velocity of 1,000 km./sec., as computed by Dr. J. C. P. Miller.

the absence of any important factor preventing unambiguous interpretation. The user of other methods must, on one hand, await the application to the ionosphere of stimuli beyond his control—the stimuli which excite magnetic disturbance or auroral activity; and, on the other hand, he is baffled by the difficulty of separating his variables—as in the magnetic method—or by the masking and absorption of the message-bearing radiation—as in the auroral method, with its almost complete limitation to dark and nearly cloudless nights.

The limitations of the radiotelegraphic method—that the wireless wave can be made to bring back clear evidence only from that particular height at which it is turned back earthward, that it brings back only obscure evidence of the vicissitudes and indeed with a healthy scepticism—before it is related to the geometry of the ionosphere. For the very mechanism of return from above involves the reduction to zero of the group velocity of propagation, so that the equivalent path is always greater than the actual path, and this by an amount that can be inferred only in certain special cases.

By measuring the time of travel for a number of different radio frequencies in quick succession, the radiotelegraphist is able to obtain very important information as to the levels at which certain measured maxima of ionisation density are found. The early picture of a single attainable region of maximum ionisation (the 'Kennelly-Heaviside layer') the existence of which was

finally demonstrated—after two decades of doubt—in 1925, was within five years of that date shown to be inadequate, and the 'Appleton region' was found to be, in general, richer in ionisation than the Kennelly-Heaviside region, and to lie at approximately twice the equivalent height.

Recent issues of NATURE, and the discussion on the ionosphere at the meeting of the Royal Society on June 22, have revealed the existence of intermediate maxima, usually of minor importance, between the heights assigned to the main maxima. Our present knowledge of the structure of the ionosphere is more complete stratigraphically than topographically; an attempt will be made to trace what is now established and what is still in doubt in the picture of the moment.

There is no firm evidence of the return of wireless waves from levels below about 75–80 km., and this may be taken to be the lower limit for the extreme base of the ionosphere. If reflection at such a low level does in fact take place, it is effective only for the lowest frequencies, the longest wave-lengths, in commercial use. The level of maximum ionisation in the Kennelly-Heaviside region, or region E, is very close to 100 km. above ground in middle latitudes. This region is found to contain at noon on an equinoctial day the equivalent of $1{\cdot}8 \times 10^5$ free electrons per cubic centimetre, and the summer noon ionisation content is about 2·2 times that of winter. The ionisation content usually reaches its maximum very near noon, and during the hours of darkness the 'normal' content falls, not to zero, but to a minimum of about one-twentieth of the noon value.

The intermediate region recently reported, virtually simultaneously, by American and British workers, lies at equivalent heights between 130 km. and 180 km., and the evidence as to its ionisation density requires amplification before it can be fully discussed. The observations in America, in lat. 40° N., indicate that its winter ionisation content exceeds that of the E region only for a few hours round noon, and that during the hours preceding noon it has the same order of density as has E. Independent observations reported by Appleton and by Ratcliffe in Great Britain (lat. 51½°–52½° N.) agree in showing the intermediate region as being more heavily ionised, and consequently more prominent, than E in the early morning and the late evening; but while Ratcliffe finds this region more heavily ionised than E throughout many winter days, Appleton concludes that its ionisation content is usually less than that of E.

The communicated data for the Appleton, or F, region is less copious than that relating to the E region, although it is naturally more complete than that for the 'new' intermediate region. The noon ionisation density of F is some 3½–4 times that of E, and the diurnal maximum is reached an hour or two after noon. The actual height at which the maximum ionisation content is found in the F region is less certain than in the case of E, because of the group retardation effects in the E and intermediate regions, but it cannot be far from 180 km. This figure is justified by recognising that, on occasions when the lower regions are comparatively lightly ionised, so that the highest frequency which they will return earthward is still relatively low, the group retardation effect, in these regions, on waves of the considerably higher frequencies which are returned by F, will be quite small. An extrapolation, towards zero frequency, of the curve relating equivalent path to frequency for waves returned from F will then give, in the simplest and most favourable cases, an approximation to the actual height reached, and this height may, as Prof. Appleton stated in opening the discussion, be taken as 180 km.

The seasonal and diurnal variations of the ionisation in F region are still under investigation, but they may both be stated to be of less relative amplitude than those of E region. Appleton gives the ratio of summer to winter maxima for F as 1·5–1·8. The recent contributions to our knowledge of the fine structure of the ionosphere establish the existence of a stepped structure for F region; Schafer and Goodall, the American observers, find evidence of "remarkably abrupt ionic density gradients at heights near 200, 240, and 280 km. This type of phenomenon has been found only during daylight hours". Appleton finds on a particular occasion the following maximum ionisation contents (in electrons per c.c.): region E, $1{\cdot}8 \times 10^5$; intermediate region, $2{\cdot}5 \times 10^5$; region F ledge, $3{\cdot}8 \times 10^5$; and region F main, $6{\cdot}1 \times 10^5$.

It will have been appreciated that evidence of the existence of any particular maximum in the curve of ionisation plotted against height can only be obtained if there is no more prominent maximum at a lower height; thus we are able to say confidently that there is normally no region above F with a greater density of ionisation than that found in F, but we cannot say anything about the possible existence of lesser maxima at greater heights. For corresponding reasons, we cannot readily obtain information about the upper parts of the main divisions of the ionosphere; occasionally, however, evidence is obtained of an 'M reflection' by way of the under side of F region, the upper side of E, again the under side of F, and so to ground. This indicates that on these occasions, at least, the upper surface of E is also characterised by a steep gradient of ionisation density.

The importance of determinations of the polarisation of the received wave arises from the effects of the terrestrial magnetic field on ionic motions in the ionosphere. Appleton laid the foundation of the magneto-ionic theory in 1925 by pointing out the importance of the gyratory terms in the equations of motion of the individual charged particles set in motion by the incident wireless waves. If these carriers are of electronic mass, the gyratory terms become of great importance, and the ionospheric medium exhibits doubly

refracting properties. In fact a single pulse of energy sent vertically upwards frequently returns from region *F* as a doublet, of which the 'extraordinary ray component' of less delay is approximately circularly polarised, with (in the northern hemisphere) a right-handed sense of rotation, and is more heavily absorbed than is the 'ordinary ray' of lower group velocity.

The quantitative development of the magneto-ionic theory has been vigorously prosecuted by Appleton, Hartree and Taylor, while an experiment by Green in Australia established its validity by the very direct and striking evidence of a reversed sense of polarisation associated with the reversed sign of the magnetic field in the southern hemisphere. Reasons for the comparatively rare appearance of both magneto-ionic components in pulses returned from *E* region have recently been given (but not yet published) by F. W. White. There is, in sum, no doubt that the effective carriers in both the main regions, and also in the intermediate region, are of electronic mass and sign.

There is need of special emphasis on the qualifying adjectives 'normal' and 'usual' employed in this summary. Much of the discussion at the Royal Society went to show that 'normal' conditions in the ionosphere are somewhat unusual. Considering only region *E*, we may note that Ratcliffe discussed a nocturnal replenishment of electron content which is frequently found to take place at times when no direct solar radiation is incident on the ionosphere near the observing station, while Watson Watt dealt with sudden daytime increases of local electron content. These increases frequently lasted for only three to five seconds, although the density temporarily increased to three times that measured immediately before or after the 'spot'.

The problem of the source or sources of ionisation was, naturally, prominent in the discussion, and there was some suggestion of an *embarras de richesse*. Appleton outlined the eclipse evidence, obtained by Henderson in Canada last year, which established the predominant part played by ultra-violet light. Appleton said: "The normal cause of ionospheric ionisation is ultra-violet light from the sun. Now our picture of the structure of the ionosphere is that there are two main regions each of which is probably made up of two elements during the day-time. Probably the four components are associated with ionisation potentials of different atmospheric constituents, atomic and molecular."

Chapman crystallised the picture of ozonospheric and ionospheric stratification as an absorption spectrum. His computations of the effects of optical eclipse agreed with Henderson's observations; there was no need to suppose that the residual ionisation found by Henderson was due to another agent than ultra-violet light; and the effect of the eclipse on the *F* region should, as Henderson actually found, be notably less than that on *E* region.

Although the possible effects of corpuscular bombardment from the sun were not taken up in the discussion, this summary would be incomplete without some reference to the unfavourable nature of last year's eclipse for the *experimentum crucis* on ultra-violet light versus solar corpuscles as contributory ionising agents. This was indicated in the summary of eclipse observations given in NATURE of September 6, 1932, and the special merits of the coming eclipse of August 21, 1933, were there enumerated. Prof. S. Chapman kindly arranged for computations leading to the diagram reproduced as Fig. 1, which shows the eclipse track for an assumed corpuscular velocity of 1,000 km./sec.

Wilson developed further his suggestions, first made nearly ten years ago, on the rôle of thunderstorms in modifying the ionisation content of the ionosphere; suggestions which Appleton and Naismith had recently taken up in relation to the experimental evidence. Ranzi had found a relation between nocturnal replenishment of *E* region and the proximity of depressions; Lutkin had found a correlation coefficient of 0·75 between ionisation density in *E* region and a 'thunderstorm index' figure representing the intensity of atmospherics originating within 3,000 km. of the observing station; Ratcliffe also found relations between 'nocturnal *E*' and thunderstorms, while Watson Watt, in the discussion, related the sudden daytime increases in local electron density, already mentioned, to local thunderstorm activity. Wilson now showed quantitatively how important may be the 'runaway electron', accelerated by the electric field of the thundercloud, and the very numerous secondary electrons released by each 'runaway electron'. It appeared, finally, that there is sufficient energy dissipation in thunderstorms to supply, several times over, the whole energy of ionospheric processes; that there is sound theoretical reason for supposing that a substantial part of this energy dissipation goes to increase the ionisation content of the ionosphere; and that there are equally sound observational grounds for believing that such increases do take place.

Ratcliffe inclined to the suggestion of a common ionising agent for the *F* and intermediate regions, with a different agent for *E*. This suggestion is, however, difficult to reconcile with Watson Watt's earlier comments on "Winter in the Ionosphere" (NATURE, 129, 761, May 21, 1932) in which he brought together Hollingworth's evidence on very long wave reflection and Wilkins's evidence on ultra-short wave reflection, in support of a very close community of ionising agency between the extreme maximum of *F* region and the extreme base of *E* region.

On the converse problem of the opposing process of electron capture, which maintains the equilibrium values of the day-time and determines the rate of nocturnal decay, Chapman and Eckersley favoured the ordinary process of recombination between electrons and positive ions. Chapman showed that the predominance of this

process would lead to a ratio of maximum ionisation contents, as between summer and winter, which was in very good agreement with the observational material. Appleton leant towards the alternative process of attachment of electrons to uncharged atoms, and Chapman pointed out that if this process were of comparable importance with recombination in *F* region, it would be predominant in *E* region. The evidence seems, however, to be so acutely complicated by the known facts of nocturnal replenishment, that judgment may well be reserved.

It was a disappointing feature of a long discussion that the geophysicists who were not actively engaged in accumulating and interpreting radiotelegraphic evidence were inarticulate. Many fascinating possibilities awaited discussion: the relation between thunderstorms and magnetic disturbance, solar control and recurrence tendencies, the composition of the atmosphere at ionospheric levels, the possibility of approximate measurement of gas density and temperature from radiotelegraphic evidence on collisional damping, and the radiotelegraphic measurement of ionospheric air velocities for use in studies of terrestrial magnetism. There is room for another, and an early, discussion, with the radiotelegraphists in the back benches.

Obituary

SIR WALTER MORLEY FLETCHER, K.B.E., M.D., F.R.S.

SIR WALTER FLETCHER died on June 7, with unlooked-for suddenness when he was just approaching his sixtieth birthday, but when his physique and brain were still those of a man in the most vigorous prime.

The first twenty years of Fletcher's active life were all spent in Cambridge, and during that time he completed the work for which in 1915 he was elected to the Royal Society. His thoughts were steadily concentrated on the problem of the respiration of muscle. The laboratory work was interrupted from time to time and his papers appeared intermittently, but each one marked a definite step forward in knowledge. At last, in co-operation with Sir Frederick Gowland Hopkins, he succeeded in unravelling the web of confusion spun by earlier workers and made one main point perfectly clear. Muscular contraction is not related directly and simply to intake of oxygen and expiration of carbon dioxide. It may proceed vigorously in the absence of oxygen and is then attended by the formation of lactic acid, not of carbon dioxide. This lactic acid is not present in resting muscle but appears during contraction and largely vanishes again during the subsequent oxidative changes of recovery. Oxygen enables the muscle to regain activity after exhaustion and to get rid of accumulated lactic acid, some carbon dioxide then appearing during this period of recuperation. But the act of contraction is anærobic and in itself makes no call on any fresh oxygen supply, oxidation being concerned solely with the processes of recuperation.

These strikingly clear results were presented by Fletcher and Hopkins in the Croonian lecture of 1915 before the Royal Society, and they have not been controverted in any essential detail since. They gave the secure foundations upon which was erected the modern thermodynamic work of Meyerhof and Hill, who carried the analysis further and by measurement of total heat production deduced the formation during muscular contraction of lactic acid from glycogen and the re-synthesis of four-fifths of it back to glycogen during the oxidative processes of recuperation. Fletcher's impulse must be recognised in this work of A. V. Hill as well as in that of Keith Lucas, who added so greatly to the knowledge of muscular contraction on the electrical side. Both were his juniors at Trinity College, and Fletcher's enthusiasm and clear outlook over the ill-mapped lands of muscular activity captured their interest from other intellectual occupations, just as Michael Foster had done with younger men in the generation before. Keith Lucas left classics to work at physiology. A. V. Hill was definitely persuaded to abandon mathematics and to learn physiology as a field in which his special knowledge might find a novel and delightful application.

The researches of Fletcher with Hopkins hold a classical place among the first exact studies of the internal metabolism of the cells of any tissue, though the lapse of twenty years has given them an air of almost primitive simplicity when contrasted with modern knowledge of the intricate systems of intra-cellular oxidation and chemical change that is emerging from the later work of Hopkins and his school. But though Fletcher's own work in the laboratory always showed perfect execution of the experiment and exact argument to a clear end; and though his thought could envisage far prospects of physiological research with a confident hope that won many younger men to eagerness in sharing the adventure, it never seems that he found full satisfaction in laboratory research. Many other affairs claimed his time and his energies at Cambridge. Trinity College held his affection and received his services fully as much as Michael Foster's School of Physiology, which he often proudly traced to its source in the action of Trinity College in making Foster prælector of that subject. His unquenchable interest in every vivid side of life, his keen intellect, his artistic sense, and the athletic ability that was simply natural for a man of his big well-balanced frame, all these from undergraduate days had given him friendships and attractions outside the ambit of physiology and none of these was he willing to suppress. President of the Pitt Club for fifteen years and a don of a

distinction which any undergraduate could recognise, for he had sprinted in the 'hurdles' against Oxford, a good shot on the grouse moor, able to stalk his own stag in a deer forest, a keen player of the Royal game of tennis, an antiquarian who could satisfy the present Provost of Eton by his company in many a holiday study of the churches of France, and intellectual friend of G. M. Trevelyan, Regius professor of modern history, on matters that lay altogether outside the scope of science—his future at Cambridge seemed incapable of contraction to the intense aim of scientific research alone. The tutorship was about to expire, and some college might then have found in him a notable master and the University have gained by the exercise of his great administrative powers what the physiological laboratory would progressively have lost. Suddenly his whole career was changed. The scene shifted to London, and in the next twenty years Fletcher found the work to which he willingly and whole-heartedly devoted all that lay in him to give.

The present abundance in England of opportunities for scientific work in medicine is no older than the beginning of this century. Even in 1902 Lord Balfour had felt driven to ask "Why do we, the richest country in the world, lag behind Germany, France, Switzerland, Italy? Are we too poor, or are we too stupid to equip our universities and our medical schools with all the costly armoury which research must have in these modern days?" The gift by Lord Iveagh of £250,000 for the completion and endowment of a building, the Lister Institute, was the first great step forward; and in 1909 it was followed by Sir Otto Beit's gift of a like sum to provide fellowships for younger men who wished to embark on the voyage of research. The stream rapidly swelled to a great river. Someone in power in government had at last realised that the tiny grants for research through the Local Government Board were a poor measure of the nation's interest in what should be done to advance knowledge of the means for safeguarding health. A Research Fund yielding £55,000 a year was created under the National Insurance Act and the Medical Research Committee was formed in 1913 to administer its disposal. The new Committee had Lord Moulton as chairman, and its members from the outset were chosen for their scientific standing and not as representatives of any body or institution. In all official dealings it was aided by the support of Sir Robert Morant, who was even then looking forward to the creation of a Ministry of Health, so that the body might be educated to its best as well as the mind. Morant was a man possessed by ardent ideals, but he was also a most competent administrator whose experience in practical education before he became a Civil Servant had taught him that many things could be better done without the restriction of 'red tape'; and his wise sympathy with Lord Moulton's views saved the Committee from being bound by official swaddling clothes in its infancy. The Committee bought a building, the empty hospital at Mount Vernon, Hampstead, to serve as a national institute for a proposed research staff, and then in July 1914 appointed W. M. Fletcher as its administrative secretary.

Fletcher's life at Cambridge had been passed on levels that appeared to be remotely high above all concern for the welfare of the ordinary people, and he had so little knowledge of the movements by which the Research Committee was established that his name was a late choice and the appointment was criticised, but only for a moment. He came to the task, in itself inspiring to him when he saw this great fund for scientific work and knew the freedom that the Committee had secured for its action; and he met Morant. Between these two men, alike in big physique, in strong personality, and in culture, friendship at once arose, and Morant's ideals found not an echo but a counterpart in what had ever been innate in Fletcher. All his spiritual depths were uplifted by the vision of service for others in so wide a field. Scientific research became more than a beautiful use of the intellect in approaching the truths of Nature, for he now realised the need by England of its direct application to all the problems of ill-health. Henceforward he too became a great public servant and sank his own conspicuous abilities for research in guiding and helping countless other men.

The War broke out a month after Fletcher's official appointment as secretary, and the resources of the Medical Research Committee were largely diverted from civilian to army needs. The Director of the Army Medical Services had no such fund or organisation for research at his own disposal, and he gave ready facilities in all areas of the War both for civilians and for his own officers to use these resources of a Government organisation which could act with a hitherto unknown flexibility and speed. The Committee could rarely meet and most of the work, both initiative and executive, fell on Fletcher who, with the economy characteristic of a man trained to work in laboratories, had begun in small quarters and with a tiny office staff. He overworked recklessly, and in the winter of 1916 nearly died from an attack of pneumonia which left behind it a fibrosed area of lung where at last flared up the sudden infection that took away his life. But when the War ended, the Medical Research Committee and Sir Walter Fletcher had established beyond all doubt the great value of the services they could render to the country.

The next step was one of great administrative importance. In 1919 the Ministry of Health was constituted, with Sir Robert Morant as its first Permanent Secretary. That Department seemed appropriate for control of a research fund derived from contributions made under the National Insurance scheme. But both Morant and Fletcher were keenly alive to the need for keeping an organisation for work by men of science free from the chances of political influence by changing

Ministers of Health, and free too from any stiffening rigidity in its methods that might follow the introduction into its machinery of many men with Civil Service training. Moreover, the Minister of Health was responsible only for England and Wales, whereas Fletcher had learned from War experience that there was need for medical research not only in Great Britain but also throughout the Empire.

A better device had already been found in 1915 when the organisation for scientific and industrial research was placed directly under a committee of the King's Privy Council. This model was accepted, and a new Charter in 1920 placed the Medical Research Council, as it was now styled, directly under a committee of the Privy Council which included the Minister of Health and ultimately the ministers responsible for health in the Empire as well as in Great Britain. The financial grant-in-aid was drawn direct from Parliament and raised at once to £125,000 a year. As a safeguard of scientific independence was a provision in which Fletcher took peculiar satisfaction, namely, that no scientific member of the Medical Research Council should be appointed by the Lord President except after consultation with the president of the Royal Society.

In the very month before the new Council was formally created, Sir Robert Morant died from the strain of excessive work, at the relatively early age of fifty-seven. Fletcher wrote of his loss in phrases of deepest sorrow—"his departure is taken for misery, and his going to be utter destruction" —but Morant's work was too well based to crumble away or fall when he had left it, and the foundations of the Medical Research Council were relaid so wisely in 1920 that it too will not be shattered, only shaken, by Fletcher's recent death.

From 1920 onwards, the Council could plan more securely for its work, and the increased financial grant enabled Fletcher to obtain fuller assistance in the routine of office work, though his administrative expenses under this heading were always kept low. The time thus freed was used to good purpose. As secretary of the Council, he was officially a member of many Government committees, and it was his steady aim to convince such bodies of the value of the help they might receive from the scientific experts who were accessible either through his Council or the Royal Society. But now his own personal guidance was being more and more sought by those who were responsible for schemes of education or funds devoted to medical research, and his influence in this direction steadily assumed a high importance. Through his advice the Dunn Trustees gave £200,000 to the University of Cambridge to build and endow Sir Frederick Gowland Hopkins's School of Biochemistry, and £100,000 afterwards to Oxford for a Department of Pathology. These benefactions were then quoted when the Rockefeller Foundation in its turn was persuaded to give a Department of Biochemistry to Oxford, and to Cambridge £130,000 for its School of Pathology. The Rockefeller Foundation put full trust in Fletcher's judgment, and his advocacy was a determining factor in many of the other great gifts which it has made with such generosity for the advancement of medical work in Great Britain. Among these gifts he was especially eager for the success of the London School of Hygiene and Tropical Medicine, since through it he hoped that the Council might gain closer co-operation with medical work in the Empire abroad. In the same sense he welcomed an invitation in 1928 to visit India as chairman of a Government Committee for the Organisation of Medical Research. The confidence which he then won among the Indians themselves was quickly proved by a gift of £250,000 for medical research in memory of Lady Tata, and he was appointed chairman of the European Committee advising the trustees in Bombay upon the scientific work itself.

It is unnecessary to review the actual advances of medical knowledge which the Medical Research Council has in recent years helped to promote. These have been admirably summarised in the annual reports of the Council, to which later students will assuredly be indebted for a valuable historical account of the yearly progress, both that made and that contemplated, in different branches of medical research in Great Britain. Moreover, as Fletcher himself emphasised in these reviews, much of the work was often not directly planned by the Council but merely supported in its total distribution of £80,000 a year to almost every university and centre of active work in Great Britain.

Fletcher's position was that of permanent secretary to a Council the scientific members of which were changing yearly, and it often fell to Fletcher to initiate—and always to him to maintain—lines of policy, especially in matters of administration, which might require long years for their fulfilment. He had thus seen medical research with its national laboratory take its rightful place under the Privy Council side by side with the organisation for scientific research in chemical and physical questions affecting the manufacturing industries. He was finally satisfied that science had obtained its due recognition by Government when to these two committees of the Privy Council a third was added in 1931, the Agricultural Research Council for scientific inquiry into the uses of plant and animal life. Then, so far as science could add to human happiness or welfare, the nation had given to it an organisation which could effectively—and that word had become one of Fletcher's most frequently used adjectives—bring to practical men of affairs all the special knowledge that might aid the industries, the health and the nourishment of man.

At the end of a career, the work done becomes the enduring record of a man, and other memory rarely lives longer than the recollection of his friends. But the simple calendar of achievements misses the deeper question, that of the personality which inspired and was the work with both its faults and virtues. Fletcher's driving motive came

first through his intellect that knew the discipline of science, and then from the spirit of human sympathy that gave him an almost apostolic ardour in convincing men that this instrument of scientific thought must for the sake of man's welfare be brought to fuller use in medicine. The achievement of this aim was made possible by the rare gifts of Nature that were so happily combined in him.

Fletcher's mind was quick, critical and retentive. He grasped intuitively both the details and the wider relationships of the many problems continually placed before him; and while he would lend sympathetic attention to every man with a piece of work to put forward, he made extraordinarily few mistakes in his judgment of men and their problems. His astonishing personal knowledge of almost all the research workers receiving support in any way from the Council was utterly unlike that of an official administrator dealing only with written reports, for he sought to meet them as comrades in the field of scientific work who should discuss with him their problems and meet his ever helpful criticism.

To this mastery of the intellectual side of his work were added other qualities which made it easy for Fletcher to win goodwill at first acquaintance, while they determined the firm affection of those who had the happy fortune to know him more intimately. No friend ever had occasion to doubt the sincerity and staunch loyalty of his character; but even without proof of that constancy, it was difficult for a new acquaintance to resist the impression made by his frank manner, his splendid physique and the sense that he gave of tireless strength and energy. His spirits remained unconquerably young, and the boyish half-smile—and perhaps some kindly jest—with which he could suddenly relieve the tedium of a dull discussion, will ever remain in the memory of his friends. These were many, and of enemies he had none among those who took what he never denied to anyone, the opportunity to know him well. Cynicism, that closed defence of the doubting mind, he never used. Rather were his thoughts so freely brought to light that men were apt to misjudge as egotism what was little more than a too frank outpouring of the self-confidence that lies within all men of action. Perhaps in the same category was a habit of giving unsought advice, *more magistri*, to others on the way in which they should manage their affairs. If mistakes in this fashion arose, he was willing, even eager, to listen to criticism; and to be aware of a misunderstanding on such personal grounds was so painful to him that he could not rest until it was banished.

These two foibles were minor elements of weakness in Fletcher's character, and he was quick to apologise for faults into which they might lead him. But on matters where he felt that principles were at stake, he was ever an unyielding and a most formidable fighter. "Walter is a most charming fellow but do be careful of rousing Morley." Then he would make no concessions, and with outspoken courage he would pierce to the heart of arguments that he could show to be based on unthinking custom, however widely honoured or clothed with men's respect. On such issues he was utterly regardless of consequences to himself, caring only that the cause of scientific research, and of the Council in so far as it was identified with that, should not suffer setback. He knew the past struggles through which medical science in England had lately come from smallness to high repute among the nations of the world, and he knew what his share in that work had been. In moments of deeper emotion Fletcher would sometimes use the emphasis of old religious phrases. As his own end came so quickly near he might well have repeated to himself the words of Mr. Valiant-for-truth when he was going down to the river side: "I do not repent me of all the trouble I have been at to arrive where I am. My sword I give to him that shall succeed me in my pilgrimage, and my courage and skill to him that can get it." T. R. E.

News and Views

New Buildings of the University of London

THE University of London was honoured on June 26, when His Majesty the King, who was accompanied by the Queen, laid the foundation stone of the new buildings which are to be erected on the Bloomsbury site. Their Majesties were accompanied by Lord Irwin, president of the Board of Education, and were received by the Earl of Athlone, Chancellor of the University, and the Mayor of Holborn. The chancellors and vice-chancellors of the principal universities of Great Britain and Ireland, and representatives of Dominion and foreign universities and learned bodies formed part of the notable company which witnessed the ceremony. In the opening address, the Earl of Athlone referred briefly to the history of the University, pointing out that although the University now has more than 12,000 internal students and a similar number of external students, it has never had a home of its own. The University is, he said, "standing upon the threshold of the great inheritance she has built up for herself, a heritage which means nothing less than that she shall become not only the University of London in name but in deed and in reality London's University." The King replied, before laying the foundation stone, congratulating the University on the approach of the centenary of its existence and on the prospect of possessing a group of buildings as headquarters for its far-reaching work and influence. He continued: "I count it of good omen that in these difficult times we have the opportunity of showing an unshaken faith in the inestimable benefits of knowledge and

education. No less auspicious is the alliance in this good cause between friends of education in the Old World and the New. The Rockefeller Foundation, our own Government, the citizens of London in corporate and in private capacities all share in a memorable achievement." An article discussing the building scheme appeared in our issue of July 9, 1932 (p. 49), and another dealing with the development of science in relation to the University in NATURE of June 24 (p. 896).

Dr. R. A. Fisher, F.R.S.

DR. R. A. FISHER, head of the Statistical Department of the Rothamsted Experimental Station, has been appointed to the Galton chair of eugenics at the University of London. Since 1919, when he first went to Rothamsted, Dr. Fisher has successfully developed statistical theory so as to make application possible to the somewhat special type of data furnished by agricultural experiments, and he has also devised new methods of experiment which have proved very valuable in minimising the disturbances due to soil heterogeneity and other unavoidable irregularities in the experimental material. This is the third professorship obtained by members of the Rothamsted staff during the past twelve months, the two earlier appointments being that of Dr. W. B. Brierley to the chair of agricultural botany at the University of Reading and of Dr. R. H. Stoughton to the chair of horticulture in the same University.

Joseph Nicéphore Niepce

A CENTURY ago, on July 5, 1833, at the age of sixty-eight years, Joseph Nicéphore Niepce, the pioneer of photography, died near his birthplace, Châlon-sur-Saône. Born on March 7, 1765, in good circumstances, Niepce, who was of a meditative and poetical temperament, entered the army in 1792, but after serving for two years had to resign owing to ill-health and failing eyesight. Afterwards, for six years, 1795–1801, he held an administrative post in the Nice district and then returned home and with his brother devoted himself to mechanical and chemical experiments. Having his attention directed to the new art of lithography, he conceived the idea of making pictures by the aid of the sun. Many years were spent before he succeeded in obtaining impressions on plates of polished metal covered with asphaltum. Some of his results were shown to the Royal Society in 1826. Niepce then became associated with his countryman, Louis Jacques Daguerre (1789–1851), by whom, after Niepce's death, the art of photography was established on a practical basis. The first daguerreotypes were produced in 1839, and shortly afterwards the French Government granted pensions to Daguerre and to Niepce's son, Isidore. To-day both inventors are commemorated by statues; Daguerre at Cormeilles and Niepce at Châlon-sur-Saône. In fashioning the statue of Niepce, one writer says: "The sculptor worked for nothing, animated by no motive more selfish than the desire to express in lasting bronze his respect for a great man's memory. If every human being who has had occasion to be grateful to the discoverer of photography had contributed to his work the sculptor might have been royally remunerated, and the statue, instead of bronze, might have been of silver and gold." In the museum not far from the square in Châlon are preserved some of the apparatus with which Niepce made his notable experiments.

Experimental Production of Cancer

THE discussion on experimental carcinogenesis and the experimental transmission of cancer at the Royal Society on June 15 was rather of the form of a symposium which, in spite of compression by the speakers, could not be completed in the two and a half hours occupied. The possibilities of the genetic hypothesis of Boveri and Bauer were not further explored than the brief summary given by the opener, Dr. J. A. Murray. Of the subsequent speakers, valuable contributions to the virus hypothesis were made by Drs. Peacock, Andrewes, W. Cramer and J. McIntosh. The chemical carcinogenic agents and their mode of action formed the subject of an extremely interesting review by Dr. J. W. Cook, who dealt with the possibility of substances of similar action and chemical constitution being formed in the body by non-specific irritants. The biology of the tumours in fowls produced by tar, etc., was described by Dr. Peacock and Prof. J. McIntosh. Prof. A. E. Boycott reminded the meeting of the fascinating possibilities for speculation presented by a combination of the primary hypotheses discussed.

Origins of the General Relativity Theory

THE Gibson foundation lecture, delivered at the University of Glasgow by Prof. A. Einstein on June 20, consisted of a first-hand account of the mental struggles that precede the establishment of new fundamental ideas in science. The special relativity theory showed that velocity was purely relative, and from one point of view the same should be true of acceleration, yet physics seemed to show evidence to the contrary. The attempt to include gravitation in the special theory had to be abandoned. Prof. Einstein came to the conclusion that the key to the real understanding of inertia and gravitation was the experimental result that all bodies in a gravitational field were subject to the same acceleration. From 1908 until 1911 he endeavoured to apply this, but a dilemma arose from which he did not escape until 1912, when he conjectured that the space-time continuum had a Riemann metric. The development of this hypothesis by the aid of the absolute differential calculus of Ricci and Levi-Civita kept Einstein and Grossmann busy from 1912 until 1914. They found the correct gravitational equations, but failed to recognise their physical validity, and thus wasted two years of hard work. Finally Einstein "returned penitentially to the Riemann curvature". "Our final results appear almost self-evident . . . but the years of searching in the dark for a truth that one feels but cannot express; the intense desire, and the alternations of confidence and misgiving, until one breaks through to clarity and understanding, are only known to him who has himself experienced it."

Silica-Glass from the Libyan Desert

A WIND-WORN lump of clear and transparent, pale yellowish-green silica-glass resembling bottle-glass from the Libyan Desert, has been presented to the Department of Minerals of the British Museum (Natural History) by the Survey of Egypt. This material has been recently discovered by Mr. P. A. Clayton of the Desert Surveys at latitude 25° 20′ N., longitude 25° 30′ E. (about 480 miles south-west of Cairo). It was found in considerable amount and over a wide area (20 km. by 20 km.) as isolated pieces up to 10 lb. in weight in the hollows between the sand-dunes. It closely resembles the problematical glass long known from Bohemia and Moravia, which has been cut as a gem-stone under the names 'bottle-stone' and 'water-chrysolite'. This is also known as moldavite and, with the australites ('blackfellow's buttons'), it is classed with the tektites, the origin of which is still obscure. The new glass from the Libyan Desert is found in much larger pieces and in greater quantity than any tektite yet known. It differs from the abundant silica-glass found last year by Mr. Philby around the meteorite craters at Wabar in Arabia in showing an indication of flow structure and in the almost complete absence of bubbles; but it forms a very suggestive link between tektites and the silica-glass that has been definitely proved to have been formed by the fall of large meteorites.

Botanical Acquisitions at the British Museum (Natural History)

MISS I. M. WRIGHT has presented to the Department of Botany of the British Museum (Natural History) the British herbarium of her father, C. A. Wright, which contains about 6,000 specimens. The interest of the collection is that it contains plants from several eminent botanists who used to send them to Wright, as for several years he was unable to travel from his home at Kew on account of lameness. Dr. A. B. Rendle has recently been on a botanical trip to Jamaica and Bermuda and has brought back about 800 plants in which all the main groups are represented. The stay in Jamaica was short and collecting also suffered on account of the recent severe drought, but the collection as a whole is likely to prove of special interest. Dr. Rendle has been engaged for many years on the "Flora of Jamaica" and is therefore specially qualified to make the best use of what opportunities there were. The plants of Bermuda, accompanied by copious notes, will serve as an indication of the present state of the flora, from which many endemic species are being ousted by aliens.

Colourless Generators of Anthocyanins

IN continuation of their survey of the anthocyanins, Prof. and Mrs. Robert Robinson, in a paper recently published in the *Biochemical Journal*, have established the presence of a new class of colourless generators of anthocyanidins, which were first noted by Rosenheim and have been worked on to some extent by Jonesco. Such compounds are apparently quite widely distributed in plants: they require boiling with 10 per cent hydrochloric acid for a minute or so before they are converted into coloured anthocyanidin. Prof. and Mrs. Robinson are the first to recognise that the change is one of dehydration and not of oxidation, and to this extent the name leuco-anthocyanin suggested for the class is unfortunate. They assume that carbons 3 and 4 in the middle ring of the complex three-ring anthocyanidin formula both carry hydroxyl groups and that on dehydration there is loss of hydroxyl at 4 and hydrogen at 3. It is early yet to speculate on the significance of these compounds, which may be precursors of the anthocyanidins proper: their structure fits in with the theory that such compounds are derived from two and a half molecules of sugar. It is further of interest that many of the leuco-anthocyanins listed are obtained from bark and wood. The new discovery shows that even the identification and the synthesis of the natural anthocyanins have not terminated the potentialities of this interesting field of inquiry.

The Newcomen Society

THE summer meeting of the Newcomen Society was held in Cornwall on June 13–16. On arrival at Falmouth, which was its headquarters, the members were received by the Mayor, Alderman J. Harris, and other members of the Council, and in the Municipal Building in which the reception took place, Mr. W. T. Hooper, the borough librarian, had arranged an exhibition relating to Cornish engineers and engineering. The meeting was devoted almost entirely to excursions to mines, foundries, engine-houses, china-clay works and places of interest with engineering associations, such as the houses in which Watt, Boulton, Trevithick, the Hornblowers and others lived from time to time. On behalf of the Society, the president, Mr. H. W. Dickinson, laid a wreath on the statue of Trevithick in Camborne and at St. Gluvias Church, Penryn; Mr. Hooper gave a short account of the work of the Hornblower family, one of whom, Jonathan Hornblower, was a pioneer of the compound steam engine. Although in many parts of the county are still to be seen fine specimens of 'Cornish' engines, the extension of the 'grid' will soon lead to these falling into disuse, electrically driven pumps being particularly suited for much of the work.

Spectroscopic Conference at Massachusetts Institute of Technology

THE programme for the Spectroscopic Conference to be held at the Massachusetts Institute of Technology, Cambridge, Mass., on July 17–21 has recently been issued. The following topics will be discussed: quantitative spectroscopic analysis of materials, Dr. C. E. K. Mees, Dr. W. F. Meggers, Mr. C. C. Nitchie and Mr. F. Twyman; biological and photochemical applications of spectroscopy, Prof. G. B. Kistiakowsky, Mr. P. A. Leighton, Mr. W. A. Noyes and Mr. F. Twyman; physical and astrophysical aspects of spectroscopy, Prof. F. H. Crawford, Prof. G. H. Dieke and Prof. D. H. Menzel; analysis of complex spectra, Dr. K. Burns, Prof. G. H. Dieke, Dr. W. F. Meggers

and Prof. A. G. Shenstone; spectroscopy and atomic structure, Prof. G. R. Harrison, Prof. D. R. Hartree and Prof. J. C. Slater. Only the mornings are to be occupied with these topics, the afternoons being left free for informal discussions, the inspection of laboratories, etc. The Conference, it should be noted, is merely the central feature of a summer research gathering of spectroscopists which it is hoped will become an annual feature of the Institute's programme. Already this year a number of investigators have stated their intention of spending some time investigating specific problems with the very complete spectroscopic equipment now available at the Institute.

The British Electrical and Allied Manufacturers' Association ('Beama')

THE 'Beama' (Kingsway, London, W.C.2) has recently published a book entitled "Twenty-One Years" which gives an interesting review of the work done by the British Electrical and Allied Manufacturers' Association since it was founded in 1911. The founders thought that voluntary co-operative action would go far to meet the economic difficulties which at that time were proving a severe handicap to the development of the electrical industry in Great Britain. Practically all the electrical manufacturers in the country are members of this Association. It has done excellent work in introducing order into the commercial relations between its members and its customers. Its opinion has carried great weight when legislation affecting the industry has been proposed. It has promoted far-reaching policies of research and standardisation benefiting engineering in general. The principle behind the Association's activities has been co-operation without the sacrifice of individual initiative. It has succeeded in linking together the manufacturing interests with the leading professional engineering institutions. Mr. D. N. Dunlop has been the director of the Beama since its start and much of its success is due to him. It has done excellent work in providing for the education in Great Britain of students from all countries, particularly from the Dominions. In 1920 it founded a research association which has done excellent work. During the past few years electrical manufacturers have begun to increase their exports to Europe, a sign of competitive efficiency. The Association took a leading part in encouraging the World Power Conference and also in encouraging the National Grid Scheme, the largest electrical achievement in the world.

The National Physical Laboratory

THE report of the National Physical Laboratory for the year 1932 is an illustrated volume of 277 pages which gives a short account of the activities of each department of the Laboratory. Owing to the trade depression, the number of investigations carried out for industry and the number of routine tests have fallen off, and the resulting diminution of income has necessitated reduction of expenditure on materials and equipment, and leaving vacancies on the staff caused by resignations unfilled. The new tank for ship tests has been completed, the acoustics building is nearly ready and the new wind tunnel for high speed tests is well in hand. The erection of the photometry building has been postponed. A gift of £5,000 has been received from Sir James Lithgow for a propeller water tunnel in the Froude Laboratory. In addition to eighty reports and memoranda on aerodynamical subjects, ninety-one official and twenty unofficial papers on other branches of the work of the Laboratory have been published in scientific and technical journals during the year, and they afford ample evidence that the Laboratory is taking a prominent part in the advance of science and industry.

Physics in American Industry

IN connexion with an editorial note in the April issue of the *Review of Scientific Instruments*, American manufacturers are urged to keep in touch with the fundamental science of physics in all industries which deal with the mechanical and electrical properties of materials, the flow of heat, the use of colour and the reproduction of sound; and some useful information is given as to the means at present available for securing this contact. The *Review*, which is published monthly, goes free to every member of five scientific societies and at a reduced subscription to any person who already subscribes to one of the seven other journals dealing with physics, which are published in the United States. A large proportion of the five to six thousand copies of the *Review* goes into the hands of people associated in one way or other with manufacturers, but the editors consider that in the interest of industry many more copies should be utilised in this way. It is hoped that the association of local physical societies with the recently formed American Institute of Physics will help to link physics and industry more closely throughout the United States.

Science and Education in Poland

THE two outstanding contributions in vol. 16 of *Nauka Polska*, an annual publication devoted to studies in science and letters in Poland, are "The New Trends in Scientific Thought" by Prof. C. Białobrzewski and "The Promotion of Education in the Provinces of Podolia, Volhynia and the Ukraine before the Partition of Poland" by Prof. A. Knot. Prof. Białobrzewski is concerned mainly with the philosophical outlook and with recent developments in psychology, but he also remarks upon the progress now taking place in various branches of physics. He asserts that one epoch in the history of science has just closed and that another, more definitely creative, is beginning. Prof. Knot's account of the early educational facilities in south-east Poland is a well-documented article. The author has traced the development of educational institutions in these remote districts from the fourteenth century to the close of the eighteenth, when the kingdom of Poland was completely partitioned between Russia, Prussia and Austria. Mention is also made in this number of *Nauka Polska* of the celebrations held at Warsaw last year, commemorating the fifty years' existence of the Mianowski Institute. Among the notes from

abroad there is an account of the organisation of science in Great Britain with special reference to the aims and objects of the British Association and of the British Science Guild.

Power Production in the United States

THE chief sources of energy to-day in the United States are coal and petroleum, which between them account for more than 90 per cent of the demand, water power supplying only 10 per cent. A marked change has occurred in the relative proportion of energy obtained from coal and oil in that country over the last two or three decades. According to Messrs. W. S. Hutchinson and A. J. Breitenstein, whereas thirty years ago 91 per cent of the horse power came from coal and only 4 per cent from oil and natural gas, in 1930 horse power from coal had decreased to 60 per cent while that from oil and gas had risen to 31 per cent. It is estimated that by 1950 coal will furnish only 46 per cent of the country's power, while 45 per cent will come from oil and gas, the remaining energy being derived from water power. Consumption of coal in America apparently reached its zenith in 1917, according to Science Service of Washington, D.C., but from this date decline has been rapid, dropping from 6·08 tons per capita to 4·2 tons in 1930; a further drop is forecast for 1950. Although figures, and particularly estimates regarding the relative importance of coal and oil fuels, can be made to be most misleading, this summary of the situation in America, together with the forecast which experts have made, are not without interest and significance in the controversy which is still waging on this very question in Great Britain.

Announcements

SIR RICHARD GREGORY, BT., editor of NATURE, has been elected a fellow of the Royal Society under the provisions of Statute 12, which provides for the recommendation by the Council of "persons, who, in their opinion, either have rendered conspicuous service to the cause of science, or are such that their election would be of signal benefit to the Society".

BRIGADIER E. E. B. MACKINTOSH has been appointed director and secretary of the Science Museum in succession to Sir Henry Lyons who is retiring next October.

PROF. JOHAN HJORT will deliver the next Huxley Memorial lecture at the Imperial College of Science and Technology, on May 4, 1934, at 5.30 p.m. The subject of his lecture will be "The Restrictive Law of Population". Prof. Hjort is professor of marine biology in the University of Oslo, and was formerly director of Norwegian Fisheries. He was elected a foreign member of the Royal Society in 1916.

AT a meeting of the Royal Meteorological Society held on June 21, it was announced that the Council had decided to recommend to a special general meeting of fellows the adoption of revised by-laws, whereby the annual subscription would become two guineas as from January 1, 1934, instead of three guineas as at present. It is hoped that as a result there will be an increasing number of new fellows.

THE annual conference of the Museums Association will be held at Norwich on July 3–7, under the presidency of Sir Henry Miers. Several papers will be read and two discussions have been arranged, namely, "Provincial Art Galleries" and "The Illustration of Natural Science". A film entitled "The Bittern in Norfolk and other Illustrations of Bird Life", will be exhibited by Lord William Percy. Further information can be obtained from the Local Secretary, Museums Conference, Castle Museum, Norwich.

THE Minister of Health has made Amendment Regulations, to come into force on September 1, to the Public Health (Imported Food) Regulations, 1925 (Statutory Rules and Orders, 1933, No. 347), with explanatory circular (Circular 1325). The principal purpose of the Amendment Regulations is to extend the existing scheme of certification now applied to the importation of any edible part of a pig so that it will apply in the same way to the edible parts of cattle, sheep and goats.

A SUPPLEMENT to the *Times* of June 20, entitled a "Gold Number", gives an account of gold from a number of different aspects. It is shown that the production of gold is in some respects a British Imperial monopoly, the British Empire producing something like 70 per cent of the world's gold output, 50 per cent of this output being due to the Transvaal. The issue is a very complete one and contains information on practically every aspect of gold production and utilisation.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A lecturer in mechanical engineering at the Municipal Technical College and Junior Technical School at Bolton—The Director of Education, Education Offices, Nelson Square, Bolton (July 7). A head of the Department of Biology at the Chelsea Polytechnic, London, S.W.3—The Principal (July 8). An assistant lecturer in organic chemistry at the University College of North Wales, Bangor—The Registrar (July 10). A demonstrator in zoology at University College, Southampton—The Registrar (July 10). An assistant lecturer in mathematics at King's College, Strand, London, W.C.2—The Secretary (July 10). A junior lecturer in chemistry at The University of Edinburgh—The Secretary (July 10). A librarian and curator of the museum for the Borough of Whitehaven—The Town Clerk, Town Hall, Whitehaven (July 15). An assistant lecturer in physics at the University of Leeds—The Registrar (July 17). An assistant master in machine design, applied mechanics, electricity, etc., at Erith Technical College—The Principal, Erith Technical College, Belvedere. A science master at Eastbourne Technical Institute—The Town Clerk and Secretary, Education Office, Mead's Road, Eastbourne.

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.*]

Date and Place of Priestley's Discovery of Oxygen

IN NATURE of March 11, Mr. H. G. Wayling states that "At Lansdowne House on August 1, 1774, Priestley discovered oxygen"; and a similar statement is made by Sir Philip Hartog in the "Dictionary of National Biography".

Sir Edward Thorpe in his "Joseph Priestley" says, however, that "the course of inquiry which he began at Leeds was continued by him with characteristic assiduity and conspicuous success at Calne", and again, "The years which Priestley spent at Calne constitute the most fruitful period of his scientific career", and "it cannot be maintained that during the subsequent period he added many first-rate facts to our knowledge, or indeed discovered any facts at all comparable in importance with those he ascertained during his life in Wiltshire".

Moreover, Lord Shelburne, when he became Priestley's patron, was, Thorpe tells us, "living in retirement at Bowood" which was near to Calne; and provided for Priestley "a pleasant house at Calne in the summer and a house in town during the winter".

Further, on p. 34 of vol. 2 of "Experiments and Observations on Different Kinds of Air", Priestley says: "Mr. Warltire, a good chymist, and lecturer in natural philosophy, happening to be at that time in Calne, I explained my views to him, and was furnished by him with many substances which I could not otherwise have procured. With this apparatus, after a variety of other experiments, an account of which will be found in its proper place, on the first of August 1774 I endeavoured to extract air from *mercurius calcinatus per se;* and I presently found that, by means of this lens, air was expelled from it very readily."

Soon after this, Priestley visited the Continent with his patron, and met Lavoisier in Paris; but in the following March he was back again in Calne. This is shown by an autograph letter which I have been privileged to see amongst a collection in Dr. Williams's library in Gordon Square. In this letter, Priestley, after referring to his indifferent health—he was suffering, he says, from painful boils—states that when able he hoped to continue his experiments on the new air, which he was now able to prepare in larger quantity; and at the foot of this letter, on the left hand side, occurs the single word "Calne".

In view of this evidence one would not doubt that Priestley discovered oxygen in Wiltshire rather than in London, were it not for the categorical statement in the "Dictionary of National Biography". Is there any evidence to support this statement? I have found none.

R. M. CAVEN.

The Royal Technical College,
Glasgow, C.1.

I AM obliged to the Editor of NATURE for having communicated to me the foregoing letter by Prof. Caven.

I wish at the outset to say, after looking through the voluminous notes on which my article on Priestley was based, that I cannot confirm my statement that Priestley's experiment of August 1, 1774, on *mercurius calcinatus per se* was made at Lansdowne House, and I think Prof. Caven is probably right in suggesting that it was made at Calne. But the matter does not end there. My error must, I think, have been due to the following passage (of which I have been reminded by Sir Harold Hartley) in a letter of Priestley of April 1, 1775:

"By the heat of the flame of a candle . . . I get *the pure air I discovered in London* in great plenty from a variety of cheap materials; not only from red lead, but many earthy substances moistened with spirit of nitre and dried," etc.[1]

This should be read in connexion with the following well-known passage from the "Experiments and Observations on Different Kinds of Air", vol. 2 (1775), p. 40, in which, after referring to his experiment of August 1, 1774, Priestley says:

"In this ignorance of the real nature of this kind of air, I continued from this time (November) to the 1st March following."

The comparison of these two passages indicates clearly that for Priestley himself the date of the "discovery of oxygen" was March 1, 1775, and the place, London.

That Priestley's experiments in London were made in the house now called Lansdowne House (but which was then called Shelburne House, presumably until Lord Shelburne became Marquis of Lansdowne in 1784)[2] is shown by a passage in his "Philosophical Empiricism" (1775), p. 4, where he speaks of having shown some of his experiments (on oxygen) at that house to friends on May 23, 1775, the day before he wrote his third letter on the subject to the Royal Society. (I owe this reference to Prof. A. N. Meldrum.)

An undue importance has, as I have always thought, been attached to the date August 1, 1774, since, as Priestley himself pointed out[3], he "was in possession of", that is, had isolated, the new gas in his laboratory "before the month of November 1771"—though he did not recognise the fact either then or in August 1774. It is to be hoped that the statement that Priestley "discovered oxygen on August 1, 1774" may now disappear from our textbooks.

An examination of the letter-books of the Royal Society and of the Journal Book has revealed certain slight inaccuracies in the text of Priestley's three letters on the discovery of oxygen published in the *Philosophical Transactions* (vol. 65, pp. 384–394; 1775); and together with the letter in Dr. Williams's library of March 25, 1775, addressed to Rev. Theophilus Lindsey (the letter to which Prof. Caven refers), these MSS. enable one to trace Priestley's movements at the time. Letter I to Sir John Pringle, president of the Royal Society, is in Priestley's own handwriting and is dated "London, March 15, 1775"; that letter was read on March 23, 1775; and this must be taken as the date of Priestley's first public announcement of the discovery of oxygen. Letter II is not printed in full but is in reality an extract from a letter of April 1, 1775 to the Rev. Dr. Richard Price; it is in Price's handwriting; it is definitely stated in it that the letter was dated Calne, April 1; and it was read on April 6, 1775. It was quite natural that Priestley should refer in it to the gas which he "had discovered in London" as Price, his intimate friend, and himself a fellow of the Royal Society, would

have known about the gas and also that he had recently gone from London to Calne. (The letter to Lindsey shows that he was already in Calne on March 25.) Letter III was from Priestley to Pringle and is dated London, May 24, 1775; it was read on May 25, 1775. The *Philosophical Transactions* wrongly give the date of Letter III as May 25, and an inset at the beginning of the communications wrongly suggests that all three letters were read on that day.

To complete the matter, it may be added that the MSS. show that Priestley asked Price to show Letter II to Pringle, so that, if he chose, it might be "read to the Royal Society, but not to be published", but that he withdrew his objection to publication. Letter I has endorsed on it "Withdrawn by the President through mistake, believing that such was Dr. Priestley's inclination". But the words are crossed out, perhaps to avoid their being reproduced by the printer. Obviously the passage in Priestley's Letter II made Pringle doubt if he wished his Letter I to be published. It is probable that Priestley only hesitated about the publication of Letter II because he wished to continue his experiments before publishing them. I am afraid that some of these details may seem meticulous; only the importance of the discovery to which they refer justifies my taking up so much space. The points of chief importance are the place and date which Priestley himself assigns to his great discovery.

P. J. HARTOG.

5 Inverness Gardens,
W.8.

[1] *Phil. Trans.*, **65**, 390; 1775. (The italics are mine.—P.J.H.)
[2] Lord Lansdowne, to whom I sent a copy of this letter, confirms my statement that Shelburne House and Lansdowne House were the same. He adds that the room at Bowood (Lord Shelburne's country seat near Calne) in which Priestley conducted his experiments is to this day known as "The Laboratory", though it has certainly not been used as such since Priestley's, and, following him, Ingenhousz's time. Lord Lansdowne thinks that the experiment of August 1, 1774, was in all probability made in this room, though it may have taken place at the private house (on "the Green" at Calne) where Priestley lived when he was in Lord Shelburne's employ.
[3] "See Experiments and Observations on Air", vol. 1, pp. 155–157; 1774; and "Expts. and Obsns. relating to . . . Natural Philosophy", vol. 1, pp. 194–198; 1779. In these early experiments Priestley obtained oxygen from saltpetre.

Isomeric Forms of Carotene and the Further Purification of Vitamin A

CALCIUM hydroxide or calcium monoxide are splendid adsorbents for carotene. One chromatographic adsorption suffices to bring about a complete separation of α- from β-carotene. The α-form has thus been isolated in an absolutely pure state, showing a melting point of 183° uncorr., 187° corr. The absorption spectra of β-carotene in antimony trichloride solution has up to now been described as showing characteristic bands, one at 590 mμ, the other at 542 mμ. We find that under the same conditions, pure α- and pure β-carotene each give in reality only one of these bands. That one at 590 mμ belongs to the β compound, the other at 542 mμ to the α compound.

Highly concentrated vitamin A can be further purified in the same manner and also separates into two fractions. The main portion, which we will call the β substance, shows the well-known absorption at 328 mμ, the other much smaller fraction, only a few per cent, a band at 270 mμ. Vitamin A preparations purified according to the old methods give in antimony trichloride solution, just as impure carotene does, two absorption bands. After purification by adsorption on calcium hydroxide, the β-fraction shows the band 620 mμ. The solution of the α-fraction has at the beginning only the band at 580 mμ, but very soon a band at 620 mμ also appears, probably in consequence of an isomerisation.

The analysis of the β-fraction agrees exactly with the formula $C_{20}H_{30}O$ and ozonisation yields geronic acid. This fraction therefore represents the substance for which we proposed our vitamin-A-structure formula.

P. KARRER.
O. WALKER.
University, K. SCHÖPP.
Zurich. R. MORF.
May 29.

Vitamin A Concentration of Cod Liver Oil correlated with Age of Cod

ACTING upon the previous recommendation of the Imperial Economic Committee for the consideration of research to throw light on "the nature of the variations in the vitamin content of cod liver oil produced from fish from various sources and a study of the underlying causes of such variations", the Empire Marketing Board in 1930 published the report of Drummond and Hilditch (E.M.B. 35) on the "Relative Value of Cod Liver Oils from Various Sources". These investigators established the superior richness of the liver oils of Newfoundland cod from actual observations on Newfoundland, Scottish, Icelandic and Norwegian samples, and in their study of the causes of the variations reported as follows: "There appear to be two important factors influencing the concentration of vitamin in the liver. The first is the nature of the food supply, and the second is the quantity of oil stored in the liver". They concluded that, "The richest vitamin oils will, therefore, be obtained in areas where abundant food supplies for the fish are available and at seasons when the oil content of the livers tends to be low".

Numerous investigators have been studying this problem, and up to the present time no very satisfactorily clear-cut explanation has been forthcoming. Since the inception of this Laboratory two years ago, I have been studying the problem of vitamin concentration. Conditions are ideal for obtaining liver oil samples; the cod are obtainable on the spot and the oil samples can be prepared immediately in the laboratory. Indeed, the lack of such facilities is probably the reason for much confusion in work done on long-kept samples of doubtful origin. I have been able to establish a definite relationship between vitamin A concentration, colour of the liver oil and the age of the cod. Young cod give liver oils of pale colour and of low vitamin content, whilst old cod give richly pigmented oils of high vitamin content. The extreme values so far found for Grand Bank cod are as follows:

Vitamin A value: Lovibond blue units (10 per cent dil.)	Colour of oil measured in 1 cm. cell.		Length of cod in cm.	Approx. age of cod in years
	Yellow	Red		
2·5	0·6	0·1	42	4
2·5	0·6	0·1	52	5
21·0	2·2	0·3	105	12
24·5	2·4	0·2	117	13

Reported differences in vitamin A values between average commercial east coast oil samples and average west coast samples have been confirmed. The west coast samples are twice as potent as the east and evidence has been obtained to explain the difference as being due to the preponderance of older fish on the west coast of Newfoundland. Whilst those west coast fish are older fish, they are not larger fish because they have a slower growth rate[1]. The average annual vitamin values of the oil samples may possibly fluctuate within narrow limits defined by the predominating year classes of commercial size fish, and this possibility will be investigated.

The conclusion can now be drawn that the relative value of the oils from different sources depends upon the growth rates and ages of the cod at those sources. Thus Graham[2] gives the age of a 78 cm. cod of the North Sea as five years. A 78 cm. cod of Grand Bank, Newfoundland is, according to Thompson, eight to nine years old, owing to a slower growth-rate. The liver oil therefore has, according to my work, a higher vitamin A concentration.

That large variations in vitamin concentration of the liver oils occur with fish feeding on the same grounds and obtaining the same food materials is now apparent. Also, variations in vitamin concentration over a period when the oil yield covers its limits do not attain magnitudes at all comparable with the differences attributable to age. Therefore the feeding conditions and oil content of the livers must play parts of minor significance in the variation in vitamin concentration. The major influence is the age of the fish.

In view of the small amounts of vitamin present in the food sources of the cod and the doubt of synthesis of vitamin A from carotene in the liver, it may be argued that the increasing concentration with age represents an accumulation due to effective retention by the liver of the small daily amounts ingested. If the corresponding increase in intensity of pigment represents vitamin precursor, this is probably a similar accumulated ingestion. As concentrated in the liver oil, vitamin A is presumably a storage product, not for immediate metabolic use, and there seems no apparent reason, apart from mass action effect, for cessation of synthesis of a storage product whilst the precursor is still available. Therefore, with regard to the problem of the reason for the relatively large stores of vitamin A in the liver of the cod, the present evidence points to ingestion of both carotene and vitamin, with effective retention and storage. The result is increasing accumulation of the vitamin with the years.

Complete details will be published later, as expeditiously as the comparative isolation here will allow.

N. L. MACPHERSON.
Biological Laboratory,
Newfoundland Fisheries Research Commission,
St. John's, Newfoundland.
May 10.

[1] H. Thompson, Reports of the Newfoundland Fishery Research Commission No. 4, Annual Report 1931.
[2] *Rapp. et Proc. Verb.*, **74**; 1931.

Chemical Test for Vitamin C, and the Reducing Substances Present in Tumour and Other Tissues

IN previous communications a method has been described for estimating the hexuronic (ascorbic) acid content of foodstuffs, based on titration in acid solution with the oxidation-reduction indicator 2-6-dichlorophenolindophenol after preliminary extraction with trichloracetic acid [1, 2, 3]. Judging from the fact that this method when applied to some forty common sources—mostly fruit and vegetable materials—enabled the 'minimal antiscorbutic doses' to be calculated to give results in excellent agreement with the values determined directly by biological tests, it is evident that the method has a considerable range of specificity. A number of necessary conditions and provisions were set out, which unfortunately there seems to have been some tendency to overlook, and it would appear advisable therefore to direct attention to certain considerations which must be borne in mind if the possibility of misleading conclusions is to be avoided.

As we have already pointed out[3], the reagent does not possess an *absolute* degree of specificity. Notably, free cystein (which may be present in stale or autolysed materials) was found to reduce it as readily as did the vitamin itself: this could easily be allowed for by a separate determination for cystein by the Sullivan method. Adrenalin also reduced the indicator, but much less intensely, so that in practice no ordinary natural source contains sufficient to interfere seriously. Products obtained by heating solutions of certain sugars, especially in alkaline media, tended to reduce the indicator; and we find that a number of proprietary baby foods and similar preparations give suspiciously high readings. Mr. A. L. Bacharach, of the Glaxo Research Laboratory, has titrated a series of specimens of malt-extracts by our method and found some of them to reduce the indicator strongly[4]. Among other materials of vegetable origin we found that the following also react appreciably with the indicator: yeast[3]; whole oats[3]; incubated pea mush[7]. Since these materials have not hitherto been regarded as sources of vitamin C, it would appear advisable to suspend judgment as to the precise nature of the reducing substance in such special cases until the biological tests, now in progress, are concluded.

Turning to the animal kingdom, it might have been anticipated that the specificity of the test would be less certain. Nevertheless we found that the suprarenal gland (not hitherto recognised as an antiscorbutic) was very potent, the biological activity agreeing with the value determined chemically; and the same is true, approximately at least, for liver. A systematic survey of various animal tissues, initiated in this laboratory by Messrs. Birch and Dann[6], showed that many of them gave very substantial titres, often accounting for a large fraction of the total iodine-reducing value, hitherto held to be a measure solely of the glutathione content. In the case of one of these materials, the aqueous humour of the eye, the very surprising indication of the presence of large amounts of vitamin C has already been confirmed biologically[7].

Another material giving a high iodine value and of very obvious interest in this connexion is tumour tissue. Dr. E. Boyland of the Cancer Hospital Research Laboratory approached us for details of our method to apply to tumours. We are indebted to him for permission to refer here to his results, which show that tumour tissues of various kinds likewise reduce the indicator[8]. Our own independent observations confirmed this finding, although our experiences were limited only to the Jensen rat sarcoma. This we find to give a very constant titre, equivalent in terms of hexuronic acid to 0·4 mgm. per gm. of wet

tissue. Biological tests have so far given somewhat inconclusive results as to whether the titre is due wholly to vitamin C. The freshly excised sarcoma (rendered available by the collaboration of Mrs. B. Holmes) was fed to a series of five guinea pigs in curative tests at the level of 3·5 gm. per day. If the indophenol titre were due *entirely* to vitamin C, 2·5 gm. per day would suffice as the minimal dose. However, the experimental animals receiving 3·5 gm. lost weight as rapidly and survived no longer than the negative controls, although at death the degree of scurvy appeared less severe. In such tests a complicating factor due to the possible toxic effect of relatively large amounts of animal tissue fed to a herbivorous species like the guinea pig has always to be borne in mind. Further assays by several alternative methods are in progress. In any case the presence in the tumour tissue of such high concentrations of an intensely reducing substance, hitherto unrecognised, seems of special significance, bearing in mind the distinctive character of the cell respiration of tumours. Furthermore, observations in another connexion with Dr. E. W. Fish seem to indicate that vitamin C is needed primarily for the maintenance of certain actively functioning cells, so that its apparent presence in tumour tissue seems additionally suggestive. It is proposed to investigate the effect of deprivation of vitamin C on tumour growth.

Returning to the question of the applicability of the chemical test, it may be concluded that, on all fours with the now well-known and extensively used antimony trichloride test for vitamin A, it furnishes a valuable if not absolutely infallible guide. Certainly for fruits and vegetables as ordinarily dealt with, the test seems to give perfectly reliable results without further elaboration; when unusual types of material are under investigation, the test must be used with due understanding.

Nutritional Laboratory, Cambridge.
June 20.

LESLIE J. HARRIS.

[1] T. W. Birch, L. J. Harris and S. N. Ray, NATURE, **131**, 273, Feb. 25, 1933.
[2] L. J. Harris and S. N. Ray, *Biochem. J.*, **27**, 303; 1933.
[3] T. W. Birch, L. J. Harris and S. N. Ray, *Biochem. J.*, **27**, 590; 1933.
[4] A. L. Bacharach, private communication.
[5] L. J. Harris and S. N. Ray, *Biochem. J.*, **26**, 2067; 1932.
[6] T. W. Birch and W. J. Dann, NATURE, **131**, 469, April 1, 1933.
[7] T. W. Birch and W. J. Dann, unpublished work.
[8] E. Boyland, private communication; *Biochem. J.*, in the press.

The Rise of the Himalaya

DURING the present Mount Everest Expedition, I have had the opportunity of travelling through the Central Himalaya and over part of the Tibetan plateau. The remarkable way in which certain rivers, for example, the Arun, rise in the Ladak Range about 20,000 ft. high, and then flow southwards through the considerably higher main range of the Himalaya, has been commented upon by H. H. Hayden, A. M. Heron, N. E. Odell and others; and the phenomenon has been explained either as the result of the cutting back by the rapid Himalayan torrents until they eventually captured east-to-west flowing Tibetan rivers, or as the result of the rise of the Himalaya subsequent to the establishment of the present drainage system. A method is here given which seems to make it possible to decide between these alternatives, and to distinguish two distinct phases in the formation of the Himalaya.

With the help of the existing maps, the average height of the Tibetan plateau to the north of Sikkim may be estimated as about 16,000 ft. In the part of Sikkim lying between lat. 27° 30′ N. and 28° 0′ N. (which includes Kangchenjunga 28,146 ft. and the Teesta valley, so low as 4,000 ft.), an estimation of the volume of the country lying above 15,500 ft. has shown that it equals the volume of the valleys below 15,500 ft. From the point of view, therefore, of the general isostatic conditions of the earth's crust, this region of High Himalaya is equivalent to the extension of the plateau of Tibet over the same area.

Some time ago, Fridtjof Nansen showed theoretically that the cutting of valleys in a plateau that is in isostatic adjustment will at first cause a rise in the general level of the district. The preliminary estimation given above suggests with considerable probability, that the rise of the Central Himalaya to its present height has been the result of rivers cutting their valleys into the edge of the Tibetan plateau, which formerly extended farther southward. There is ample evidence to show that the usual compressional mountain-building movements were responsible for the initial high plateau; but the further uplift giving the well-defined Himalayan range appears to have been a vertical uplift due to isostasy.

The close association of Mount Everest with the deeply cut gorges of the Arun River is thus probably no mere coincidence; the Everest group would seem to have risen to its present height after the establishment of the Arun River and as a direct result of the excavation of the Arun and adjacent valleys in an isostatically adjusted part of the earth's crust.

It would be of great value if a future expedition to this region could carry a light apparatus for the determination of gravity, and thus attempt to discover the extent to which this part of the crust is in isostatic adjustment.

L. R. WAGER
(University of Reading).

Mount Everest Expedition
Base Camp, Tibet.
April 25.

Solar Radiation and Planetary Atmospheres

I ADMIT that I have asserted too absolutely the principle that for a radiating planet fed by radiation from the sun, the relative change of equilibrium temperature (namely $\delta T/T$) of the planet is of about the same order as that of the sun which is its cause. This assumes that dynamical processes in a blanketing atmosphere overlying the planet are not in control. All such effects, whether upward or downward, are superficial: the annual variation of temperature is no longer sensible thirty feet underground: and an ice age lasting 10,000 years could not be felt at $\sqrt{}$ 10,000 times this depth, which is about half a mile. Astronomers see down to the surface features of the planet Mars, so that there cannot be much of an atmosphere, though I observe that Dr. Simpson[1] discovers a different reason in the low temperatures (ranging from 10° C. to −70° C.). On the other hand Venus, which is subject to radiation nearly twice as intense as the earth, is entirely covered with cloud, so that inhabitants below exist in a leaden atmosphere scarcely conscious of the sun: and if the cloudy shield presents a bright surface to the incident radiation, sending most

of it back and absorbing little, increased intensity of it might even conceivably diminish the temperature below by increasing the density of the shielding layer and so preventing more of it from penetrating. The Smithsonian pioneers have announced fluctuations up to one or two per cent in the solar radiation, while meteorologists seem to be disinclined to recognise any proportionate change in terrestrial temperatures. Their problem is thus to explore what are the special circumstances in the terrestrial atmosphere which lead to this result.

I am indebted to Dr. G. C. Simpson for the loan of his second memoir on this subject[2], which I have found most interesting and instructive. It is sufficient apology for my too brief communication that otherwise I would probably have never heard of it: such is the penalty that an observer interested in the general relations of things has to pay in this age of isolated domains of specialisation. The numerical data available for the earth enable Dr. Simpson to trace the steady exchanges of radiation in the atmosphere and strike a balance. If I understand aright, he finds the most potent item to be the reflection of the incident radiation by bands of cloudy condensation, which turn it back but do not absorb much, with as a result surface currents underneath carrying diminished temperature and increased precipitation of moisture. He considers that a sufficient increase of solar activity may actually be the cause of an ice age by intensifying these atmospheric currents, and recalls various other unexplained phenomena which may stand in relation thereto. Perhaps he would not press for complete acceptance of his views—which ought not to be hasty, for has he not given a rather long list of eminent investigators including himself whose previous theories are now to be condemned ?—but will be content with the judgment that no explorers in this domain of secular terrestrial climates can afford to neglect his discussion.

In attempting to paraphrase this interesting memoir, however, I have been deflected from noticing that Dr. Simpson's recent letter is mainly about a later memoir[3], in which he has even found himself encouraged to detect, in an actual doubling of the solar radiation within recent times, the necessary foundation of the pluvial periods and ice ages which geologists have been recognising in the Pleistocene period. This as he notes stands in flat contradiction with my remark that (but for the atmosphere) it would lead to unallowable rise of terrestrial temperature. It is mainly the fact that astronomers observe an actual mean temperature so low as $-25°$ C. for Venus notwithstanding the more intense incident radiation, that in my judgment conduces to an opinion that the question is an open one.

In this second memoir now to hand dealing with the urgent problem of recent Pleistocene climates, Dr. Simpson finds himself compelled to supplement variations of solar radiation by the Wegener doctrine of extensive flotation of the continents, with their recent strata already fully laid down, across the astronomically invariant poles of the earth's rotation. Certainly to account for the obvious non-destructive crumplings and elevations of the strata some process of movement strenuous yet simple is required. The descriptive analysis of Penck into two complex ice ages with a pluvial mild interval in the middle of each is favoured. Perhaps also it is natural to relieve any want of balance of the radiational exchanges by taking into account an item of convection and delivery of latent heat by rushing saturated currents of condensing vapour, which would provide significance for such pluvial periods wherever the currents could get established. In general contrast, one recalls the theory worked up by Prof. Joly, who puts forward decay of radium in the rocks as the source of a super-abundant supply of heat, based on the experimental estimates of R. J. Strutt and of himself, leading up by accumulation to periodic catastrophes without making any call on solar variability.

JOSEPH LARMOR.

Holywood, Co. Down.
June 9.

[1] NATURE, **131**, 875, June 17, 1933.
[2] "Further Studies in Terrestrial Radiation", *Mem. R. Met. Soc.*, **3**, July 1928.
[3] *Proc. R. S. Edin.*, 1930.

Wire Nests of Crows

THE nest illustrated in Fig. 1 was removed from one of the ends of the top horizontal framework of an electricity transmission tower near Colenso, Natal, in April, 1933. These towers are some thirty feet in height. The nest proper, consisting of branches, twigs and dried grass, was built in a stout wire basket, some twenty-three in. in diameter. The crows (pied crow, *Corvus scapulatus*, Daud.) picked up odd scraps of wire to form the basket, and they bent some of the pieces round the 2-in. angled iron of the tower in such a manner as to fix the nest very securely. The kinds of wire so used were: No. 8 hard-drawn copper; Nos. 8 and 6 galvanised iron; No. 14½ baling; No. 14 2-strand barb-wire. The total weight of the nest is 20 lb.

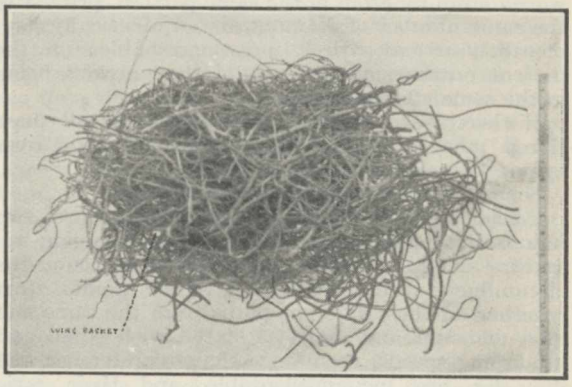

FIG. 1. Nest of pied crow set in a wire basketwork.

It is especially to be noted that wire is about the only thing which could have been used to attach the nest firmly to the iron framework of the tower, and the birds had the wonderful intelligence to utilise this artificial material for the purpose. The nest was, in fact, so securely attached to the iron bars of the tower that the greatest difficulty was experienced in removing it. Also, the mere manipulation of such heavy gauge wire by a bird is a surprising feat of strength.

If nest-building is the non-intelligent and purely instinctive action that some regard it, how is it that these crows definitely met a difficulty by utilising wire, since twigs and branches by themselves would

have been insufficient to wedge the nest securely on the narrow and open framework of the tower, and an artificial material like wire could not lie within the purview of instinctive action ?

It is stated that similar wire nests are frequently made by these crows on the transmission towers of the Orange Free State. Electrification of the railway line in that part of the Union is comparatively recent, and owing to the scarcity of trees the crows have taken a great liking to the towers and they have discovered that by using wire they are able to nest on them. However, the birds will have little opportunity to improve on their initial and successful attempt to utilise the towers to their own advantage, since the line-men invariably interfere with the nests.

ERNEST WARREN.

Natal Museum,
Pietermaritzburg.
May 10.

Does History Repeat Itself?

IT is sometimes stated[1] that, given a vast but finite number of particles and an infinity of time, history must needs repeat itself, so that all the particles will find themselves reassembled in some previous arrangement possessing the very same relative positions with the identical original velocities, so that cycle after cycle of similar events must necessarily recur, and history in the large is like the repeating pattern of a wall-paper.

If there is an infinite past duration it would then follow that I have written these words before, and the very you have read them, not once, but again and again in the past, by the same light that falls now upon the previously printed paper actually manufactured as before from the same material, woven atom by atom in the same pattern, printed in the same number of NATURE, dated identically day, month, year and entirely indistinguishable from the present number, all the rest of the universe being in the same state as before.

If there is an infinite future before us all these things must happen not once, but over and over again, without limit.

No one believes this, but is it true ?

Consider a simple universe consisting only of two infinitesimal particles or points, one swinging to-and-fro along a diameter, the other going round the circumference of a circle. If these points start together on their different paths from the same end of a diameter and move as stated with equal and unvarying speeds, then since the circumference and diameter are incommensurable, and their ratio $\pi = 3{\cdot}14159\ldots$ never repeats or terminates even in an infinity of figures, it follows that the two points will *never* meet again at their original starting point. Incommensurables such as the square root of 2, 3, etc., are also common enough in our pattern of Nature so that it is safe to reject the idea of recurrent cycles and to state definitely that history does not and can not repeat itself. So that creation, new things for old, is proceeding to its fullest extent now.

If it is urged that the above argument about two ideal infinitesimal particles racing round a circle and to and fro along a diameter (none of such things existing) is too academic and abstruse, it may be stated that if there is no limit to the smallness of a displacement, then any three bodies may occupy an infinitude of relative positions, which will not necessarily recur in an infinity of time. If the height of a wave is capable of all values, then the pattern of the waves on a lake or ocean will never repeat. Radiation in the universe, even in infinite time, is certainly yet more unlikely to recapture a previous state, even ignoring the tendency to 'run down' or change from short to longer waves.

Two swinging pendulums of unequal length will not twice achieve the adventure of being at their lowest points together, and my colleague, Dr. L. V. King, has pointed out to me that, even two equal pendulums (were such equality possible) starting together from their lowest points and acquiring unequal amplitudes, would never arrive together again at their lowest points. The same is true of two small round particles oscillating in a spherical bowl ; and the reason is that such problems involve transcendental numbers. But enough has been said to demolish what, after all, is only a bogey.

A. S. EVE.

McGill University,
Montreal.
May 20.

[1] NATURE, 131, 529, April 15, 1933, reviewing J. B. S. Haldane's "The Inequality of Man" (pp. 165–170).

Formation of Formaldehyde and Reducing Sugars from Organic Substances in Light

WE have observed that when aqueous solutions of tartaric, citric and lactic acids are exposed to direct sunlight in presence of air, formaldehyde and reducing sugars are produced.

A few observations are recorded below :

Time of exposure	100 c.c. of *N*/4 tartaric acid		100 c.c. of *N*/4 citric acid	
	Gm. of formaldehyde per 100 c.c.	Gm. of reducing sugar calculated as glucose	Gm. of formaldehyde per 100 c.c.	Gm. of reducing sugar calculated as glucose
10 hours	0·0001	0·0114	0·0111	nil
20 hours	0·0024	0·0153	0·0125	0·0060
30 hours	0·0008	0·0183	0·0093	0·0093

In the case of lactic acid, a solution containing 2·245 gm. in 100 c.c. when exposed to sunlight gave Schryver's test for formaldehyde after 6 hours' exposure but no reducing sugar could be detected in 20 hours. After 35 hours' exposure, the same solution yielded 0·0081 gm. of reducing sugar calculated as glucose.

It is interesting to note that glycine, malic acid, acetic acid and acetone solutions form formaldehyde very readily on photo-oxidation, but no reducing sugar has been obtained so far. Formaldehyde is also readily obtained when aqueous solutions of colouring matters like methylene blue, methyl violet, acridine orange, crystal violet, malachite green, gentian violet, etc., are exposed to light in presence of air. We are trying to find out if the antiseptic properties of some of these dyes are associated with the ease with which they yield formaldehyde on photo-oxidation.

N. R. DHAR.
L. N. BHARGAVA.

Chemical Laboratory,
University of Allahabad,
India.
April 22.

Research Items

The Aleut. Dr. Waldemar Jochelson, as the leader of the ethnographical section of the great Riaboushinsky Kamchatka-Aleutian Expedition, spent the years 1909–10 in the investigation of the archæology and ethnology of the Aleutian Islands. The results, submitted to the Russian Academy of Sciences in 1916, remained unpublished owing to the War, until 1925, when an archæological volume was published by the Carnegie Institution of Washington. Dr. Jochelson has now issued, through the Institution, a monograph (Publication No. 433) dealing with the history, ethnology and anthropology of the Aleut. The expedition secured seventy skulls, of which fifty were in a sufficiently good state of preservation for measurement. They showed an average cranial index of 82·1 with a standard deviation of 2·7 and individual range of 78–88. As these skulls were from pre-Russian graves, the conclusion is that the Aleut were not a pure race. Measurements by Mme. Jochelson of 138 living individuals gave a cephalic index of 84 with a standard deviation of 3·3 and individual range of 76–94; this, allowing two units, agreeing substantially with the skull measurement. Thus it would appear that contact with the Russians did not affect head measurement. Comparison with neighbouring Indians and Palæoasiatics shows the Aleut to be higher than all in comparative head breadth: for example, cephalic index of Alaskan and Siberian Eskimo, 79 and 80 respectively; Koryak, Kamchadals and Yukagir, 78, 79, 80 respectively; and Indians—Tlingit, Tshimshian, etc.—not more than 82. Two explanations are possible: either a mixture with Athapascans, some of whom are so high as 84, or the acquisition of a superbrachycephalic index after a period of isolation. The latter would be a modification comparable to that attributed by Boas to the physical characters of immigrants to America or those found recently in Russia as the result of a starvation diet.

Water-borne Enteric Fever: Enteric Carriers. The enteric (typhoid) fever outbreak at Malton, Yorkshire, in the closing months of last year, is the subject of a report by Dr. W. V. Shaw (Reps. on Pub. Health and Med. Subjects, No. 69. London: H.M. Stationery Office. 1*s*. 6*d*. net). The number of primary cases was 235, and the outbreak was traced to a patient suffering from enteric fever admitted to the public assistance institution at the end of September and remaining there for a month. This patient's infected excreta were drained into the river by a drain, afterwards found to be broken, which allowed part of the contents to soak into the surrounding soil and polluted the water supply. A small proportion of those who have recovered from an attack of enteric fever become permanent 'carriers'—fæcal or urinary—of the specific organism and constitute a danger to the community. The whole subject of enteric carriers and their treatment is exhaustively discussed in a recent report to the Medical Research Council by Prof. Browning and Drs. Coulthard, Cruickshank, Guthrie and Smith (Spec. Rep. Series, No. 179. (London: H.M. Stationery Office. 1*s*. 6*d*. net).

Nutritive Properties of Pasteurised Milk. A valuable review of existing knowledge on this subject has been compiled by Drs. Stirling and Blackwood and is issued by the Hannah Dairy Research Institute, Kirkhill, Ayr (Bull. No. 5. 4*s*. net, including postage). The inquiry is limited, so far as possible, to a consideration of the 'holding process' of pasteurisation, which consists in heating the milk to 62·5°–65·5° C. and maintaining it at this temperature for 30 minutes, after which it is cooled. Pasteurisation results in the coagulation and partial decomposition of a small amount of lactalbumin, a slight diminution in the soluble calcium and phosphate, some alteration in the rate of rennin curdling, and destruction of vitamin C. Nevertheless, the available evidence suggests that "infants can satisfy all their requirements on diets of adequate amounts of pasteurised milk provided that extra vitamin D, and, of course, vitamin C, are added to the diet". With these safeguards, there do not appear to be any grounds for the belief that pasteurised milk is a less valuable component of the diet for children than raw milk. A considerable bibliography of the subject is appended.

Prehistoric Birds in New Mexico. Cave deposits in the Pyramid Peak range in Dona Ana County, New Mexico, have yielded remains of fifty-eight species of birds. The deposits appear to belong to late Pleistocene or early Recent times, and were associated with the remains of extinct mammals, part being also found with human skeletal remains and evidences of the 'basket-maker' culture. In a summary account of their identifications (*Condor*, Jan. 1933, p. 15), Hildegarde Howard and Alden H. Miller point out that four species represented are now extinct, two being confined to cave deposits while the other two, a vulture and an eagle, were first found in the asphalt deposits of California. Of the species represented in the caves which are still living, several show extended distribution in prehistoric days. For the first time the sage hen appears in southern New Mexico, and the prairie chicken, plumed quail, magpie, caracara and California condor were more common in that area then than now. The occurrence of sixteen birds of prey, some of them large species best known from the Pleistocene asphalt pits of Rancho La Brea, suggests that in those times they were relatively abundant and that the Californian species formerly spread across the southern United States, so that the apparent absence of a rich falconiform fauna in the eastern States may merely be due to lack of suitable traps like the asphalt pits.

Inheritance of the Piebald Pattern in Horses. Piebald coat patterns are known in several domestic animals, and in cattle, sheep and rabbits the dominant and recessive types of piebald pattern are known to be different. Mr. V. Klemola (*J. Heredity*, **24**, No. 2) has made a study of these markings in horses. He finds a dominant type (dominant to self-colour) in which the white areas are mainly dorsal, on neck, shoulder, back and croup. The recessive type is somewhat complementary to this, the white areas being mainly ventral, with a more or less white head. For distinction, the recessive form is designated as splashed white. This is generally associated with wall eye, in which the external membrane of the iris is more or less extensively white. The nature of this association is not clear, but it may be allelomorphic to the splashed white pattern. In Clydesdales the wall eye may occur alone. The coat colour inheritance was traced from certain German and Finnish stallions.

The dominant type is common in oriental breeds and American prairie and pampas horses and in Shetland ponies, some of the latter being homozygous for it. The recessive type is found in the breeds of northern Europe.

Urino-Genital Organs of Cetacea. F. D. Ommaney has described in detail ("Discovery" Reports, 5, 363–466; 1932) the urino-genital system of the fin whale (*Balænoptera physalus*) based on the examination in South Georgia of four fœtuses—two males, 2·65 and 1·23 m. in length, and two females, 2·1 and 1·73 m. in length respectively. Among the primitive features in the female are:—the ovary, which lies free upon the broad ligament and is not enclosed in a peritoneal sac, is multilobular and there is complete absence of accessory glands. In the male the prostata is not strictly a prostate gland but a diffuse assemblage of urethral glands opening along the dorsum of the urinogenital canal; there are no Cowper's glands and no vesiculæ seminales, and the testes are intra-abdominal. While the genital system shows many primitive features which suggest affinity to some group near the insectivores, there are, nevertheless, reasons for comparing it with the corresponding system of the ungulates, especially of the perissodactyles. The vascular and nervous supplies to the genital organs are also described. Each kidney is a composite organ made up of a great number of small unipyramidal kidneys (renculi) grouped together in lobules of four to six renculi. These renculi drain into a main urinary duct running through the centre of the kidney. The number of renculi in the kidney of a female fin whale was estimated to be about six thousand.

Control of the Loganberry and Raspberry Beetle. The depredations of the beetle *Byturus tomentosus* cause much damage to crops of raspberries and loganberries. Several papers are devoted to the control of this pest in the *Journal of Pomology and Horticultural Science* (11, No. 1). "The Control of the Loganberry and Raspberry Beetle (*Byturus tomentosus*)" by H. G. H. Kearns and C. L. Walton (pp. 39–52) shows that a 0·25 per cent pyrethrum wash is inadequate as a control, but two applications of derris wash (0·004 per cent rotenone) killed almost all the larvæ. Dusting with derris powder could replace the first spray if the adult beetles are seen to cluster round the opening flower buds. A short note in the same *Journal* (pp. 77–80) by the authors mentioned above shows that a barium silicofluoride spray is quite effective in controlling the pest. Messrs. Kearns and Walton write from the Long Ashton Research Station. Mr. W. Steer has also attacked the same problem at the East Malling Research Station and the third of his "Studies on *Byturus tomentosus Fahr*" appears in the *Journal*. He reports control of the beetle by means of one spray with derris wash late in June. Two late applications of nicotine wash checked the pest on raspberries. Some very illuminating figures showing the cost of spraying are also given.

Geological History of the Black Sea. An important contribution to the difficult problem of the origin and history of the Black Sea, based on sea-floor investigations and studies of raised beaches, has been published by A. D. Archanguelsky and N. M. Strahov (*Bull. Soc. Nat. Moscou, sect. géol.*, 10, 1, 3–104; 1932). Operating from the S.S. *Pervoie Maia*, columns of sediments up to four metres in length were obtained. There is now no doubt that the Black Sea is of the nature of a *graben* with an area that has gradually increased in size by repeated peripheral faulting. The present abrupt 'cliff' that separates the littoral from the central depression is a recent product of post-glacial faulting, and during post-glacial time the shallow-water floor has itself subsided more than a hundred metres by slow movement. The authors believe that the central depression dates from the Miocene. The detection of characteristic fossils of the Pontian stage in the northern floor off the Crimea and the southern floor off Asia Minor is conclusive evidence that a basin existed in the early Pliocene. At the dawn of the Quaternary the area was occupied by a brackish-water basin with a fauna like that of the modern Caspian. A succession of upward and downward movements is traced, and the causes accounting for the periodical changes in salinity are discussed, and correlated tentatively with the various stages of glaciation and dependent isostatic movements of the crust.

Coal of the Northumberland Yard Seam. Paper No. 26 of the Survey of National Coal Resources (H.M. Stationery Office, 9*d*. net) reports carbonisation tests, at high and low temperatures, of the coal of the Northumberland Yard Seam. Their interest lies in the fact that this is a weakly coking coal of the lignitous section in Seyler's classification, not usually regarded as a gas coal. The results showed that neither in thermal yield nor quality of gas was the coal equal to a good Yorkshire gas coal, but that the carbonisation could be satisfactorily carried out, yielding a satisfactory coke. The low temperature coke was readily combustible in a domestic grate of conventional pattern. The results indicate that, with some monetary allowance for the lower thermal yield, the coal might be used in the industries concerned.

Distribution and Frequency of Earthquakes in Italy. Prof. A. Cavasino has made a valuable study of the seismicity of Italy during the forty years 1891–1930 (*Boll. Ital. Soc. Sism.*, 30, 195–216; 1932). The annual number of perceptible earthquakes varies from 143 to 1,294, the total number being 16,501 and the average yearly number 412. Deducting after-shocks, there remain 6,060 principal earthquakes. Of the stronger shocks, those of intensities 6–10 (Mercalli scale), the total number was 768 or about 19 a year. Thus, in Italy, an earthquake strong enough to cause some damage to buildings occurs on an average once every 19 days. During the year, earthquakes are most frequent in November, least in June. The greatest two-hourly number of shocks occurs from 2 to 4 A.M., but Prof. Cavasino regards this distribution as more apparent than real, for, taking earthquakes of intensities 6–10, the ratio of the nocturnal to the diurnal number is only 1·04. The principal seismic provinces (in decreasing order) are Sicily, Calabria, Tuscany, Emilia, Campania, Abruzzo and Molise, Venetia, Umbria, Latium, the Marches, Lombardy and the Basilicata; moderately seismic regions are Apulia, Piedmont and Liguria; no province is seismically weak, but in Sardinia, which is aseismic, only four slight earthquakes were felt during the forty years.

Bleaching and Improving of Flour. During recent years, many processes have been suggested for bleaching or 'improving' the flour and yeast used in bread-

making. Marked differences of opinion exist as to the desirability of permitting such treatment of flour, and it is held by some that a material of such importance and of such widespread consumption should not be subjected to any manipulation beyond what is necessary to convert it into a wholesome food. A reasoned discussion of this question was presented to the Reale Istituto Lombardo di Scienze e Lettere in December of last year (*Rendiconti*, vol. 65, parts 19–20) by Prof. Bertarelli, director of the Institute of Hygiene of the University of Pavia. Both chemical and physical methods of treating flour are considered in this communication and a useful and critical summary is given of the opinions expressed by different authorities and of the decrees regarding such treatments promulgated in various countries. Bertarelli finds that flour bleached by the electrical process contains nitrites corresponding usually with 0·1–0·2 gm., and at most with 0·5 gm., of sodium nitrite per 100 kgm. and considers that these quantities are far too small to constitute a danger to the consumer. The use of 'improvers' containing, for example, persulphates or peroxides, is also strongly defended.

Estimation of Bismuth in Copper. The estimation of small quantities of impurities in copper has assumed a new importance since the introduction of Customs duties on metals. The most important impurity in this respect is bismuth, and a memorandum has been received from the Fiscal Policy Sub-Committee of the Brass and Copper Industries, dealing with this question. The proportion of bismuth to be estimated does not exceed 0·020 per cent, and very much smaller proportions have sometimes to be considered. It is not certain that any method is in use which can be trusted for quantities less than 0·002 per cent, but this point is being investigated. The quantity of copper to be taken for the analysis is not stated in the memorandum, but apparently it is of the order of 10 gm. A colorimetric method is recommended, depending on the yellow colour produced when bismuth sulphate reacts with an excess of potassium iodide. A small addition of iron is recommended when the bismuth is being precipitated from the nitric acid solution by ammonia. The mixed hydroxides must be re-precipitated to remove copper, and each precipitation demands at least six hours to be complete. The hydroxides are dissolved in sulphuric acid, and brought to a slightly acid condition, the iron being then reduced to the ferrous state by sulphurous acid. The colorimetric comparison is made with a solution which has been carried through all the analytical operations, but to which no sample has been added. The standard solution should contain 0·001 gm. bismuth per c.c., and not more than 4 c.c. should be required to produce the match. The Committee bases these recommendations on the experience of competent analysts, but submits them for criticism. Suggestions as to the best analytical procedure should be sent to the Secretary, Mr. Lester Smith, c/o Squiers and Co., King's Court, 115 Colmore Row, Birmingham.

Astronomical Topics

Meteor of June 4. A brilliant meteor much brighter than the moon was observed in evening twilight on June 4 at $8^h\ 32^m$ G.M.T. Observations have been received from Hanwell, Surbiton, Rye, Arundel, Hindhead; and a satisfactory computation of the height and other details of the object has been made by Mr. A. King as follows: height 75 miles at appearance, 44 miles at disappearance; length of path 83 miles; speed 22 miles per second. The radiant was in Libra at 235° − 12°.

Photography of Faint Nebulæ. A useful paper on this subject has recently been published by K. Haidrich of Vienna (*Astr. Nach.* No. 5932–33). He discusses the nebular spectra, and the distribution of light at different wave-lengths and also the sensitivity of various kinds of photographic plates at these wave-lengths. Even the gaseous nebulæ are not all alike in their spectra; some give emission spectra, while others appear to derive their light by reflection from neighbouring stars, generally of type *B*. Then there are the obscure nebulæ, discussed by Father Hagen, the light of which is mainly red or yellow (some of the light is said to come from sodium). The spiral nebulæ give continuous spectra, resembling those of stars of types *G* and *K*. It is clear that no single process is suitable for the photography of all kinds of nebulæ, and that more than one method must be followed before it can be asserted that no nebulosity is present in a particular region. The tables given in the paper of the sensitivity of various kinds of plates at different wave-lengths should be of use to photographers.

Greenwich "Astrographic Catalogue", Vol. 6. This volume concludes the publication of the results obtained from photographs taken with the Greenwich astrographic equatorial during the last forty years. The earlier volumes gave the measured positions of the stars in the zone between Decl. 64° and the pole; a second series of plates was taken in order to give the means of obtaining the proper motions of the stars. The brighter stars had previously been observed on the meridian at Kasan or by Carrington at Redhill; for the fainter stars the motions are deduced by comparing the earlier Greenwich plates with the later ones. Owing to the shorter time-interval, an annual motion of 0·03″ has been taken as the minimum for the adoption of a proper motion for these stars. A diagram in the introduction shows the distribution of proper motions in different directions. It shows that the larger motions belong to Stream I; half the stars of this stream have motions greater than 0·05″, while the number in Stream II is less than a quarter.

Determinations of the solar apex were made; grouping the stars by spectral type, the R.A. of the apex is 257° for types *B*8, *B*9 and *A*0; it increases steadily as the type grows later, being 275° for *G*5 and *K*0. A general solution without regard to type, but limited to stars in the B.D., gave 272° for the R.A. of the apex. Stars with annual motion exceeding 0·2″ were not included in these investigations.

A list is given of the cases of two or more stars that appear to have common motion. There is one pair, separated by more than ten degrees, that have a large common motion of 1·1″; but a more certain case of connexion is that of a pair about 70′ apart with a motion of 0·66″.

Another list gives measures of stars separated by less than 30″; the differences of their motions are given, which in many cases makes it possible to decide whether they are physical or optical pairs.

Cost of German Scientific Periodicals

By DR. WILFRID BONSER, University Library, Birmingham

THE increasingly high cost of German medical and biological periodicals is causing the gravest concern to libraries both in Great Britain and in the United States. A letter by me on this subject appeared in NATURE of April 7, 1928 : the same arguments apply now as then, but the situation has become more acute, especially since the suspension in Great Britain of the gold standard. Not only have the prices continued to increase, but also the economic stringency, which has already been felt by learned institutions in Great Britain during the past year, will in all probability be still more severe during the next few years.

The amount of money which has to be expended in order to obtain the results of German research is totally disproportionate to that spent on the corresponding journals of any other country. The larger German journals are beyond the means of many institutions in Great Britain. The following table, printed in an American pamphlet, will demonstrate this :—

	American.	British.	German.
Journals costing 20.00–49.99 dollars	4	3	29
,, ,, 50.00–99.99 ,,	0	0	16
,, ,, 100.00 dollars and upward	0	0	6

Perhaps the most expensive journal of all is the *Zeitschrift für Anatomie und Entwicklungsgeschichte*, which is advertised as being published in four volumes a year at the price of about Rm. 175 each. This works out at present rates at £50 a year. Even then this journal is only *Abteilung* 1 of a larger journal.

From correspondence which I have had with the United States, it is clear that the breaking point has been reached there as well as in Great Britain. Appropriations there to State-supported institutions are made in many States for a two-year period, and the fact that the next appropriation is now due to be made indicates that, although American libraries have not been forced to reduce their subscriptions by more than twenty per cent at present, they will undoubtedly have to do so far more for the next two years.

It is said that the cost of German periodicals varies with the number of the subscribers. If this is so, it is obvious that the price will be increased from now on in proportion to the number of American libraries which will then be obliged to cancel their subscriptions. The deficiency will most certainly not be made up in the present crisis by an increase in the number of subscriptions in Great Britain.

In these circumstances, it is highly desirable that some accommodation should be reached with the German authors and publishers in order that the results of German research may still be available. A memorandum, issued by the Börsenverein der deutschen Buchhändler "in reply to numerous complaints", is by no means convincing. It is criticised in a most illuminating article by Dr. Georg Leyh, librarian of the University of Tübingen, which appeared in the May number of the *Zentralblatt für Bibliothekswesen* and shows a German librarian's point of view.

The difficulties may be summarised under the two headings (*a*) format and (*b*) contents.

(*a*) It is impossible for the librarian to estimate the annual cost in advance owing to (1) the fact that the number of volumes in which a journal is published each year often varies considerably ; (2) the practice of issuing monographs as *Ergänzungshefte* to, or as extra volumes of, important journals—often being included in their running number. An example of this is the *Archiv für Entwicklungsmechanik*, published by Julius Springer of Berlin. This is announced as appearing in about two volumes a year, the price of each being about Rm. 130. In 1927, in addition to the normal *Bde.* 109 and 110, two *Festschriften* appeared as *Bde.* 111 and 112, at the cost of Rm. 104 and Rm. 140 respectively. Such monographs and *Festschriften* should be issued as independent publications not connected with any journal.

(*b*) The publishers are being forced to realise, in view of the repeated complaints received from the United States, that it is necessary to reduce the bulk of their periodicals.

The notices issued to contributors to the *Zeitschrift für klinische Medizin* and to the *Deutsches Archiv für klinische Medizin* by the publisher (Julius Springer), show how this is to be done. The former notice declares that "the size and price of our periodicals have reached a height which menaces their spread and with it the prestige of German medicine". "Epic breadth accords not with science". The latter notice instructs contributors to practise the greatest brevity in future, "as is done in English writing and in German chemical writing". Extensive introductions containing historical matter will not be accepted. Very few case-histories can in future be printed in detail. Long wordy quotations are to be avoided, and references only are to be given. Articles which have appeared elsewhere will not be accepted. Coloured illustrations can only be included in exceptional cases. The editor is cutting out the less important articles.

It has been the practice in Germany to publish in journals dissertations which have already been printed and distributed by the universities. The *Zeitschrift für klinische Medizin* requires that they shall be "freed from historical and literary ballast" before being submitted.

If similar instructions are issued to contributors to all German journals and carried out systematically, the desired effect should be produced, since most of the British and American complaints with regard to the contents of the journals have been discussed above.

It is to be hoped that those institutions in Great Britain which are contemplating the cancelling of subscriptions will delay doing so in the hope that the Germans will accommodate them in this matter. A radical change of method is required, for by this means alone can German research continue to be available to English readers. The object of this article, apart from stating the position, is to ask readers of NATURE—who are scientific workers rather than librarians—to exercise their influence with their friends in Germany in order to ameliorate the position. If the German writer would be willing to publish only the essentials of his research, the bulk and consequent cost of the German journals could be reduced by a considerable percentage.

Plaice Fishery of the North Sea

THE fourth of a valuable series of post-War reports on the plaice stocks of the North Sea has recently been published by the Ministry of Agriculture and Fisheries.* The first (published in 1923) dealt with the effect of the partial closure to fishing due to hostilities—so far as it could be ascertained by two years of intensive work. It was found that the stock as a whole consisted of much larger fish than in pre-War years. This condition lasted but a short time after normal fishing activities were again resumed, and a second report, dealing with the investigations in the period 1921–23, recorded a marked falling off in abundance and size, though the fish had not by that time reached so small an average size as in pre-War days. Further work carried out in 1924 and 1925 formed the substance of a third report in which it was stated that the effects of the War were still being felt but that other important changes were also taking place. The information acquired was insufficient, however, for the purpose of separating the effect of natural fluctuations in the stocks from the effect of fishing. From 1926 onwards, therefore, the work carried out by the Ministry was increased in scope and magnitude with special reference to the solution of this problem.

The present report deals in a very comprehensive manner with the statistical and ichthyometrical data gleaned during the period 1926–30, and these are also compared and contrasted with those of the earlier years.

Considered as a whole, this report shows that the total quantity of plaice landed by British vessels has been declining slowly during the last five years.[1] Not only is this the case, but also the investigations dealing with market categories clearly indicate that 'smalls'—which normally account for about seventy per cent of the total landings and may consist of fair-sized fish—have also been steadily deteriorating in average size and now consist of really small fish of low economic value. While this falling off in size may not be unconnected with natural fluctuations, the combined results point to the conclusion that it must be attributed to ever-increasing intensity of fishing.

While the British fishery has decreased, however, the total landings of plaice from the North Sea by all countries has grown very much larger in the five years under consideration, the greater portion of this increase being credited to Denmark, with Holland and Germany sharing in it to a small extent. This change in the fish stocks is reflected in the constitution of the fishery. Whereas formerly the steam trawlers of Great Britain, Holland and Germany were the principal vessels engaged in catching plaice, their importance is now declining and their place taken to a considerable extent by Danish motor craft using seine nets and by German and Dutch coastal vessels.

The decline of steam trawling and the rise of the Danish seining industry is considered to be probably beneficial for the plaice stocks. In Denmark the demand is for living plaice. In consequence, a high size limit is imposed upon fish landed and, in consequence, undersized fish are spared for future capture. English and Dutch trawlers, on the other hand, destroy nearly all the undersized plaice they catch. In both England and Holland, too, a considerable industry is said to exist in supplying small fish to fish meal and fertiliser factories, whereby a very large number of plaice too small for human consumption are sacrificed. That the size of the plaice landed in all countries is decidedly small and tends to grow smaller, and that this is prejudicial to the interests of the fishing industry, is the main conclusion reached. The consumer also is shown to suffer, for experiments have been made which demonstrate conclusively that there is considerably 'less to eat' proportionately with decrease in the size of the fish.

The report under review is a notable contribution to the study of the plaice stocks in the North Sea, but the problems with which it deals cannot be said yet to be finally settled, and differences of opinion concerning them still remain. Dr. Buckman, of the State Biological Institute, Heligoland, is firmly of the opinion that the plaice stocks of the North Sea are being much more rationally fished to-day than they have ever been before, and holds tenaciously to the view that the present intensity of fishing has not, as yet, resulted in any serious general depletion of the plaice stocks as a whole. Other Continental workers are also inclined to this belief. Great as has been the work accomplished, therefore, there remains still much to do. We look forward with interest to the appearance of reports recording still further progress towards supplying answers to some of the many questions which remain as yet unanswered.

* Ministry of Agriculture and Fisheries. Fishery Investigations, Series 2, Vol. 12, No. 5, 1932. "Report on the English Plaice Investigations during the Years 1926 to 1930." By D. E. Thursby-Pelham. Pp. 149. (London: H.M. Stationery Office, 1932.) 6*s*. 6*d*. net.

[1] *Bulletin Statistique des Pêches Maritimes*, vol. 20.

Forestry in New Zealand

AS appears to be inevitable in times of economic stress, reductions were made in the research staff of the New Zealand State Forest Service as in other directions, and the Forest Biological Research Station at Nelson, New Zealand, was closed soon after its official opening. It is pleasing, however, to be able to read as reported in the annual report of the New Zealand State Forest Service for the year ending March 31, 1932 (W. A. G. Skinner, Govt. Printer, Wellington), that research work was continued on a restricted basis.

The total area of new plantations under the afforestation campaign exceeded 40,000 acres, the total area of State plantations being now approximately 348,000 acres, in addition to which there is a very large area of commercially-formed plantations in New Zealand. The milling industry naturally suffered from the depression and the volume cut was not more than half that exploited two years previously. The most interesting and important event in the local market was the increased domestic demand for exotic locally grown timber for use in the various box-making factories. With the large and increasing area now under exotic coniferous

plantations in New Zealand, it is scarcely surprising that the important question of disposing of the thinnings which it would be necessary to make in them has been receiving the most serious attention; and investigations have been carried out by utilisation research officers.

Apparently it is now hoped that the manufacture of the thinnings into boxes and crates will prove a promising industry. In this connexion, it is pointed out that whereas during the past year saw-mills operating in native bush were, on the average, cutting only up to 40 per cent of their normal output, mills working in exotic plantations were reported to be cutting beyond 60 per cent of their normal capacity. The saw-milling industry is also recognising the value of dry kilns, two new units being established during the year, one for drying box timber, whilst another for the same purpose was under construction. Timber trade-extension efforts, inaugurated during the year for Southland silver-beech (*Nothofagus Menziesii*), were so satisfactory that it was decided to send representatives to Great Britain to continue negotiations. Both in Australia and Great Britain this timber has been shown as promising for rifle-stocks.

It was estimated that the area planted in trees by private companies approached 250,000 acres, an increase for the year of 50,000 acres, whilst local bodies planted 6,500 acres, making the total under corporate control of approximately 27,500 acres. Thus the total area of commercial tree-plantations other than those established by the State Forest Service (which amount to 348,000 acres) is in the vicinity of 277,500 acres.

The area planted by the State fell off during the year, and says the report, "will probably decline still further for some years to come in accordance with Government policy to taper off the afforestation operations of the State". In view of the great commercial activity in this direction, the decision of the Government must be regarded as the correct one; since the policy of a Government should ever be avoidance of direct competition with commercial projects.

The first laboratory study undertaken by the Forest Service—an investigation into the fundamental physical and chemical properties of the indigenous timbers—has been completed after ten years' work. The results will be published shortly, and structural grades, together with working-stresses, developed for the principal species.

The most significant information in the report under review is to be found in the remarks on the exotic plantations. New Zealand has now 625,500 acres of these and the area increases yearly. It is difficult to estimate the important influence these will exert on the commercial development of the country in the future. Already they are being used extensively in the box-making industry for the export of New Zealand produce; "during the year over a million apple-cases were manufactured from insignis pine (*Pinus radiata*), several hundred thousand fruit-boxes for the Pacific Islands fruit trade, over one hundred thousand benzine-cases, and several hundred thousand cheese-crates, besides numerous other containers".

There is much in this annual report which merits study by officers in other parts of the Empire. The research work and experience gained in the utilisation of the thinnings from the exotic coniferous areas should prove invaluable to other growers of this type of plantation.

University and Educational Intelligence

CAMBRIDGE.—R. C. Evans, of Clare College, has been appointed University demonstrator in the Department of Mineralogy and Petrology.

Frank Smart prizes have been awarded to M. Ingram, Queens' College (botany) and G. C. Varley, Sidney Sussex College (zoology and comparative anatomy).

W. S. Bristowe, Gonville and Caius College, has been approved for the degree of Sc.D.

EDINBURGH.—Dr. D. O. Morgan, senior research assistant at the Institute of Agricultural Parasitology, St. Albans, has been appointed lecturer in helminthology in the University and in the Royal (Dick) Veterinary College.

WALES.—Dr. Ralph M. F. Picken, medical officer of health of the City of Cardiff, has been appointed Mansel Talbot professor of preventive medicine in the Welsh National School of Medicine, Cardiff, in succession to Prof. E. L. Collis, who is retiring. Dr. R. St. A. Heathcote has been appointed to the independent lectureship in materia medica and pharmacology.

Dr. John Robinson Airey, principal of the City of Leeds Training College since 1918, is retiring at the end of the present session. A well-known mathematician, Dr. Airey has, since 1912, been a member of the Committee on Calculation of Mathematical Tables, and was secretary to this Committee from 1918 until 1930. Dr. Airey's work was of prime importance in the development of aircraft during the War when his services were available at Farnborough. At present he is engaged on calculations for the British Association Committee on the Constitution of the Stars. Dr. Airey will be succeeded at the City of Leeds Training College by Prof. R. W. Rich, professor of education at University College, Hull, for the last three years.

TECHNICAL education in England and continental Europe was discussed on May 10 at a meeting of the Royal Society of Arts. Lord Eustace Percy was in the chair. The proceedings, reported in the Society's *Journal* of May 26, began with a paper by Mr. A. Abbott, formerly chief inspector, Technological Branch of the Board of Education, whose official report on his visits to France, Belgium, Czechoslovakia and Holland was recently noticed in these columns (NATURE, Dec. 24, 1932). Among other opinions to which his special qualifications lend exceptional weight are the following: the training in manual skill given in senior elementary schools has been of substantial value to British craftsmanship and should be increased in volume and enlarged so as to include a far wider range of materials and operations; we should continue to look to our schools of general education rather than to trade schools, as on the Continent, for the great bulk of our supply of skilled workmen; as regards the higher staff of industry, we should arrange for the release of young men during working hours for attendance at technical schools instead of relying on evening study; the leaders of industry, both employers and employed, should overhaul antiquated recruitment policies and readjust them to modern conditions, which have been transformed in the last thirty years by the wide extension of

secondary education and the recent institution of central, junior technical and junior commercial schools. The discussion which followed the reading of the paper brought out interesting points in relation to changes in the proportion of skilled workers in industry, changes in qualifications needed for success in industry, technology in the modern universities and the teaching of artistic crafts in trade schools.

Calendar of Nature Topics

'Dog Days'

July 3–August 11. The period of greatest heat in the summers of western Europe usually extends from early in July until about the middle of August. At the beginning of July the sea, which is slow to warm up, still keeps the temperature moderate, while towards the end of August the shorter days and smaller elevation of the sun begin to be noticeable. In the French Revolutionary Calendar of 1793, the period from July 19 until August 17 was the month "Thermidor". In Greek mythology the heliacal rising of Sirius, the Dog star, was associated with the coming of the dry, hot and sultry season, and the evil effects of this period on vegetation led to a belief in the baleful influence of Sirius on human affairs in general; the belief was adopted by the Romans and by them transmitted over the greater part of Europe. In England the weather of the 'dog days' is proverbially sultry and thundery. Towards the end of July especially, there have, in recent years, been a number of severe night thunderstorms in the neighbourhood of London.

A Parasite of Gorse and its Economic Possibilities

In July the pods of many gorse bushes (*Ulex europœus*) harbour in their heart an insect enemy which has just passed into the pupal stage preparatory to emerging as a weevil, *Apion ulicis*. During this month also the adults make their appearance, and although they do little damage to gorse bushes, the destruction caused by the larval stage within the pods affects seriously the fertility of the plants and their chances of spreading. Dr. W. Maldwyn Davies found that the numbers of pods infected, in samples taken throughout the length of Britain, varied from 0 per cent, which was rare, to 92 per cent, but 50 per cent infestation and above was common. The numbers of individuals in a pod varied from one to sixteen, the average being 4·6, and of 500 pods collected at Harpenden, 69·4 had their entire contents devoured by the larvæ (*Ann. App. Biol.*, 15, 263; 1928).

The point of the investigation lies far away in New Zealand. There Darwin observed gorse plants in 1835, and the introduction, like so many others, has proved disastrous. For in the intervening years gorse has so spread that it now covers large areas and threatens to make derelict some of New Zealand's most valuable pasture land. Could a parasite be discovered which would destroy New Zealand's unwanted gorse, as introduced cochineal insects are destroying Australia's prickly pear, a difficult problem would be solved. The weevil, *Apion ulicis*, so far satisfies the conditions that it has been found to destroy the fertility of the plant, while experiments have shown that it is unlikely to attack any other leguminous plant.

Some Problems of Birds' Eggs

The first clutches of eggs have long since hatched, and in many cases the young of the second clutch are now being fed by their parents, even in northern Scotland; the egg graph of the year is rapidly declining. This suggests that some problems should be stated before it fades out. Why is it that every full clutch of house-sparrow's eggs contains one egg which departs from the symmetry of the remainder, a longer rather narrower egg, often a little different in coloration? Is it that the muscles of the oviduct do not reach their standard tone until after a first egg has passed? Why is it that in some species the average number of eggs in a clutch seems to be different in different localities? What regulates the number of eggs in a clutch, for it seems to show a geographical relationship? This last problem has recently been investigated by Charles K. Averill (*Condor*, May, 1933, p. 93) and he finds that amongst North American passerine birds the small clutches, with a maximum of three eggs, are invariably of limited distribution in the south, south-west or west, although they do not differ particularly in size from their representatives in the north and east. Clutches of four to six eggs are laid by the majority of passerine birds, but none are Holarctic except about ten genera of long-winged boreal or arctic birds. Large clutches of seven to ten eggs belong to a group of very small woodland birds, Holarctic and of extensive distribution, although of feeble flight, chiefly the goldcrests, wrens, creepers, nuthatches and titmice. There are exceptions to these generalities, but they are generalities nevertheless.

Number of Eggs and Size of Bird

It may be said that birds of temperate zones lay more eggs than their representatives in the tropics. Chapman cites, among others, the sooty, bridled, and noddy terns of the tropics, which lay only one egg each, whereas the temperate species, arctic, roseate, and common terns, usually lay three. But the first group includes large birds, the second small; and as a rule the smaller birds lay the most eggs, and the eggs are smaller. Averill compares several species; the three to five eggs of the western grebe measure 2·50 in. × 1·54 in., the four to eight or six to nine of the pied-billed grebe, 1·72 in. × 1·17 in. The eggs of the large owls (great horned, barred, and great grey) measure about 2·16 in. × 1·7 in. and there are only two to four in a clutch, whereas the four to six clutches of the smaller species (for example, long-eared, and screech) measure 1·65 in. × 1·3 in. or less. The black swift lays one egg, the much smaller chimney swift four to six; in the genus *Sula*, the North Atlantic gannet lays one egg, the much smaller booby, a tropical bird, has two. As a rule, the larger bird in a group of similar habits and environment lays fewer eggs.

Perhaps the amount of food required is a factor regulating size of clutches, for the larger chick requires more parental attention during the nestling period, and there must be a limit to the number of mouths that can be fed. The limiting factor does not lie in the capacity of the bird to lay eggs, for in the case of a water-hen nesting on a pond in the Royal Botanic Gardens, Edinburgh, the regular removal of one egg from an incomplete clutch induced the bird to lay on until it had contributed about thirty eggs, in place of the normal number of seven to nine.

Societies and Academies

LONDON

Physical Society, May 19. W. F. FLOYD: Interference tones in superheterodyne receivers. The problem involves the reception of at least three signals, double detection, and a filter action between the two detectors. In the case of rectification by detectors with generalised characteristics, quantitative analysis is extremely complex. The form of the result, however, shows how large is the number of possible sources of interference tones. The specific case of square-law rectification is also considered. W. G. MARLEY: A method of measuring the specific heats of poor conductors. A brief review of existing methods of determining specific heats is given with reference to their suitability for poor conductors. The method of cooling, which has received scant attention in the past, is developed to afford an accurate and ready method. D. BROWN: The demonstration of eddy currents in conductors of various shapes. A method is described whereby it is possible to demonstrate visually the existence of eddy or Foucault currents in masses of conducting material, and the way in which the flow of the currents may be distorted or baffled by suitable slots or laminations. S. TOLANSKY: The absence of fine structure from the arc spectrum of silver. The arc spectrum of silver, produced in a water-cooled hollow-cathode discharge, has been examined for fine structure with a variable-gap silvered Fabry-Perot interferometer in the region 8300–4000 A. Results for the resonance lines at approximately 3300 A. are quoted also. Silver consists of two odd isotopes 107, 109, and although 5*s*, 6*s*, 7*s*, 5*p*, 6*p*, and 5*d* terms have been studied, no trace of fine structure has been found, in spite of very excessive over-exposing in many lines. All lines are extremely sharp and are worth considering as wave-length standards, being well distributed. Attention is directed to the fact that the analogous spectrum of CdII also shows no fine structure, so that it is concluded that the absence of structure is probably due to the electron configuration and not necessarily to smallness of the nuclear magnetic moment. This is remarkable, for penetrating *s* electrons are involved in some configurations. W. Y. CHANG and WILLIAM BAND: Thermomagnetic hysteresis in steel. The temperature variation of a new hysteresis of the thermomagnetic electromotive force in a steel wire is described. The hysteresis is of a negative or abnormal form with a maximum amplitude of about 2 microvolts between up and down branches. The accuracy of the apparatus and method is critically examined, and an error of more than 0·5 microvolt in any reading is considered to be unlikely. A qualitative explanation of the phenomenon is given.

PARIS

Academy of Sciences, May 15 (*C.R.*, 196, 1445–1552). HENRI LAGATU and LOUIS MAUME: The comparative composition of the dry material of homologous leaves of fruit-bearing branches and naturally sterile branches of the vine. P. BOUIN and W. BUCHHEIM: The action on the male sexual gland and on the sexual characters of a diet lacking in vitamin A. WILLEM DE SITTER was elected *Correspondant* for the Section of Astronomy in succession to the late A. VERSCHAFFEL. LÉON POMEY: Involutions of the third order. S. KIERST and E. SZPILRAJN: Certain singularities of uniform analytical functions. ADOLPHE LINDENBAUM: The superpositions of functions representable analytically. GEORGES VALIRON: A class of integral functions admitting two Borel directions of divergent order ρ. H. PAILLOUX: Percussions in wires. A. GAY: Permanent waves in a circular channel of any section. MICHEL LUNTZ and PAUL SCHWARZ: The movement of a viscous fluid round a cylinder in uniform rotation and the law of similitude. MAURICE ROGER: A new indicator of the angle of attack. A. ETÉVÉ: The automatic steering of aeroplanes. PIERRE BRÉMOND: The viscosity of gases at high temperatures. The viscosities of air and carbon dioxide were measured at varying temperatures up to 1134° C. and the results compared with those calculated from Sutherland's formula using a viscosity coefficient determined at low temperatures. Sutherland's formula was found to be applicable within the limits of the experimental error. JEAN-J. PLACINTEANU: The mass of the neutron. AUREL JONESCU: The fine structure of the absorption bands of sulphur dioxide in the ultra-violet. R. ZOUCKERMANN: The high-frequency spectrum of argon in the presence of mercury. C. BÉCHARD: The use of bimetallic anodes in the electrolytic synthesis of alloys. P. SAVEL: The radiations excited by the α-rays in fluorine. S. ROSENBLUM and P. CHEVALLIER: The direct measurement of the fine structure of the α-rays. P. LAFFITTE and H. PICARD: The temperatures of inflammation of mixtures of ammonia and air. With the ammonia varying from 8·9 to 57·4 per cent, the temperature of inflammation started at 960° C., fell to a minimum (917° C.–922° C.) with ammonia between 23 and 36 per cent and rose to 1002° C. The results are substantially higher throughout than those of Holm. F. BOURION and MLLE. O. HUN: The cryoscopic determination of the total hydration of the ions of sodium chloride. MLLE. SUZANNE VEIL: The star-shaped precipitation of strontium carbonate. Study of the Liesegang rings formed by the addition of a drop of strontium chloride solution to gelatine impregnated with potassium carbonate. MME. RAMART-LUCAS and RABATÉ: Structure of the heterosides by means of their absorption spectra. E. VELLINGER and G. RADULESCO: The photolysis of petrol produced by cracking. The amount of oxygen absorbed by petrol when exposed to the light from a mercury lamp serves as a measure of the tendency to gum formation. PAUL BAUD: The first French soda factories. From the historical summary given it would appear that Nicholas Leblanc set up the first factory for the large-scale production of soda from sea salt. G. ALLARD: The electronic structure of ethylenic carbon. H. HERLEMONT and J. DELABRE: An improvement of Carnot's method for the determination of fluorine. The silica used in this method is replaced by powdered 75 per cent ferrosilicon. Test analyses are given showing the increased accuracy obtained. GEORGES DENIGÈS: Cholesterol as a microchemical reagent for the acids of the acetic series. Cholesterol is shown to be a very useful microchemical reagent for the qualitative identification of the fatty acids and their halogen derivatives. E. M. BELLET: The decomposition of glycol diacetin by alcohol in weak alkaline solution. LÉON PALFRAY, SÉBASTIEN SABETAY and MARCU ROTBART: Some aldehydes with ether-oxide function. Study of the methods of preparation and purification of aldehydes

of the general formula $RO.CH_2.CHO$. MARCEL GODCHOT, MAX MOUSSERON and ROBERT GRANGER: The preparation of new active amino-cyclanols. FRÈREJACQUE: The acetylsulphate and acid sulphate of camphor. L. GLANGEAUD: The composition of the eruptive massif of Cavallo (province of Constantine). R. C. SABOT: A riebeckite-granulite and a detritic limestone rock from the Niari basin (French Congo). JEAN GOGUEL: The tectonic rôle of the conglomerates of Valensole (Basses-Alpes). A. AMSTUTZ: The tectonic of Mayombe, in the French Congo. J. DUCLAUX: Measurements of the absorption coefficients of the atmosphere. The absorption coefficients were deduced from the brightness of distant objects measured by photographic photometry. ROBERT LEMESLE: The existence of water-bearing tracheids in *Calligonum*. HENRI COUPIN: The assimilation of the glycides by pollen tubes. V. HASENFRATZ: The presence of an alkaloid not containing oxygen in *Gelsemium sempervirens*. Sempervirine (Stevenson and Sayre, T. Q. Chou), contains no oxygen and has the composition $C_{19}H_{16}N_2+H_2O$. The nitrate is nearly insoluble in water. ARMAND DEHORNE: The long pygidial filament of *Sigalion Mathildæ*. Comparison with the caudal tendril of some Heteronemertians and the filiform prolongation of certain heteropod gasteropods. RAOUL HUSSON: Reaction of the pharyngeal resonator on the vibration of the vocal chords during phonation. JEAN SAIDMAN: The visibility of the ultra-violet up to the wave-length 3130 A. Description of a special filter with a transmission band extending from 3130 to 2800 A.; 72 persons out of 102 described the appearance of the mercury arc as seen through the screen. Hence it would appear that the crystalline lens is not so opaque to the ultra-violet as has been supposed. The opacity of the lens to ultra-violet light increases with age. J. BASSET, M. LISBONNE and M. A. MACHEBŒUF: The action of ultra pressures on the pancreatic juice. B. GOUZON: The production of urobilin by the action of ultra-violet rays on chlorophyll and the porphyrins. Irradiation by ultra-violet rays of solutions of chlorophyll and of hæmatoporphyrin give a disintegration product presenting all the spectroscopic characteristics and chemical reactions of urobilin. HARRY PLOTZ: The curve of evolution of a culture of the virus of bird plague. G. FLEURY: The coli bacillus in marine mammals. Four specimens of porpoise were examined and found to contain no *B. coli*. As this bacillus is regarded as a constant saprophyte of the mammal intestine, this exception is noteworthy. M. and MME. ANDRÉ PUPIER and RENÉ PRIEUR: New facts showing the effects of thermal action on the bulb. C. IONESCO-MIHAESTI, A. TUPA, B. WISNER and G. BADENSKI: Tabetic anatomo-clinical syndrome following the intraperitoneal inoculation of lympho-granulomatous virus (Nicolas Favre disease).

CAPE TOWN

Royal Society of South Africa, March 15. C. VON BONDE: The class Enteropneusta, with special reference to the South African species. J. P. T. VILJOEN and B. F. J. SCHONLAND: The distribution of the ionising particles of the penetrating radiation with respect to the magnetic meridian. An investigation by a coincidence counter of the direction of arrival of the ionising particles associated with the penetrating radiation has been made at sea-level in Cape Town (mag. lat. 31° S.). It is concluded that any charged particles of extra-terrestrial origin are accompanied by a larger number of secondary particles generated in the atmosphere by some radiation which is not affected by the earth's magnetic field. The north east difference suggests that the majority of the primary particles are positively charged. T. F. DREYER: Middle Stone Age industries near Bloemfontein.

CRACOW

Polish Academy of Science and Letters, March 7. ARK. PIEKARA: Dielectric polarisation (1). The polarisation of benzene, carbon disulphide, hexane and nitrobenzene. The polarisation of benzene decreases as the temperature falls but increases in the neighbourhood of the solidifying point. The polarisation of hexane and of carbon disulphide increases as the temperature rises but the increase is much less rapid than with benzene. W. SWIETOSLAWSKI: The classification of zeotropic and azeotropic mixtures. K. DZIEWOŃSKI, J. MOSZEW, T. CHECHLIŃSKI and MLLE. I. PIETRZYKOWSKA: A new method of synthesis of compounds derived from quinoline (4).

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, **19**, 209–275, Feb. 15). WILLARD J. FISHER: The Newton-Denning method for computing meteor paths with a celestial globe. A combination of Newton's and Denning's methods for the case of two observers only. DORRIT HOFFLEIT: A study of meteor light curves. Selected simple meteor trails fall into two groups. The greater the velocity of the meteor, the nearer is the point of maximum brightness to the vanishing point. JOEL STEBBINS: Absorption and space reddening in the galaxy as shown by the colours of globular clusters. Photometric studies with a photoelectric cell of the globular clusters indicates a reddening in low galactic latitudes. Assuming absorption by a thin homogeneous layer near the plane of the galaxy as producing the differential colour effect, it is concluded that some of the clusters in low latitudes are at a distance only one-fourth of that generally supposed. SOPHIA A. GOULD, RAYMOND PEARL, THOMAS I. EDWARDS and JOHN R. MINER: Available food, relative growth and duration of life in seedlings of *Cucumis melo*. Seeds of approximately the same weight were sterilised and different amounts of the cotyledons were cut away; the seeds were incubated in darkness. In no case is a measured character of the seedling proportional to the amount of cotyledon left intact. The duration of life is relatively prolonged over expectation, the proportion of roots to hypocotyl is higher, and the period of most rapid growth is more advanced the more drastic the preliminary operation. ROBERT K. NABOURS and W. R. B. ROBERTSON: An X-ray induced chromosomal translocation in *Apotettix eurycephalus* Hancock (grouse locusts). RICHARD V. HUGHES: The geology of the Beartooth Mountain front in Park County, Wyoming. A discussion, with sections, a map and references to the literature. R. E. A. C. PALEY and N. WIENER. Characters of Abelian groups. EDWARD KASNER: Geometry of the heat equation. (2) The three degenerate types of Laplace, Poisson and Helmholtz. M. BIOT: Theory of elastic systems vibrating under transient impulse with an application to earthquake-proof buildings. JESSE DOUGLAS: A Jordan space curve which bounds no finite simply connected area. R. E. A. C. PALEY: On lacunary power series. J. W. ALEXANDER: A matrix knot invariant.

Forthcoming Events

Tuesday, July 4

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—(Special Meeting). Prof. Peter H. Buck: "Polynesian Voyages".

INTERNATIONAL CONFERENCE OF SHEEP BREEDERS, July 3 (at Derby).—Major T. Dalling: "A Consideration of some Sheep Diseases, their Prevention and Treatment".

IMPERIAL SOCIAL HYGIENE CONGRESS, July 3–7.—Sixth Congress to be held at the London School of Hygiene and Tropical Medicine. President: Sir Basil Blackett.

MUSEUMS ASSOCIATION, July 3–7.—Annual Conference to be held at Norwich. President: Sir Henry Miers.

Official Publications Received

GREAT BRITAIN AND IRELAND

Report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich, read at the Annual Visitation of the Royal Observatory, 1933 June 3. Pp. 18. (Greenwich.)

Empire Marketing Board, May 1932 to May 1933. (E.M.B. 63.) Pp. 127. (London: H.M. Stationery Office.) 1*s*. net.

Journal of the Society of Glass Technology. Edited by Prof. W. E. S. Turner. Vol. 17, No. 65, March. Pp. x+34+92+132+xxiv. (Sheffield.) 10*s*. 6*d*.

Imperial Institute. Annual Report 1932, by the Director, Lieut.-General Sir William Furse, to the Board of Governors. Pp. 54. (London: Imperial Institute.) 2*s*.

City and University of Birmingham: Joint Board of Research for Mental Disease. Annual Report, 1932–1933. Pp. 15. (Birmingham.)

Stonyhurst College Observatory. Results of Geophysical and Solar Observations, 1932; with Report and Notes of the Director, the Rev. J. P. Rowland. Pp. xx+43. (Blackburn.)

A Guide to Instructional and Educational Films, available for use by Educational and Social Organisations in Great Britain. Pp. vi+184. (London: The Central Information Bureau for Educational Films.) 3*s*. 6*d*.

Society of Chemical Industry: Chemical Engineering Group. Proceedings, Vol. 13, 1931. Pp. 177. 10*s*. 6*d*. Proceedings, Vol. 14, 1932. Pp. 183. 10*s*. 6*d*. (London: Chemical Engineering Group.)

Transactions of the Royal Society of Edinburgh. Vol. 57, Part 3, No. 24: The Late-Glacial Readvance Moraines of the Highland Border West of the River Tay. By Dr. J. B. Simpson. Pp. 633–646+3 plates. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 3*s*.

Air Ministry: Aeronautical Research Committee: Notes and Memoranda. No. 1503 (I.C.E. 804, 882): Surging in Centrifugal Superchargers. By G. V. Brooke. Pp. 43+28 plates. 2*s*. 6*d*. net. No. 1504 (T.3293): Tests on a Bristol Bulldog fitted with a Thin Townend Ring. By W. G. A. Perring. Pp. 18+5 plates. 1*s*. net. (London: H.M. Stationery Office.)

Proceedings of the Royal Society. Series A, Vol. 140, No. A842, June 1. Pp. 483–744. (London: Harrison and Sons, Ltd.) 13*s*.

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 72, No. 438, June. Pp. 461–556+xviii. (London: E. and F. N. Spon, Ltd.) 10*s*. 6*d*.

Memoirs and Proceedings of the Manchester Literary and Philosophical Society, 1931–32. Vol. 76. Pp. iv+122+liii+8 plates. (Manchester.) 10*s*.

OTHER COUNTRIES

Japanese Journal of Astronomy and Geophysics. Transactions and Abstracts, Vol. 10, No. 3. Pp. ii+305–367+29–40. (Tokyo: National Research Council of Japan.)

Tanganyika Territory: Geological Survey Department. Bulletin No. 4: Limestone Deposits of Tanganyika Territory, with a Description of the Commercial Uses of Limestone and Lime, and Brief Notes upon the Occurrences of Gypsum and Magnesite. By Frank Oates. Pp. iii+120. (Dar es Salaam: Government Printer.) 5*s*.

Cornell University: Agricultural Experiment Station. Bulletin 545: Retail Prices of Fertilizer Materials and Mixed Fertilizers. By E. E. Vial. Pp. 157. Bulletin 551: Economic Studies of Dairy Farming in New York. 10: 141 Farms in the Tully-Homer Area, Crop Year 1926. By E. G. Misner. Pp. 105. Bulletin 553: Studies of Potato Storage. By Ora Smith. Pp. 57. Memoir 145: Relation of Hydrogen-Ion Concentration to the Growth of Onions. By A. L. Wilson. Pp. 59. Memoir 146: The Buffer Capacity of Peat Soils. By B. D. Wilson and M. J. Plice. Pp. 11. (Ithaca, N.Y.)

U.S. Department of the Interior: Geological Survey. Water-Supply Paper 713: Surface Water Supply of the United States, 1931. Part 3: Ohio River Basin. Pp. ix+346. 20 cents. Water-Supply Paper 716: Surface Water Supply of the United States, 1931. Part 6: Missouri River Basin. Pp. x+347. 20 cents. Water-Supply Paper 722: Surface Water Supply of the United States, 1931. Part 12: North Pacific Slope Drainage Basins. A: Pacific Slope Basins in Washington and Upper Columbia River Basins. Pp. vii+188. 15 cents. Water-Supply Paper 724: Surface Water Supply of the United States, 1931. Part 12: North Pacific Slope Drainage Basins. C: Pacific Slope Basins in Oregon and Lower Columbia River Basin. Pp. vi+166. 15 cents. Water-Supply Paper 725: Surface Water Supply of Hawaii, July 1, 1930, to June 30, 1931. Pp. iv+99. 10 cents. (Washington, D.C.: Government Printing Office.)

Memoirs of the Faculty of Science and Agriculture, Taihoku Imperial University. Vol. 5, No. 7, Mathematics No. 4: Über Fläche und Kurven (II), von Sôji Matsumura; Beiträge zur Geometrie der Kreise und Kugeln (III), von Sôji Matsumura; Beiträge zur Geometrie der Kreise und Kugeln (IV), von Sôji Matsumura. Pp. 207–285. (Tokyo: Maruzen Co., Ltd.)

Spisy vydávané Přírodovědeckou Fakultou Masarykovy University (Publications de la Faculté des Sciences du l'Université Masaryk). Čis. 159: Ústní orgán, hltan, septalní, žlázy a sympatická nervová soustava roupic (Sur la structure de l'organe buccal, du pharynx, des glandes septales et des nerfs sympathiques chez les Enchytréides). Napsal Dr. Sergěj Hrabě. Pp. 39. Čis. 160: Příspěvek ke studiu cis-trans-isomerie solí typu $MeX_2.2A$. (Ein Beitrag zum Studium der Cis-Trans-Isomerie der Salze vom Typus $MeX_2.2A$.) Napsali J. V. Dubský a V. Dostál. Pp. 20. Čis. 161: Příspěvek ke studiu acetato-sloučenin kovů alkalických zemin (A Contribution to the Study of Acetato-Compounds of the Alkaline Earth Metals). Napsali J. V. Dubský a J. Trtílek. Pp. 30. Čis. 162: Mineralogické zprávy; 1: Beryl ze Spitzkoppje v pohoří Erongo v jz. Africe; 2: Křištál z Hot Springs v Arkansasu; 3: Ptilolith od Ždárku u Hodkovic v sev. Čechách (Rapports minéralogiques; 1: Le béryl de Spitzkoppje aux montagnes d'Erongo (Afrique Sud-Occidentale); 2: Le quartz de Hot Springs en Arkansas; 3: La ptilolite de Ždárek près de Hodkovice en Bohême-norde.) Napsala B. Bobková. Pp. 20+1 plate. Čis. 163: Trois théorèmes sur la limite des transformations itérées. Par Miroslav Konečný. Pp. 19. Čis. 164: Isanomaly thermické kontinentality a thermodromického kvocientu v Československu (Isanomales de la continentalité thermique et du quotient thermodromique en Tchécoslovaquie). Napsal B. Hrudička. Pp. 19+2 plates. Čis. 165: Recherches sur la courbure des surfaces dans des espaces à n dimensions à courbure constante I. Par O. Borůvka. Pp. 22. Čis. 166: Příspěvky ku mineralogii ČSR (Beiträge zur mineralogie du ČSR). Napsal Dr. Jaroslav Kotka. Pp. 15. Čis. 167: Dolní Svratka; Studie Paleopotamologická (La Svratka inferièure: Étude paléopotamologique). Napsal Fr. Říkovský. Pp. 28. Čis. 168: O komplexu os rotačních cyklid třetího stupně (Sur le complexe formé par les cyclides du troisième degré). Napsal J. Kabele. Pp. 15. Čis. 169: On the Bodily Difference between Sprinters and Non-Sportsmen (A Study of 100 Students from different Grammar Schools in Brno). By Dr. R. Malafa. Pp. 11. Čis. 170: Generis Trigonella L. revisio critica, VI. Scripsit G. Širjaev. Pp. 37. Čis. 171: Příspěvek k theorii Brownova pohybu (Contribution à la théorie du mouvement Brownien). Napsal Jan Potoček. Pp. 16. Čis. 172: O rozpadu statistických souborů (Sur la desagrégation d'un groupe statistique). Napsal Dr. Otomar Pankraz. Pp. 10. Čis. 173: Příspěvek k petrografii okoli Mor. Budějovic (Ein Beitrag zur Petrographie der Umgebung von Mor. Budějovice). Napsal Lad. Švábenský. Pp. 29. (Brno: A. Píša.)

Spisy Lékařské Fakulty, Masarykovy University (Publications de la Faculté de Médicine). Svazek 12, Spis 115–124. Pp. iii+9+36+22+58+4+4+40+35+9+54. (Brno: A. Píša.) 40 kč.

Zprávy komise na přírodovědecky výzkum Moravy a Slezska. Oddělení botanické, Čis. 10: "Vodní květ" a plankton na Lednicku v letech 1930 a 1931. Napsal Jindř. Zapletálek. Pp. 22. (Brně: A. Píša.)

Suomen Geodeettisen Laitoksen Julkaisuja: Veröffentlichungen des Finnischen Geodätischen Institutes. No. 18: Beobachtungsergebnisse. 1: Die Winkelmessungen an dem Hauptnetze; 2: Die Grundlinie in Ilmajoki und ihr Vergrösserungsnetz; 3: Astronomische Azimutbestimmungen an den Dreieckspunkten 1926–31; 4: Astronomische Längen- und Breitenbestimmungen im Jahre 1931. Pp. iii+240. (Helsinki.)

Bulletin de l'Association des Diplômés de Microbiologie de la Faculté de Pharmacie de Nancy. No. 5, Décembre 1932. Pp. 32. Conférence faite au Laboratoire de Microbiologie de la Faculté de Pharmacie de Nancy. Fascicule 5. Pp. 14. Travaux du Laboratoire de Microbiologie de la Faculté de Pharmacie de Nancy. Fascicule 5, 1932. Pp. 204+7 plates. (Nancy.)

Carnegie Institution of Washington. Catalogue of Publications. Pp. xlii+129. (Washington, D.C.: Carnegie Institution.)

U.S. Department of Commerce: Bureau of Standards. Bureau of Standards Journal of Research. Vol. 10, No. 5, May, Research Papers Nos. 549–560. Pp. 575–704. (Washington, D.C.: Government Printing Office.) 25 cents.

Canada: Department of Mines: Mines Branch. A Method for Rating the Grindability or Pulverizability of Coal, developed by the Fuel Research Laboratories (F.R.L.), Department of Mines, Canada (Correlated with the "Cross" and "Hardgrove" Methods). By C. E. Baltzer and H. P. Hudson. (No. 737–1.) Pp. v+17+1 plate. (Ottawa: J. O. Patenaude.)

CATALOGUES

A Catalogue of Books on Zoology and Geology. (No. 475.) Pp. 160. (London: Bernard Quaritch, Ltd.)

Water Level Alarm and Control, "Noflote" System. (List No. 173.) Pp. 2. The Evershed Electrical Water Level Indicator, Automatic "Plumb-Bob" System. (List No. 172.) Pp. 2. (London: Evershed and Vignoles, Ltd.)

Sotheran's Price Current of Literature. No. 837: Catalogue of Second-hand Works on Meteorology, Geology, Mineralogy, etc.; with a Supplement of rare and valuable Works on Mathematics, Astronomy, Physics and Chemistry. Pp. 124. (London: Henry Sotheran, Ltd.)

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