NATURE

SATURDAY, AUGUST 7, 1926.

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

The State and Science.

IN electing the Heir to the Throne to fill its highest office, the British Association has honoured both science and itself. Since the Prince Consort filled this position in 1859, no member of the Royal Family has presided at its functions, and in succeeding his great-grandfather, H.R.H. the Prince of Wales has followed worthily in the footsteps of one who revealed an extraordinary insight into the possibilities of science, and initiated proposals that have led not only to the wide dissemination of scientific knowledge, but also to the harmonious co-operation of Science and the State.

The British Association has long been regarded as the mother of scientific parliaments, among the most important duties of which is that of bringing home to our people the significance and value of science to human life. No more effective spokesman could have been chosen than His Royal Highness, who, by virtue of his great experience as a traveller and interest in world-affairs, and of his immense popularity among all classes of the population, is pre-eminently qualified to convey the message of science to the nation and to the Empire. The onlooker, he says, sees a great deal of the game, and his experiences of things military and naval, his contacts with industry, education, public health, land-settlement, agriculture, transport, and housing, have convinced him that the future of civilisation lies "along a road of which the foundations have been laid by scientific thought and research." He has also come to realise that the future solution of practically all our industrial and social difficulties will only be found by scientific methods.

However divergent men's views may be on the course of human progress, whether it is rectilinear, or gyratory with frequent interruptions (like the recent traffic in Piccadilly Circus), the most pessimistic will admit that the thoughts, interests and achievements of men have appreciably expanded within modern times, and that this development has been attended by a noticeable growth in the spirit of toleration. Our universities are now open to all classes, creeds, and nationalities; the social 'cat' can not only look at the social 'king,' but rub shoulders with him on the playing field and at charitable functions; we no longer consign to the stake those who practise the profession of necromancy, or to the gallows those who unlawfully prey upon their fellow-citizens: instead, we give them 'space' in our popular newspapers, and leave them to the verdict of 'time.' This unfolding of the spirit of toleration is especially marked in the attitude of conservative interests towards science, and the Prince is very happy in his allusion to the Oxford Meeting of the British Association in 1832, when there was strong opposition to conferring honorary degrees on such distinguished men of science as Brewster, Robert Brown, Dalton, and Faraday, whom Keble stigmatised as a "hodge-podge of philosophers"; and in his reference to the memorable meeting in 1860 when Bishop Wilberforce, at his famous encounter with Huxley, displayed an attitude of mind toward science that is rarely found nowadays, although, as Tennessee has taught us, it is not yet quite extinct. Such times are happily past, and even our most ancient and orthodox institutions are doing their best to march to the syncopated strains of modern civilisation. We must not, however, forget that feeling of 'dumb hostility' toward science and its works, referred to by Prof. Lamb in his presidential address last year, and again by the Prince on the present occasion; or the even more blighting feeling of apathy which still stalks in the land. Both these negative forces are the consequences of that ignorance and lack of imagination which instigated Voltaire to remark that although we had a hundred different religions, we had only one way of cooking a potato.

The history of the relations between science and the State in Great Britain, which is one of the principal themes of the presidential address, was sketched with a masterly hand, and nothing in it is more remarkable than the long period of delay—more than eighty years—which elapsed between the conception of a State department of science and its realisation when the Department of Scientific and Industrial Research was established during the late War. The time-lag between thinking and doing is ascribed by the Prince to lack of prevision of successive Governments, and to mutual distrust between science and the State; to these causes we would add ignorance of science and its methods, and the conservative attitude of the governing classes toward any disciplines which might compete with the study of the humanities and with orthodox religion. Many of us can well remember the bitter controversies which took place during the latter part of the last century between the respective champions of individualism and collectivism, and whilst the contention of the former that the genius of our people is ill-adapted to wholesale measures of nationalisation or widespread State control, is still held by the majority, it is evident that the ultra-individualism advocated by J. S. Mill, Herbert Spencer, and others is equally unsuitable as a practical creed. At any rate, time has largely solved the problem by the parliamentary method of compromise, and if we are not 'all socialists now,' we recognise that in certain matters affecting the welfare, and even the existence of our people, there is a legitimate field of State intervention; not necessarily for the purpose of assuming control, but rather for that of rendering assistance and giving advice.

Opinions will, of course, vary concerning the nature and extent of the fields into which the State can usefully penetrate. Those leaders of modern thought who are not obsessed by the mechanical and material aspects of Western civilisation, conceive progress to lie in a sense of values, and the majority of them admit that the cultivation of science, the broad and imaginative outlook which that cultivation engenders, and the application of scientific discoveries to human ends, are among the things that really matter to-day. Security in time of war, industrial progress in time of peace, education and national health at all times, cannot be left entirely to individual effort and initiative; and the only question that arises is the nature and range of the help which the State should give. In this connexion, the views recently expressed by the Earl of Balfour to the Society of Chemical Industry, which are evidently the views of the Department of Scientific and Industrial Research, over which he presides, are of interest. Apart from allocating grants to universities and the Royal Society, Lord Balfour holds that the State should not concern itself directly with promoting or assisting fundamental research work. Nor should it travel to the other end of the scale by finding capital for building factories and acquiring markets. Its legitimate sphere lies in helping to bridge the gap between laboratory experimentation and full-scale industrial operation, and in maintaining institutions like the National Physical Laboratory and the Fuel Research Station which, among other duties, pursue investigations of fundamental problems that are common to many industries, and therefore of great national importance.

In the recent attitude of the State toward science, the Prince discerns "a definite step in human progress," which is both novel and teeming with possibilities for Great Britain, the Empire, and the relations subsisting between them. Few, if any, of us know as much about the conditions in, and the needs of, our great overseas dominions as does the Prince; and none can speak with greater prestige. His remarks on the importance of extending knowledge of our overseas territories, on the value of co-ordinating the results of research work throughout the Empire, and on the good that results from personal contact between scientific workers from its various parts, require no emphasis from us; but we would point out that much as men of science may strive to serve the needs of Empire in the manner indicated, their services can only be small compared with those rendered by H.M. the King and H.R.H. the Prince of Wales, who, by their repeated visits to the Dominions, have strengthened beyond measure the natural ties of kinship that attach the motherland to her children beyond the seas.

Bacteriophage.

The Bacteriophage and its Behaviour. By Dr. F. d'Herelle. Translated by Dr. George H. Smith. Pp. xiv + 629. (Baltimore, Md.: Williams and Wilkins Co.; London: Baillière, Tindall and Cox, 1926.) 36*s.* net.

An indication of the appeal that the subject of bacteriophage has made to the interest of bacteriologists is afforded by the fact that, in this second book of d'Herelle's, the bibliography contains more than six hundred papers, of which more than five hundred have appeared during the last five years. In taking up the book one has in mind not only the importance of the bacteriophage in relation to fundamental problems of bacteriology, but also that the author was the first to make extensive investigations on the subject, under this name, and to demonstrate the phenomena by the striking and easily learnt technique which made it at once widely known. From the beginning of his publications in 1917, he has maintained the view that the bacteriophage is a living non-visible virus that exists as a parasite upon bacteria. All the facts discovered since that time have been interpreted by him on the basis of this hypothesis and, as was to have been expected, it is in the light of this interpretation that the book has been written.

All those who have worked at the bacteriophage are not, however, adherents to this view. The phenomena produced by the bacteriophage and such properties of the active principle (bacteriophage itself) as can be determined by controlled experiments, are generally accepted. But to many the significance of these facts is chiefly in their relation to the possibilities afforded for further investigation of the nature and causes of bacterial variation and further analysis of bacterial metabolism. To these fields bacteriophage has opened new and valuable approaches, none the less valuable because numerous scientific investigators are unable to accept the hypothesis of a living virus. Amongst other contributions to the discussion written with less advocacy of a particular point of view, those of Bordet (*Annales de l'Institut Pasteur*, 1925, 39, 717) and Otto and Munter (*Ergebnisse d. Hyg., Bakteriol., Immunitätsforsch., u. exp. Therapie*, 1923, 6, 1) may be noted. The book under discussion is more than a review of the subject, it is as well an argumentative exposition of the author's views of the nature of the bacteriophage, his interpretation of the phenomena produced by it and his claim to priority in its discovery.

The larger part of the introduction of thirty-four pages is taken up with mention of observations of others so far back as 1892, in which, in the light of present knowledge, bacteriophage may have played a part. In several instances it is impossible to be certain whether this is a correct surmise, but it appears highly probable that the irregular forms of colonies described by Gildemeister (1917) in cultures of *B. typhosus* and *B. coli* were the result of the action of bacteriophage. Gildemeister himself is of this opinion. Five pages are occupied with a detailed consideration of a paper by Twort (1915) which appeared two years before d'Herelle's first publication and of which he was at that time unaware. The contention is that the phenomena described by Twort were not due to bacteriophage, although this view is not held by most of those who have studied the question and written on it. Indeed, though the class of bacteria was different and the ease of demonstration was less, it is generally accepted that the main characters of the two phenomena are identical and that Twort recognised the essential facts though uncertain as to the interpretation. The point in continuing these arguments for priority is not clear. It seems quite certain that d'Herelle was not the first to observe the phenomena due to the action of what we now term 'bacteriophage,' but, on the other hand, no one wishes to detract from the work of d'Herelle, who was the first to make extensive systematic investigations in the subject, and was chiefly responsible for bringing it forcibly to the attention of the scientific world.

The book itself is divided into three parts: (1) The phenomenon of bacteriophagy, (2) the bacteriophage, (3) the behaviour of the bacteriophage protobe. A lengthy discussion of these matters would lead one into highly technical fields of bacteriology into which it is not possible to enter here or necessary for those who are acquainted with the subject. For those who may wish to inquire further, d'Herelle's book or the reviews that have been mentioned will be of value.

In general terms the phenomenon of bacteriophagy consists of bacterial lysis transmissible in series. If one puts a small amount of 'bacteriophage' with a culture of a susceptible bacterium in a liquid medium, in the course of a few hours the turbidity of the culture decreases. Not all the bacteria are destroyed, however, and from the lysed culture, subcultures can be obtained of bacteria that resist lysis when exposed again in a similar way to bacteriophage. If the lysed culture be filtered through a Chamberland or similar filter, and all the bacteria removed, the filtrate contains a much greater amount of bacteriophage than was originally put in; the increase may be as much as ten thousand times in the course of six or eight hours. This process can be repeated indefinitely, the bacteriophage increasing in association with living susceptible bacteria upon which it has a lytic action. A similar lytic phenomenon may be obtained on solid media if inoculation is made with a mixture of bacteriophage and susceptible bacteria. In place of normal bacterial growth there will develop, according to the conditions of the experiment, small clear areas devoid of growth, larger irregular areas, or almost complete absence of growth. If inoculation be made sparsely to allow isolated colonies of bacteria to be seen, some of them will be deformed by the absence of growth in part of the area they would normally have covered.

The bacteriophage is therefore an 'agent' or 'principle' that passes readily through filters that retain bacteria, that increases in association with living bacteria which are susceptible to lysis by it; its action upon a susceptible culture shows that all the organisms in the culture are not equally susceptible but that some are resistant, and if isolated are neither lysed by bacteriophage nor permit its increase in association with them.

The bacteriophage was first obtained by d'Herelle from the intestinal contents of patients recovering from dysentery. A Chamberland candle filtrate of a culture of intestinal contents added to a culture of a suitable organism produced clearing of the turbidity. Since then bacteriophage has been found widely distributed. It is present in the intestinal contents of healthy individuals and animals, in purulent discharges, in sewage, in river water, in soil, etc. In discussing the "ubiquity of the bacteriophage," p. 37, one would like to have seen set down along with these other sources the experiments of Bordet, who obtained bacteriophage from the exudate that formed after guinea-pigs were inoculated intraperitoneally with *B. coli.* One notes also that the experiments of Otto and Munter, who found that bacteriophage appeared spontaneously in some of the cultures in their laboratory, are dismissed with brevity. It is a question of fundamental importance whether the phenomena associated with bacteriophage are accentuations of processes that normally occur in bacteria. To dismiss these experiments with the statement that the strains from which bacteriophage had been directly derived had been "contaminated" with it from the time of their isolation, that is, that the bacteria and the bacteriophage virus had been isolated together from the body is, to say the least, a one-sided account and is, in fact, begging the question.

The explanations given of the phenomena of bacteriophagy are all based on the author's view that the bacteriophage is composed of individual living 'corpuscles.' For example, the mechanism of dissolution of a bacterial cell by bacteriophage as seen by the author under dark-ground illumination is summed up in a paragraph on p. 115, ". . . the single fact that the phenomenon of rupture is 'explosive' in nature shows that the bacteriophage corpuscle certainly penetrates to the interior of the bacterium, and that it is in this location that multiplication takes place." It is stated without any qualifications in the context, p. 18, that "the science of immunity has been held back for more than twenty years by the equivocation created in the subject by the term 'lysis,' which as a matter of fact has entirely lost its real significance." For this reason the destruction of the bacterial cell by bacteriophage is termed 'dissolution.'

One notes also the manner of mentioning the work of others whose results have been difficult to assimilate into the author's thesis. In particular, a sentence on p. 212, referring to one whose work is well known and accepted, which reads: "the contribution is absolutely incomprehensible, and it would seem that he has no idea of what in reality is the phenomenon of bacteriophagy," is an illustration of the author's attitude of mind.

The second part of the book deals with the characters of the bacteriophage itself. Its behaviour towards physical and chemical agents is discussed and a chapter is devoted to hypotheses concerning its nature, in which this aspect of the subject is extensively presented.

A point of some interest is the introduction of a new term to indicate a class or genus which is to include several of the so-called filterable viruses. The definition is as follows (p. 359):

"Up to the present time the infravisible agents of rabies, of variola, of vaccinia, of encephalitis lethargica, of the animal plagues and of the mosaics of plants, have been considered by the majority of biologists as living beings, but this point of view has been, however, disputed. Although the proof of the living nature of the bacteriophage is only valid for itself alone, it is none the less true that the living nature of all the beings which present the same characteristics is rendered the more probable by the facts disclosed in connexion with the bacteriophage. These infravisible beings have been termed 'invisible viruses,' 'ultraviruses,' 'ultramicrobes,' etc. This does not give them a name, for these terms are simply qualifying terms, designating their state of invisibility. In presenting the demonstration of the living nature of the bacteriophage I have proposed to designate this group of living 'micellar' beings by the name Protobes, a term which I have applied to the bacteriophage."

P. 357: "It is to this being, infravisible, parasite of bacteria, that I have given the name *Protobios bacteriophagus* (syn. *Bacteriophagum intestinale*) d'Herelle 1918."

The rôle of the bacteriophage in immunity is, broadly, the subject of the third part of the book. On p. 488 is found, "With plants, as with animals, antibacterial immunity is 'exogenous,' it is the bacteriophage protobe. This is a general fact throughout nature." If this were so one might expect important results from prophylactic immunisation with bacteriophage and its use in treatment. The final two chapters are taken up with these matters, but the enthusiasm of the author for his theme has produced an atmosphere of hope which will require much further work to be justified. Whatever view may be taken of the nature of the bacteriophage, it has undoubtedly a markedly destructive action on susceptible bacteria in the test-tube, but the principles involved in employing bacteriophage for prophylaxis or treatment of disease are as yet but little understood, and indeed further evidence is required to establish the reality of this branch of therapeutics.

The book, compared with the first one "Le bactériophage, son rôle dans l'immunité," 1921 (English translation, 1922), has increased in size. The presentation of almost every aspect of the subject has been expanded. A section on ultra-filtration is new. Much of the discussion concerning the various hypotheses that have been put forward to explain the nature of the bacteriophage is also new. This part of the subject has been given attention by most of those who have worked at bacteriophage. One is dealing with a filtrable, non-visible agent, possessing unique properties, of much interest in its relation, on one hand, to living viruses, and on the other, to bacterial and cellular lysins and to enzymes. In spite of much work, this exact relationship is still undetermined.

The Science of Photography.

(1) *The History of Three-Color Photography.* By E. J. Wall. Pp. x+747. (Boston, Mass.: American Photographic Publishing Co., 1925.) 15 dollars net.

(2) *Stereoscopic Photography: its Application to Science, Industry and Education.* By Arthur W. Judge. Pp. xv+240. (London: Chapman and Hall, Ltd., 1926.) 15*s*. net.

(3) *Die photographisch-chemische Industrie: die Erzeugung und Verarbeitung photographisch-chemischer Präparate.* (Technische Fortschrittsberichte, Fortschritte der chem. Technologie in Einzeldarstellungen, Band 10.) Pp. xvi+363. (Dresden und Leipzig: Theodor Steinkopff, 1926.) 18·50 gold marks.

PHOTOGRAPHY, in common with some other subjects, has the peculiarity of being both an art and a science. The manufacture of sensitive emulsions suitable for very variable requirements, the design of cameras and optical systems by the use of which the light impression is obtained on the sensitive film, and the processes of development, printing, etc., are essentially scientific, involving as they do chemical and physical problems which are often of a very complicated nature. On the other hand, photography is commonly spoken of as an art, and it may be said that, with few exceptions, the best exponents of the art know very little of the science underlying the use and practice thereof. Even in connexion with the scientific side, it is true to say that the present high standard which has been reached in the manufacture of plates, films, and papers, which may be used for an infinite variety of purposes and in all climes, is due to empiricism and experience having far outstripped scientific knowledge; this is also true of developers and development, toning, sensitising and de-sensitising dyes, etc. At the same time, it must be emphasised that since the investigation of the scientific foundations of photography was initiated by Hurter and Driffield, increasing attention has been paid to this branch of applied science, and the effect of the results obtained has been very marked on the progress of manufacture and on the applications of photography.

In two of the branches of photography dealt with by the works under review, namely, colour photography and stereoscopic photography, it is self-evident that the scientific basis is all-important, and that any advances made must be dependent on progress made in our knowledge of colour and stereoscopy. At the same time, the necessity of satisfying artistic requirements has had a great influence in directing the course of scientific inquiry. The third book, "Die Photographisch-chemische Industrie," treats only of matters which are industrial and scientific in character.

(1) Mr. Wall has long been noted for his encyclopædic knowledge of the processes of photography, especially of colour photography, and it is not to be wondered at that he has produced a remarkable and unique book. It is the product of thirty years' study and search of the original literature of colour photography and allied subjects, and the author claims, with justification, that "there is no work in any language which has brought together a history and summary of colour photography comparable to this book." Reserving the Lippmann, Seebeck, and bleach-out processes and photo-mechanical reproduction for another volume, the attempt is made to record, even to the most minute detail, every step in the progress of colour photography of both still and moving subjects, from the earliest beginnings to the early part of 1925; detailed references to the original articles or patent specifications are given in every case. The first chapter gives the necessary "Historical and Theoretical Data," after which comes an extremely valuable chapter on colour filters and colour screens,

the use, preparation, and transmission factors of which are given in detail. In three succeeding chapters, still cameras and chromoscopes, bi-packs and tri-packs, and various optical devices are described. Colour sensitive plates, with the methods of sensitising and testing, de-sensitisation, and the preparation of photographic papers, are fully discussed and a list of sensitising dyes, together with their range of action, is given. Subtractive processes and screen plates are dealt with, each in five chapters, whilst other chapters give an account of three-colour transparencies, autochrome stereoscopy, dichromate printing, prismatic dispersion processes, etc. The chapter on colour kinematography is most valuable; this has necessitated a search of the patents of all countries, there being practically no literature on the subject.

The great value of this book lies in the fact that the practising photographer, the inventor, and the researcher will find therein complete records of what others have done; time will not be wasted in re-discovering ideas already known. In this respect it should be mentioned that numerous patents are reviewed which could not be found from the patent office indexes, as they are listed only under other classifications.

Very few errors and misprints have been noticed, but occasionally, as on pp. 55 and 544, the author's mathematical equations go wrong, although the right result is obtained in the end. It is stated that the edition is limited and the type will be distributed as soon as printing is completed, otherwise the reviewer would have suggested that the various and numerous data which are given in terms of the Fraunhofer lines should be expressed in wave-lengths in the next edition.

(2) On the Continent, stereoscopic photography seems to be practised much more than in England, and, for the most part, the literature has been chiefly in French and German. The appearance of an English book on the subject is therefore to be welcomed, not only because stereoscopic photography forms a fascinating hobby, but also because of the applications to which it is being put. The anaglyph is being utilised more and more for the stereoscopic illustration of commercial catalogues, books, and magazines.

The reader of the book will probably be surprised at the extensive applications of stereoscopy in science.

"By its aid the microscopist, for example, is able to observe stereoscopically and to photograph the minute solid objects revealed under his microscope, and eventually, in the stereo-photographs, to obtain permanent records of these objects in relief. The astronomer employs stereoscopic principles not only to detect the presence of faint stars and binaries, but also to show in realistic relief the features of the moon, comets, certain of the planets, and also the proper positions in space of stars of greater magnitudes forming the constellations. The radiographer is enabled by stereoscopic X-ray pictures to locate exactly foreign bodies in the human system, to show the position of flaws, air-pockets, or defects in castings, metals, or other materials, and to reveal the internal structures of organic bodies and interiors of composite bodies and mechanisms."

It is becoming of increasing importance in aerial and land survey, and its possibilities in enabling the student to visualise complex diagrams and objects are being recognised more and more.

In order to maintain a popular as well as technical interest in stereoscopy, the theoretical and analytical sections have been reduced to the minimum proportions, but the treatment is sufficient for the end which the author has in view, namely, that of interesting both the advanced worker and the amateur. Stereoscopy with a single lens camera, the selection of stereoscopic cameras and accessories, the viewing of stereograms, photographic processes, and notes, etc., are all adequately described before the applications of stereoscopy are considered. For those who wish to pursue the subject there is an appendix giving a bibliography of the literature. There is no lack of illustrations, there being some 150 line and half-tone reproductions and 19 plates in stereoscopic pairs.

The author is to be congratulated on a book which will occupy a worthy position in English photographic literature.

(3) This book, as its title indicates, is mainly concerned with the manufacture of photographic material, and gives a literature summary covering the period from 1914 to the present time. There are four sections, which deal respectively with: (*a*) The manufacture and testing of photographic dry plates, (*b*) the manufacture and testing of films, (*c*) the manufacture and testing of photographic papers, and (*d*) the working of photographic materials. This last section occupies practically half of the book and deals with the testing of photographic materials and the usual operations of photography (exposure, development, etc.). Fundamental researches on the scientific basis of photography are not neglected, but are not dealt with in detail. The German aptitude for summarising literature is well in evidence, and if this book is used together with the various Reports on Photography which have been published by the Society of Chemical Industry, it will be invaluable to photographic workers, both those in the industry and in research laboratories.

There are occasional errors, and among these the names of English workers sometimes suffer considerably, as when "Fog" is written for "Toy."

T. S. P.

History and Evolution.

Theory of History. By Prof. Frederick J. Teggart. (Published on the Foundation established in Memory of Philip Hamilton McMillan of the Class of 1894, Yale College.) Pp. xix+231. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1925.) 14s. net.

PROF. TEGGART'S book is a useful and learned contribution to a very important contemporary discussion. What is the relation between historical method and the method in the natural sciences, and especially in that nearest to history, namely, biology? It would be difficult to find any statement so clear and pointed as Prof. Teggart's of the difference that has arisen, mainly in the last century and especially since Darwin, between what one may call the 'sociological' and the 'historical' school among the writers of history. Prof. Teggart states it clearly, truly, and forcibly, and traces it to its source; he gives apt and numerous quotations from representative thinkers; unfortunately, he does not work out his own solution in the same fulness. He points out the difficulties, but does not solve them: the solution, in fact, demands a prolonged and thorough philosophical treatment, far beyond the scope of his short essay, and still more of a shorter notice of it. However, we may be thankful to him for having cleared the ground, and await the more leisured cultivator who must come later.

To take two prominent names as representing the two philosophical poles in the discussion, Comte and Bergson: as Frenchmen they have the national gift of expressing logical extremes, though it would be easy in each case to quote amply from the author evidence that his own practice was not, and could not be, in accord with his own logical presumptions. Comte is fully, and on the whole justly, treated by Prof. Teggart as the most powerful voice in the nineteenth century in favour of the sociological, or generalising, view of history. That view maintains that in the limit, that is, if our knowledge were complete, and in proportion as our knowledge increases, we can formulate 'laws' for history and neglect particular events and personalities; that, in the limit, human history would become, like astronomy, a completely reasonable evolution of an idea, or set of ideas, which with adequate knowledge might always have been predicted beforehand as we predict the movements of the heavenly bodies. That is the extreme, logical or determinist point of view, and it was fortified in 1859 by Darwin's formulation of evolution as proceeding by an infinite and unceasing series of minute variations. Its extreme opposite can be found in M. Bergson's view that every human action is a new and creative thing, and that our actions become more perfectly human just in so far as they are free and undetermined by previous happenings. History, therefore, which is an account of human action, cannot be a science, because it deals with the particular and individual, whereas science is always making general conceptions from the recurrence of particulars. Prof. Teggart illustrates this attitude from the two leading thinkers in the nineteenth century who reacted against the generalising and intellectualist attitude in human affairs—Schopenhauer among philosophers and Ranke among historians. This part of his book is the most impressive.

Where is the plain man to take his stand, especially one who comes to history from the orderly discipline of the natural sciences? He will say, in the first place, that neither of the extreme philosophical points of view can be wholly true; he will deny, on one hand, that every human action or event can be properly treated as merely individual; he will be sure that there are, if not 'laws,' at least connexions, movements, and tendencies in history. On the other hand, he will be equally sure that exact formulation, as in the case of mathematics, or prediction, as in the case of astronomy, is out of the question in history or sociology. He will look in history for general similarities and general movements containing an infinite variety of individual difference and freedom of development. To reconcile this apparent contradiction is one of the greatest and noblest objects of human thought.

Two limited and definite suggestions may be made here, appropriate to Prof. Teggart's book. One is that he makes no allowance for the increasing importance of the history of thought in general history. This is the most characteristic and decisive thing in the history of history-writing in the nineteenth century. Whewell was its first exponent in Great Britain about a hundred years ago, one of the first exponents in the world of the history of science as a whole. This aspect of history has made increasing strides ever since, and has now several organs and a mass of literature in all leading educated communities in the world. Now in so far as we look on the history of scientific thought as a guiding thread in general history, so do we perceive an orderly advance and a community of mankind. Above all, it enables us to take a more decided line on the other and last point on which we will comment on Prof. Teggart. He ends his book by saying that the difficulty which he has been discussing will be largely solved "if we recognise the difference between a *belief in progress* and a *belief in the possibility of progress*." The difference will not appear so great between the two attitudes if we reflect that a belief in the possibility of progress, that is, in the future, depends on the establishment, by history, of progress in the past: and, as the progress of science is the most obvious and measurable thing in history, those, like Prof. Teggart, who would build their faith on the 'possibility' of progress in general, must turn to the annals of systematic and objective thought.

F. S. MARVIN.

Our Bookshelf.

Essex: an Outline Scientific Survey; including Geology, Botany and Zoology. By Members of the Essex Field Club and others. Prepared on the Occasion of the Congress of the South-Eastern Union of Scientific Societies at Colchester. Edited by G. E. Hutchings. Pp. 133+4 plates. (Colchester: Benham and Co., Ltd., 1926.) 3*s*. net.

THIS "Outline Scientific Survey," published in connexion with the recent Congress of the South-Eastern Union of Scientific Societies, at Colchester, should prove of wide and permanent interest. Consisting of a series of articles by well-known field naturalists, it provides a detailed account of past researches into the geology, botany, entomology, ornithology, crustacea, etc., of Essex, summarising the great volume of work accomplished by the Essex Field Club during the forty-six years since the club was founded, and work done by earlier Essex naturalists.

Covering a wide field, the articles are necessarily condensed, and will appeal to scientific workers rather than to the general public. The value of this survey is enhanced by the bibliographical notes appended to each article, and by the geological sketch map of the county. A useful index of the survey is also provided.

Owing to limitations of time and space, omissions could scarcely be avoided. One finds in the survey no mention of the mammals, reptiles, and fishes of Essex. These have been fully dealt with by the late Dr. Laver, past president of the Essex Field Club, in a special memoir published by the Club, and also in a report upon Essex and Kent sea fishes, compiled by the late Mr. E. A. Fitch, also a past president of the Essex Field Club, collaborating with the late Dr. Murie, published by the Essex and Kent Sea Fishery Board. Another special memoir of the Essex Field Club deserved attention, namely, the very complete report upon the Essex earthquake, by Meldola and White; and it is surprising to find no reference to the historic and world-renowned 'native oyster'—a variety of the oyster confined to the estuary of the Thames. The oyster fisheries of Essex have certainly been protected for more than seven centuries, probably for more than a thousand years, and possibly from Roman times. As the partridge and pheasant, similarly protected, are always included in British bird lists, we should have expected the Thames Estuary variety of oyster to figure in a scientific survey of Essex. An exhaustive account of this fishery by a member of the Essex Field Club appears in the Essex "Victoria History," and later a pamphlet was published, compiled by the late Dr. Laver, who took a keen interest in this fishery. The small but interesting pyrites industry formerly on the Essex coast, an account of which (by a member of the Club) is included in the Essex "Victoria History," also deserved mention. These omissions could be remedied, in later editions or reprints of the survey, by a brief editorial note.

Monumenta Medica. Under the General Editorship of Henry E. Sigerist. 3: *The Earliest Printed Literature on Syphilis; being Ten Tractates from the Years 1495–1498.* In complete Facsimile, with an Introduction and other accessory material by Karl Sudhoff, adapted by Charles Singer. Pp. xlviii+352. (London: D. Stanton, 90 North Road, N.6; Florence: R. Lier and Co., 1925.) n.p.

OWING to rearrangements, incorporations, and other changes, this beautifully printed and illustrated work, which forms the third volume in the series of "Monumenta Medica," of which the second was reviewed by us some months previously (NATURE, December 5, 1925, p. 811), is, as Dr. Singer remarks in the preface, almost a new work rather than a translation. The writers whose works are reproduced in facsimile are Konrad Schelling of Heidelberg, physician to Philip, Elector to the Palatinate and friend of the humanist Jakob Wimpheling, Joseph Grünpeck of Burckhausen, himself a sufferer from the disease, Niccolo Leoniceno of Vicenza, whose pamphlet was published by the great humanist printer Aldus Manutius at Venice, Hans Widmann of Tübingen, Caspare Torrella of Valencia, who was physician to Pope Alexander VI. and treated his son Cæsar Borgia for syphilis, Corradino Gilino, who recommended the heroic treatment of application of a red-hot iron to the head for curing the salivation caused by mercurial inunctions, Bartholomæus Steber of Vienna, Natali Montesauro of Verona, the first to describe clearly the ostescopic pains of syphilis, and Antonio Scanaroli of Modena. Their contributions to the history of syphilis, while none of them is without considerable interest, are of very unequal value. With the exception of Grünpeck's pamphlet entitled "Ein Hübscher Tractat von dem Ursprung des bösen Franzos," all the tracts are written in Latin.

Prof. Sudhoff regards the work of Torella entitled "Tractatus cum consiliis contra pudendagram seu morbum gallicum," as the most valuable of all the tracts, inasmuch as it is the least prejudiced, the freshest, and the least academic. Perhaps the next most interesting pamphlet in this collection is that entitled "De pustulis et morbo qui vulgo mal de franzos appellatur" by Hans Widmann, who distinguishes the French disease from leprosy, holds the breath of the sufferers to be contagious, and regards the rashes and, above all, the affection of the mouth, as characteristic of the disease.

As Prof. Sudhoff points out in his foreword, the works reproduced will prove of interest not only to epidemiologists and medical historians, but also to students of the history of culture and the art of printing.

Dialogues in Limbo. By George Santayana. Pp. vii+193. (London: Constable and Co., Ltd., 1925.) 10*s*. 6*d*. net.

THE dialogue form enjoys a mild vogue among American philosophers, and it is hard to imagine any more brilliant exponent of it than Mr. Santayana. It expresses admirably the subtle irony of his delicately perceptive intelligence. Of the literary success of his experiment there is no question. Yet interpretation is hard, for, as in all living discussion, the emphasis shifts and one cannot certainly infer what the message is. The scene is Limbo. The spirit of the earthbound stranger holds converse with the illustrious shades—Democritus, Aristippus, Alcibiades, Socrates and the rest—who manage to retain a stronger personal identity than even Mr. Broad's 'psychic factor' would explain; and much of their discourse is at variance with the 'Life of Reason.' For there, at all events, Mr. Santayana has declared himself on the side of reason, has shown how, from the raw material of human character, its diversity of impulse and of passion, reason has to create some kind of harmony; but here the issue is less certain.

Of all the shades, Democritus is endowed with the greatest power and energy of conviction; and he, as frank materialist, is clear enough that the life of reason is largely illusion, and that "the chief and most lasting illusion of the mind is the illusion of its own importance." True, the illusion is necessary and in its way beneficent; for the state of wisdom is "an evanescent madness when the dream still continues, but no longer deceives." Even Democritus, however, can scarce tell whether it is more important that the dream should continue or that it should not deceive. On one side, the practical business of life requires its endurance, since only so can we forbear the bewilderment of ultimate inquiry, and like Protagoras take the way of establishing, by the support of tradition and experience, a valid conventional distinction between sane beliefs and mad. Yet, when the deepest challenge comes, Democritus is impelled to the vow, "I will dismiss and expel every remnant of illusion, even in myself, in order that nothing of me may remain save the atoms that compose me"—truth before aught else. So, too, in a not dissimilar ethical discussion, the dialectic of Socrates can overthrow the vaguely emotional democratic theory of the stranger; but makes less headway against the stranger's version of the teaching of his prophet of human love and gentleness.

There is no finality here: no set conclusion, but a lively and sensitive handling of the issues, and a breathless brilliance of fine debate. H. J. W. H.

An Introduction to Historical Geology: with Special Reference to North America. By Prof. William J. Miller. Second edition. Pp. xvi+399. (London: Chapman and Hall, Ltd., 1925.) 13*s*. 6*d*. net.

PROF. MILLER'S "Introduction to Historical Geology" is not quite so successful as his "Physical Geology," recently reviewed in these columns. The fundamental principles of stratigraphy and the organic inferences are carefully dealt with, and the book contains very useful summaries of Palæozoic and Mesozoic life-forms. Indeed, throughout the book the palæontology is well done. But physical history is especially emphasised, and yet here the treatment follows the conventional lines of older text-books and fails to include the results of much modern work. In dealing with geological time the author is particularly old-fashioned. He writes, "the Cambrian period represents a long time, the best estimates ranging from 2,000,000 to 3,000,000 years. . . . Though the succeeding periods were by no means equal in duration, the best estimates would make no one of them less than 1,000,000 years long." The term 'best' evidently applies to the old estimates of Walcott, and implies ignorance of, or indifference to, the magnificent work of Barrell in this field. More attention might also have been devoted to the palæogeographical researches of Schuchert, which reveal at least eighteen great marine transgressions over the North American continent. The book is well printed and illustrated, but reveals no originality of either point of view or treatment.

Sahara. By Angus Buchanan. Pp. xv+301+78 plates. (London: John Murray, 1926.) 21*s*. net.

CAPT. BUCHANAN has added to his previous works on Africa another valuable book in which he shows his power of descriptive writing and his insight into the native mind. His journey on this occasion was across the Sahara from Kano by way of Ahaggar to Touggourt and Algiers. The main objects of his journey were to secure kinematograph films and make studies in natural history. Happily he avoids the monotonous iteration of daily marches and incidents of camp life, and succeeds in giving a series of vivid pictures of the Sahara, its animal life and its people. While the interest is mainly in natural history, there is a great deal of geographical value in the book. In fact, few volumes give better impressions of the vastness and solitude of the desert. It is a pity that the small map is wholly inadequate for a book of this importance.

Nature, Thought and Personal Experience. By Dr. W. Tudor Jones. Pp. xii+182. (London: Williams and Norgate, Ltd., 1926.) 7*s*. 6*d*. net.

DR. TUDOR JONES has consciously or unconsciously come under the influence of the new doctrine which is being preached in science under the descriptive title emergence. The theory of emergent evolution is an attempt to interpret the process of the cosmos as a succession of 'levels,' each level being characterised by new properties which, though the outcome of the conditions of the previous level, could not be predicted from it. With his well-known zeal for the recognition of moral and religious values, Dr. Tudor Jones applies this as a rationale of the relation of Nature and thought in personal experience. Though dealing with values, he never loses touch with the actualities of positive science.

My Flight to the Cape and Back. By Alan J. Cobham. Pp. vi+70. (London: A. and C. Black, Ltd., 1926.) 1*s*. 6*d*. net.

THIS small volume is a modestly told record of the great achievement of Mr. A. J. Cobham in flying from London to Cape Town and back last year. It was not a hurried flight, as lengthy halts were made at several places on the route via Italy, Greece, Egypt, the Nile, the Lake Plateau and Bulawayo, but it was most successful and singularly free from mishap. The reader may regret the lack of adventure, for Mr. Cobham does not even embroider his story, and makes slight of every incident. But the absence of sensation is a tribute to the skill of the pilot and the worth of his machine. There are several interesting aerial photographs.

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.*]

Lightning.

IN a recent and very interesting article (*Proc. Roy. Soc.*, A, 111, 56-67, 1926, May 1), Dr. G. C. Simpson advances a theory of the method of advance of a lightning stroke. As he concludes that there can be no substantial stroke of negative charge, perhaps it would be better to say that he develops a theory of the advance of a positive stroke, meaning by this the advance of a stroke of positive charge. A short time ago, I proposed (*Journ. Franklin Inst.*, 201, 485-496, 1926, April) a theory of the advance of a negative stroke. As the two theories are apparently conflicting, it is desirable to consider the conflict in order to see in how far it is real, and in how far the theories are merely complements one of the other.

Dr. Simpson regards the advance of the stroke as dependent upon the flight of free electrons. In this, the two theories agree. He says nothing about the source of the electrons, but I imagine that no serious objection will be raised to the assumption that essentially all result from collisions of rapidly moving electrons, or ions, with molecules. He pictures the positive stroke as the advance of a positively charged tongue extending from the cloud, the advance arising from a continuous sucking of electrons from an ionised region immediately ahead of the tip of the tongue, the branches of the stroke being formed in the same manner at places determined by the irregularities of the field.

But what ionises these regions ? If the field at the tip of the tongue is sufficiently intense, the positive ions in it will be driven forward with such velocity that they will ionise the air. In such fields, the electrons so liberated will be very effective ionisers, thus increasing the supply of electrons and of positive ions. Thus the tongue will advance as a result of the repulsion of its constituent ions, and the progress will be continuous so long as the field at the tip remains sufficiently intense. If we regard the tip of the tongue as a region somewhat to the rear of the advance ions which produce the ionisation, this picture accords closely with what seems to be Dr. Simpson's concept. Under favourable conditions, such an advance could certainly occur. But in order for branches to be formed by such a process, not only must the field be irregular, but also along the main spark the several regions of maximum lateral intensity must be small and quite definitely circumscribed.

It is difficult to believe that the field can have the very fine-grained structure necessary for the wonderfully rich development of branches which is frequently observed. This seems to call for another explanation. Our present conceptions of the nature of the discharge of electricity through gases suggests that the branches are not outgrowths from the trunk, but ingrowths to it. In the region within which the intensity of the field is sufficient to confer upon a free electron the ionising velocity, there occurs, here and there, a stray free electron. Each of these is sucked in by the field, and ionises the air along its path, and the electrons so freed join it in its flight. Thus each gives rise to an increasing swarm of electrons flying up the field. The number and distribution of the branches are determined, not by the irregularities of the field, but by the number and distribution of chance electrons. The trails of the electrons are positively charged; they are exactly similar to the tongue pictured by Dr. Simpson, but each arises from a negative stroke to the positive region, rather than as a positive stroke from that region. The trails extend the field, and may pick up other stray electrons which otherwise would not have been caught. Thus a branch may grow in length and may branch. In the same manner the main discharge, or tongue, may advance, not by pushing forward, but by successive negative strokes towards it. A much weaker field will suffice for this type of advance than for the other.

Even when there is ionisation by positive ions, there must in any actual case be ionisation by stray electrons also, and as the mobility of electrons far exceeds that of positive ions, it would seem that the path would be blazed by them rather than by the positive ions, and that the latter would merely enhance the charge of the blazed path and the current along it. In this case the path of the advance is determined by a succession of negative strokes, each starting from a stray electron at a distance from the tip of the tongue; and the effects of such a stroke will be similar to those produced by what I called an upward stroke of negative charge.

There seems to be no reason for doubting that a positively charged tongue, formed in either manner, might reach down into a region in which the field prior to its advent was very weak, or even adverse to the advance.

Dr. Simpson considers that the advance of a negatively charged tongue is impossible, because the mutual repulsion of the electrons would cause a continued broadening of the tip. This, however, depends upon the conditions of the problem. If the tongue consisted of a swarm of free electrons, and if it was not subjected to an external field, then it would certainly broaden out. But if it is subjected to a longitudinal field which is intense as compared with the cross-field due to the mutual repulsion of its constituent electrons, then the paths of the electrons will make only small angles with the axis of the tongue, and at the tip the path will be axial. In this case, the growth will be axial, but there will be a lateral wastage. The electrons passing away from the axis will soon reach a field which is so weak that they lose their ionising power, become ions, and cease to migrate with significant velocity.

There are also other difficulties. It is not clear how a negative tongue reaching some distance from a cloud can ever form if the field is not sufficiently intense to confer upon the positive residues an ionising velocity. If the positive residues take no active part in the ionisation, then as stray electrons near the cloud are driven away by the field, ionising the air as they go, they form a swarm of electrons which is separated from the cloud by a trail of positive residues. What is formed is not a tongue of negative ions reaching from the cloud, but a flying swarm, or dart, of electrons which is cut off from the cloud. On the other hand, if the field near the cloud is so intense that the positive residues acquire the ionising velocity, then they will serve as a continuing source of electrons, and a long tongue, or dart, of electrons will form. Being subjected to the field of the dart as well as to that of the cloud, the forward portion of such a dart may acquire a tremendous velocity; this will facilitate its passage, and also reduce the lateral wastage. But still there is no long tongue of negative ions extending from the cloud; there is nothing analogous to the tongue of positive ions, and apparently there cannot be. But there will be high-speed darts of free electrons. These and their highly ionised trails are essential features of the picture which

I proposed for the negative stroke. Many characteristics of lightning strokes can be satisfactorily correlated by means of such a concept.

With reference to the object struck, there are probably two main types of strokes: (1) The positive stroke, in which a positively charged tongue of ionised air extends from the cloud to the object; (2) the negative stroke by an electronic dart, of which the highly ionised trail extends from the cloud to the object. In general, the initial effects of the second will be more abrupt, more deep-seated, and more rending than those of the first.

The positive tongue theory advanced by Dr. Simpson and the electronic dart theory proposed by myself are not conflicting, but mutually complementary. The apparent conflicts, in so far as they are not a mere matter of words, arose solely from misconceptions, on one side or the other, regarding the completeness of the picture being presented.

N. ERNEST DORSEY.

2101 B Street, N.W.,
Washington, D.C.,
June 9.

IN the paper referred to by Dr. Dorsey, I discussed how a lightning flash is propagated from a positively charged cloud. In that paper, of set purpose, I did not discuss how the ionisation takes place, relying on the simple statement that ionisation does take place when and where the field exceeds a certain unspecified minimum value. I did this to avoid discussion of details which were unessential to the main purpose of the paper. But as Dr. Dorsey now raises these questions they must be considered, although the correspondence columns of NATURE are not appropriate for the full discussion which they really require. I must therefore be content with a few remarks on his main points.

There can be little doubt that free negative electrons which are always present in the atmosphere play some part in the ionisation accompanying a lightning discharge; but all the evidence, in particular the sharp boundary of the discharge channel, points to this action being confined to the immediate neighbourhood of the channel. In fact there is reason to believe that it is confined to the small region at the extreme tip of the advancing channel, where alone, in my opinion, the field is sufficiently strong to cause appreciable ionisation.

With regard to branching, Dr. Dorsey says: " Our present conceptions of the nature of the discharge of electricity through gases suggests that the branches are not outgrowths from the trunk, but ingrowths to it." I wonder to whom the word "our" in this sentence refers, for personally I cannot form any such conception. To me it is quite inconceivable that the branches grow from their tips inwards, finally uniting to form the trunk. This would mean that the electrical discharge starts in the weakest part of the field and not, as one would expect, where the field is strongest, near to the charged cloud.

The second half of Dr. Dorsey's letter is of more fundamental importance. He describes darts of negative electrons which are shot out of negatively charged clouds. It is not easy to understand Dr. Dorsey's ideas from this letter alone; but by reading his other publications I have come to the conclusion that his darts are very little different from the negative discharges which I considered and rejected in my Royal Society paper. I did not consider that such negative discharges are impossible " because the mutual repulsion of the electrons would cause a continued broadening of the tip," as stated by Dr. Dorsey. As a matter of fact, the mutual repulsion of the electrons never entered my head when writing the paper, for any such repulsion is infinitesimal in comparison with the fields which exist where ionisation takes place. The negative electrons would spread out at the tip of a negative discharge, if such could form, not because of mutual repulsion, but because the field under which the electrons move is divergent at the tip.

If it is granted that ionisation takes place where the field is a maximum, then the lines of force must diverge from that maximum. It is because the electrons move inwards for a positive discharge and outwards for a negative discharge that the former is possible and the latter impossible. It is this divergence of the field of force which would prevent the formation and existence of the darts imagined by Dr. Dorsey.

G. C. SIMPSON.

Butterfly Migration.

IN NATURE, September 5, 1925, Dr. E. P. Felt, State Entomologist of New York, in an article on the " Dispersal of Butterflies and Other Insects," said, " It is our belief that determinate flight is a comparatively small factor in promoting the spread of insects, and that in many cases this is accomplished largely by drifting with the wind, . . . There are a number of records of apparently determinate movement by butterflies, . . . These cases may represent a true migration, though this is scarcely established by available data."

In a later article, " Physical Basis of Insect Drift," NATURE, May 29, 1926, Dr. Felt continued the discussion and said, " the general tendency has been to explain any widespread movement as a migration, that is, a somewhat determinate or purposive movement by hosts of insects. This attitude is due in part to our very limited knowledge as to the movements of the upper air currents, . . . Turning to the western hemisphere, there are several records of enormous swarms of this butterfly, *Vanessa cardui*, being observed in apparent migration in southern California in 1924 and 1926, the movement being from the south-east to the north-west. One of the observers suggests that the source or the origin was either the foothills of the Sierras or the Sierras proper. There is a possibility that these swarms originated at a considerably greater distance. They may have been carried into the upper air in regions bordering desert areas considerably farther south or south-east, in much the same way as suggested for this insect in the eastern hemisphere, since we have in both extensive desert areas constantly producing convectional currents, and after a certain altitude is attained, the probabilities of extensive drift are certainly excellent."

Doubtless the movements of some insect swarms cannot be explained without the help of the winds. But what is needed, at least in the case of the California 'migrations,' before a general conclusion is drawn, is a careful accumulation of facts. In the early spring of 1926, there was a migration of the 'painted lady' through Palo Alto, California, in the Santa Clara Valley. The movement lasted several days and cannot by any possibility be explained by wind drift. Neither the origin nor outcome of this migration is known; it is not even known whether the swarm started from one area or was cumulative, picking up members as it went; but at the height of the movement the facts were so plain that they could not be misinterpreted. During the two days of March 25 and 26, 1926, I was out of doors nearly all the time and my official duties took me over an area of several square miles in the town and its outskirts and to the open fields. I had opportunity to watch the flight at least six hours on each of those two days.

The flight was from south-east to north-west; that was natural enough, for nearly everything in California trends that way—the great valleys, the mountain ranges, the earthquake faults, the highways and the railways. Even the people drift that way. The numbers of the butterflies were so great that thousands of them were in sight at times in the open spaces. Prof. Doane, of the department of Entomology at Stanford University, paced some of them and found them going at a speed of fifteen miles an hour. "Many south-bound motorists had their windshields entirely obscured by the little insects crushed on the glass by their impact with the car. Radiators also became clogged by them."

The flight was straight, swift, steady and continuous, and all its features were in very striking contrast with the movements of the few white butterflies that were flitting about at leisure. The whole movement left the impression of wild energy, of hurry in a definite direction. I watched carefully, but I did not once during the two days see one of the butterflies alight during the hours of flight, except in one doubtful case; and before I could reach it, it was off again.

Aside from all the characteristic features of the flight itself, the records of the U.S. Weather Bureau for those two days make the wind drift hypothesis altogether untenable. What wind there was was from the north-west and the flight of the butterflies was against it. The barometric pressure was low; and explaining the pressure in the western part of the country the weather report said, "This pressure distribution has been attended by fair and warm weather in California." The highest temperature for the 24-hour period of March 24 was 84° F. and the lowest 50°. The weather throughout the State was fine and steady; the winds were good-weather winds, "gentle to moderate, northerly."

Such waves of life being occasional and not periodic, long-continued and systematic observation over large areas may co-ordinate their occurrence definitely with winter and spring weather conditions favourable to mass production and survival of the butterflies. Those same conditions may stimulate to a high degree the impulse that underlies the flight. The weather certainly has a profound effect not only on the number of broods but also on the intensity of insect life in the case of the little yellow 'alfalfa' butterfly, so destructive, in its caterpillar stage, to the alfalfa hay crop. When the weather is intensely hot in the Sacramento Valley, the males of the great swarms very commonly find and mate with the females before the latter can pull themselves loose at the end of the chrysalis stage or spread and dry their wings.

FRANK CRAMER.

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California.

The Inheritance of Brachypterous and Macropterous Wings in *Sitona hispidula*.

IN the genus Sitona some of the species are fully winged, but in others the wings are so reduced in size that flight is impossible. In at least two species wing dimorphism occurs. One, *S. humeralis* Steph., is described by Grandi from Italy as having brachypterous wings, but all the specimens of this species which I have examined from England are macropterous; in the other, *S. hispidula* F., I find that fully winged and brachypterous individuals are common and widely distributed throughout Britain. In the brachypterous form the wings are very small and have a truncated appearance owing to the absence of the apical portion which, in the normal wing, is bent under in repose. Examples of wing dimorphism have been recorded in other beetles, usually in genera which contain both macropterous and brachypterous species, but no investigation appears to have been made to ascertain whether the two forms interbreed, and if so, how the wing condition is inherited.

With these objects in view, breeding experiments were started in 1921 with *Sitona hispidula*. Weevils were collected from two localities in the Scottish Highlands in which the two forms tended to be segregated. In one (Invershin, Sutherland) 277 specimens have now been collected, but all have proved to be macropterous; in the other (Evanton, Ross-shire) only brachypterous individuals had been met with when the experiments were started, but further collecting has since shown that 5·81 per cent. of the weevils in this locality are long-winged and about 8 per cent. of those collected and used for breeding the brachypterous race have been macropterous. The consequence of this genetical impurity

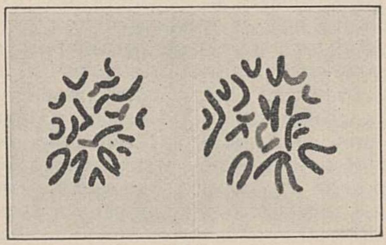

FIG. 1.—Chromosomes at spermatogonial metaphase of forms of *Sitona hispidula*. Left: brachypterous form. Right: macropterous form.

in the brachypterous strain will be referred to later. From the eggs obtained from these collected weevils the parent generation was reared in autumn 1922.

The larvæ feed upon the roots of clover and were reared in muslin-covered pots containing clover grown from seed in sterilised soil. Under such conditions the species is not easy to rear and the numbers so far obtained have been disappointing. Over 70 P_1 individuals were reared; all those bred from Invershin weevils were macropterous and those bred from weevils in the Evanton locality were brachypterous. The sexes were segregated on emergence, and crosses were later effected between long-winged males and short-winged females and vice versa. Fertile eggs were produced but progeny was obtained from only 8 couples, and this F_1 generation, which was reared in 1924, numbered 67. Of these, 5 were macropterous and the rest brachypterous. From one couple 23 individuals were reared and all were brachypterous. The macropterous individuals were obtained from three couples (consisting of both crosses), and each of these couples yielded also brachypterous offspring. One of the macropterous F_1 females was later crossed with a 'wild' brachypterous male, and 15 individuals, all brachypterous, were reared.

These results suggest that the brachypterous condition may be dominant and that the brachypterous parent in each of the three couples in which winged individuals occurred was a heterozygote. The F_1 males did not become sexually mature the same season and the F_1 females, which were then laying eggs, were mostly mated to 'wild' macropterous and 'wild' brachypterous males. From the former cross a total of 13 macropterous and 5 brachypterous offspring were obtained, each of the three families reared containing both forms; from the latter cross 23 brachypterous and 3 macropterous resulted. The 3 macropterous individuals occurred in two out of four families, and it is again possible that in these instances the 'wild' male was a heterozygote. These numbers are inconclusive, and these experiments are being repeated with the F_1 males which have since become sexually mature. It is hoped that specimens of the F_2 generation will be obtained this season.

Through the kindness of Dr. F. A. E. Crew, an investigation of the cytology of the two forms has been made by Dr. A. W. Greenwood at the Animal Breeding Research Department of the University of Edinburgh. Dr. Greenwood informs me that no difference has been found in the number of the chromosomes of the two forms. I am much indebted to him for the trouble he has taken in the matter and for his permission to reproduce his drawings here (Fig. 1).

I am anxious to obtain further particulars on the distributions of the two forms of *Sitona hispidula* and would be grateful for any information bearing on this subject.

DOROTHY J. JACKSON.
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The Stone Age of Ceylon.

THE short account of Dr. Fritz Sarasin's recent researches into the Stone Age of Ceylon, published in NATURE (April 17, p. 567), interests me deeply. It is the first intimation I have had with regard to any sort of expedition undertaken to test my conclusions with regard to the ages of the prehistoric artefacts that have been discovered in Ceylon. I could have wished that somebody connected with that expedition had communicated with me, because it would have been a pleasure to me to render any assistance of which I am capable.

The thesis set forth in my paper ("Outlines of the Stone-Ages of Ceylon," *Spolia Zeylanica*, vol. 11, Part 41, October 1919) is that the brothers Sarasin were mistaken in ascribing the manufacture of the stone implements that have been found beneath the floors of caves to their recent occupants—the Veddas (*Spolia Zeylanica*, vol. 4, Part 16, 1907). I did not, however, dispute the statement to the effect that a neolithic facies can be recognised in Ceylon, although it must be admitted that characteristically polished neolithic work has not been found.

I further maintained that the geological settings in which the older tools were discovered, and the types of tools displayed, proved them to be palæolithic. An attempt was made to subdivide these palæoliths into groups representative of cultural facies, and thus to produce rough outlines of the pre-history of Ceylon. I said (*loc. cit.* p. 123): "The above, I submit, are outlines of the Stone Ages of Ceylon—sketchy outlines, nothing more. A great deal of work must be accomplished and much detail added before these outlines can assume the aspect of a tolerable picture. Nor do I blind myself to the fact that some alteration of the outlines may be necessary. In the main, however, I fancy they will stand. For what they may be worth I give them here now; and it is for others to investigate and criticise."

The work upon which my paper was founded was brought to an end about ten years ago, and since then I have had ample time to review afresh all the evidence I collected in Ceylon, and to reconsider it in the light of discoveries I have made of similar cultures in other countries. It is now several years since I abandoned the supposition that a Chellean facies can be recognised in Ceylon. Indeed, I never definitely maintained it; for I said (*loc. cit.* p. 98): "The Chellean phase seems to be represented by the usual hand-axe, but I have found few of these." An Acheulean facies I never contended for, but I felt myself to be on fairly safe ground when ascribing many of the older artefacts (indeed the majority of them) to a Mousterian and Aurignacean culture. The view I hold at present is this:

There is some evidence of a crude 'pebble' culture which passes into a Mousterian facies, which in its turn passes into an Aurignacean facies. The youngest stone tools of Ceylon are those of the pigmy type and others associated with them. These I put tentatively at the palæo-neolithic transition.

I have not had the advantage of seeing Dr. Fritz Sarasin's paper in *L'Anthropologie*, so I cannot claim to be acquainted with the latest evidence relevant to the Stone Age or Ages of Ceylon.

It is interesting to note that in Uganda there is evidence of cultures similar to those of Ceylon, and in both of these countries, and on the high veld of the Transvaal, to my certain knowledge, tools of the Le Moustier facies are associated with large hand axes which, if collected without the rest of the suite, would suggest a Chellean culture.

While admitting the argument, that many tools are crude for no other reason than that the materials from which they are made is poor, to be a sound one, I think there has been, on occasion, a tendency to force it. It is astonishing what good work has sometimes been performed upon the poorest of material. Moreover, in Ceylon there are areas where good flint-like chert is to be obtained in abundance.

E. J. WAYLAND.
Geological Survey Office,
Entebbe, Uganda.

Equations for Thermionic Emission.

IN 1923, S. Dushman developed a general equation for thermionic emission, in agreement with the hitherto less frequently used one of the two equations suggested by O. W. Richardson, namely,

$$i = AT^2e^{-b/T}$$

when i = thermionic current in amp./cm.^{2}.
T = absolute temperature.
b = constant for the substance.
A = a universal constant.

A little later, in the same year, I. Langmuir, as a result of his researches on thermionic emission from thoriated tungsten filaments, proved that the thermionic emission of a body the surface of which is partially covered with a unimolecular layer of another substance, at any temperature, is proportional to

$$e^{\frac{-\{b_1\theta+b_2(1-\theta)\}}{T}}$$

when b_1 = constant for the substance covering fraction θ of the surface of the body.
b_2 = constant for the substance covering fraction $(1 - \theta)$ of the surface of the body.

So far, A was accepted by all authorities as a universal constant.

In the following year, however, K. H. Kingdon, as a result of very accurate observations on electron emission from thoriated and cæsiated tungsten, evolved an empirical modification of the thermionic emission equation, namely,

$$i = A_0\{a_1{}^\theta + a_2{}^{1-\theta} - 1\}T^2e^{\frac{-\{b_1\theta+b_2(1-\theta)\}}{T}}$$

when a_1 = constant for the substance covering fraction θ of the body surface.
a_2 = constant for the substance covering fraction $(1 - \theta)$ of the body surface.
A_0 = a universal constant.

While the relation between b and the contact potential of a substance has been established by Richardson, no further information on the nature of the *a* and *b* constants has been submitted so far.

I find on examination of the latest experimental data of S. Dushman, I. Langmuir, K. H. Kingdon, L. R. Koller, J. J. Weigle, C. Davisson and L. H. Germer, that, with absolute acceptance of those results for which greatest experimental accuracy may be claimed, and making slight allowance in those cases when, according to the investigators' records of experiments, and, in the case of S. Dushman, in accordance with the investigator's own opinion, such allowances appear to be warranted,

(1) '*a*' can be expressed as an exponential function of molecular volume

$$a = Be^{-nv}$$

when B and n are constants.

(2) '*b*' can be expressed as a hyperbolic function of molecular volume

$$b = Cv^{-m} - K$$

when C, m and K are constants.

There certainly may be doubt as to the validity of the '*a*' equation, as, unfortunately, only six elements are available, and of these, three and two each give a common point on the semi-long curve.

No such doubt is attached to the validity of the '*b*' equation, only one element, sodium, out of the fourteen elements, as divergent as tungsten and cæsium, appearing to be seriously out, and even in that case the discrepancy is capable of reduction in the light of Kingdon's equation. P. FREEDMAN.

70 Durley Road,
Stamford Hill, London, July 3.

Seasonal Sunshine in Great Britain.

IN reading the correspondence by Messrs. Harding and Phillips, in NATURE of May 29, regarding the rival claims of the south-east and south-west of England as to sunshine, it seems desirable to point out that in over-stressing quite trivial differences there is some danger of losing sight of the really important climatic fact of sensible equality between the two districts. The difference, for example, quoted between the average daily amount of sunshine through the year, namely, 4·53-4·49 hours, is just about two minutes a day in favour of the south-western counties. Even if such a difference deduced from a limited number of stations over no more than 35 years is real, which may be doubted, it could scarcely be of any medical or other practical importance.

Mr. Phillips objects to the inclusion of South Wales with the south-west counties on the ground that it lowers the sunshine values for the south-west district. The fact, however, that it does so rather tells, in my opinion, in favour of the south-east district, because the sunny conditions of the entire south coast of England stretch much farther north up the east coast than they do up the west coast, leaving the south-east district more centrally situated in the bright belt than the south-west. This may be verified from the sunshine maps in "Book of Normals," Sect. III., and may have some significance.

Sunshine is one of several elements that indicate a sharper seasonal variation when the daylight quarters are employed in preference to the thermal quarters which lag a month behind, namely, November-January, rather than December-February, etc. Still better is the seasonal variation exhibited by taking the four-month summer and winter (May-August) and (Nov.-Feb.) respectively, with the two pairs of equinoctial months for spring and autumn—a scheme coming increasingly into vogue. The English climate is such that the average meteorological sunniness or percentage of possible amount varies in the same sense as the astronomical sunniness or length of day. The result is that the actual amount of sunshine exhibits a very close relationship to the solstices in a land where the days are only 7½ hours at the low solstice and as much as 16½ hours at the high solstice. There are some climates, on the contrary, where, with cloudy summers and clear winters, the summer excess of sunshine is but slight. L. C. W. BONACINA.

27 Tanza Road, Hampstead, N.W.3.

Spatial Relations in a Dream.

IN a letter in NATURE of March 17, 1923, Mr. Gheury de Bray described some observations on time relations in a dream. He mentioned that hypnopompic (or hypnostrophic) images "are generally landscapes passing slowly before one's closed eyes, when in an almost awake condition . . . and having one's full reasoning powers while the illusion proceeds." It seemed "that the speed of succession of the images is an inverse function of the degree of wakefulness." A recent experience would tend to confirm these observations. A succession of faintly coloured landscape images was followed by a less ephemeral and apparently more vivid landscape, while there intruded, at first faintly, then more distinctly, sounds which became identified as knocking on the door. In the dream, the image (a well-known landscape) appeared as if the observer were in a vertical position. But after (? during) the disturbing sounds, an awareness of the actual (*i.e.* horizontal) position of the observer resulted in a conformable orientation of the image. As the observer was lying on his right side, the image seemed to have rotated 90° to the right, and thus the same relative position of observer and image, and also the continuity of the dream, were apparently preserved until completion of the wakening process. J. H. KENNETH.

The Homestead, Clynder,
Dumbartonshire, June 6.

Television or Teleoptics?

Is it too late to enter emphatic protest against admitting into English vocabulary such an excruciating hybrid as 'television'? I am afraid it is, otherwise this term would not have appeared in this journal (July 3, p. 18) as the title of A. R.'s interesting paper, thereby receiving the *cachet* of NATURE. Hitherto the terminology of science has been framed in scrupulous conformity with the unwritten law or rule against the fusion of different languages in a compound vocable. In this case there is all the less occasion for relaxing the rule because there is ready to hand the term τὰ ὀπτικά, employed by Aristotle to denote all that relates to vision—optics. Surely 'teleoptics' would be as convenient a name as the cacophonous 'television,' and would not upset the equanimity of pedants like myself. HERBERT MAXWELL.

Monreith.

Rotation and Relativity.

THE case of a vortex ring appears to have a special bearing on the question of rotation in relation to the relativity theory. An observer regarding such a ring can establish definitely that the ring is rotating with respect to himself, but not he with respect to the ring, as in the latter case he would see the ring pass round him, himself passing through the ring (together with the rest of the universe) at each revolution. These two cases are not equivalent, and it is suggested that this affords proof that rotation is not relative, but absolute. A. JAQUES.
J. S. MORGAN.

Liverpool, July 19.

Meteors and the Constitution of the Upper Air.

By Prof. F. A. LINDEMANN, F.R.S.

FROM the earliest times meteors and meteorites have probably been objects of wonder and interest. Astronomers have examined their radiants and established their connexion with certain comets, and physicists have been led by the study of their characteristics to quite unexpected conclusions about the conditions of the atmosphere at great heights. It is these latter developments that it is proposed to describe as briefly as possible.

Practically all meteorites which have been analysed are mixtures of metallic iron-nickel and of an olivine-like glass consisting of a double silicate of magnesium and aluminium, the proportions ranging from pure metal to pure glass. Since there is no real line to be drawn between meteorites and meteors, it seems legitimate to infer that meteors are composed of the same materials. Meteors appear at heights between 150 and 80 kilometres, and disappear at any height above ground-level, the meteorites of course actually reaching the ground. Their brightness varies within wide limits from the faint telescopic meteors invisible to the naked eye to the fire-balls said to rival the sun in brilliance, and their visible life may be anything between a fraction of a second and some fifteen seconds. Their recorded velocities range from some 10 km./sec. to about 100 km./sec., but it is clear from the nature of the case that these figures, especially in the higher ranges, cannot pretend to any great accuracy any more than can the estimates of luminosity. Deceleration along the path has never been certainly observed.

Presumably everybody would agree that meteors are extra-terrestrial particles moving with planetary velocities brought to incandescence by friction against the air. If further information, however, is desired, it is necessary to formulate somewhat more precisely what occurs when the meteor enters the atmosphere. To fix one's ideas it is as well to have in mind a typical meteor, for example, a meteor which appears at a height of 100 kilometres and disappears at a height of 80 kilometres after traversing a path of 60 kilometres in 1·5 seconds. It may be assumed that this meteor appears as bright at a distance of 150 kilometres as a first magnitude star, *i.e.* that it radiates in the 1·5 seconds of its visible life $3{\cdot}3 \times 10^{10}$ ergs.

The first question to be examined is the original size of the meteor. It is easy to show that practically all its initial energy will be converted into radiation; for its speed relative to the air is so great, and collisions between particles moving at this speed and air molecules consequently so violent, that they disturb the electrons; sooner or later these must return to their normal orbits, entailing, of course, the emission of radiation. If all the energy appears as radiation it is simple to calculate the mass of the particle. The total energy is $3{\cdot}3 \times 10^{10}$ ergs, the velocities 40 km./sec., so that its initial mass must have been 6·25 milligrams. If composed of iron, therefore, such a typical meteor would consist of a particle of diameter 1·15 millimetres, *i.e.* about as large as a small shot.

It is now possible to examine what occurs when such a particle approaches the earth's atmosphere. At first the atmospheric molecules are so rare that the effect of one collision with a molecule will have been dissipated before the next occurs. The result of such collisions will be inappreciable. Most of the energy will be used up in ionising and breaking up the molecules, a part will be radiated, a smaller part will perhaps cause local heating and evaporation, but enough light to render the meteor visible cannot be produced. As the meteor approaches the earth, the density of the air increases and the frequency of these impacts becomes greater, until at a certain height the original colliding molecules and the evaporated meteoric molecules have not time to escape laterally from in front of the advancing meteor before they again collide with air molecules. It is in this region that a cap of gas begins to form in front of the particle which protects it from direct impacts and from loss of heat. Heat now begins to flow from this compressed and heated cap of gas into the particle, ultimately causing it to volatilise.

It is only when evaporation is appreciable that a meteor becomes visible. However hot it might be, a particle the size of which is measured in millimetres could not be seen at a distance of a hundred kilometres; when it evaporates its vapour spreads out and is brought to rest by collision with the molecules of the air in a comparatively large cross-section. The radiation emitted in this process from an effective surface measured in square centimetres is what is observed.

It may readily be seen how this qualitative description may be put upon a quantitative basis, and used to obtain information about conditions in the upper air. Meteors cannot appear until the cap of gas begins to form, *i.e.* until the chance of a molecule escaping laterally without further collision with an air molecule is small. We know the speed at which the meteor is travelling; we can make a fairly close estimate of the average lateral component of velocity of the escaping molecules; and, as shown above, we can calculate the size of any particular meteor the distance, brightness, duration and speed of which are known. Therefore we can calculate what the density of the air must have been if a cap was to be formed. This should represent a minimum value for the density at the height of appearance of the meteor. Fig. 1 shows the calculated densities plotted on a logarithmic scale against the height of appearance of sixty-five meteors the speed, brightness, etc., of which had been observed.

A second check may be attained by considering what happens after the cap has formed. A simple application of the kinetic theory of gases enables one to calculate what fraction of the total heat produced by the impact of the moving meteor upon the air will actually flow through the cap into the meteor and become available for heating and finally volatilising it. The total heat is of course equal to the amount of air accelerated in unit time, *i.e.* the product of the atmospheric density with the cross-section and velocity of the meteor, multiplied by one-half the square of its velocity. Hence the flow of energy available for heating or volatilising in terms of the atmospheric density can be determined. Since we are fairly certain of the size and constitution and consequently heat capacity and latent heat of each meteor, we can calculate the amount of heat necessary to raise it to a temperature at which evaporation takes place (the point at which the meteor should appear), and also the amount of heat necessary to complete the meteor's evaporation (the point at which the meteor should disappear). Therefore the heights of appearance and disappearance can

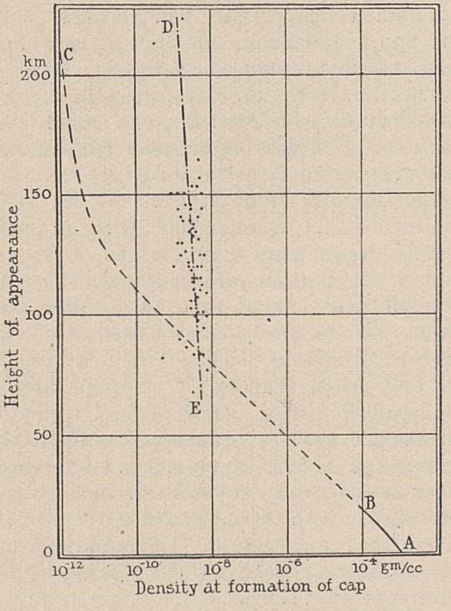

FIG. 1.

be calculated in terms of the observed meteoric characteristics and the atmospheric density, or inversely the atmospheric density can be calculated from the meteoric characteristics. Fig. 2 shows densities calculated on this basis for some hundred meteors plotted as crosses and dots against their heights of appearance and disappearance.

Though one could wish these points lay more closely upon a curve, their agreement may be regarded as satisfactory considering the uncertainty in the observational data, introduced more especially by the determination of the meteor's velocities. The two methods agree quite well among themselves, as is shown by the line DE repeated in Fig. 2 from Fig. 1.

In both figures the line AB represents the density of the air derived from *ballon sondes* observation and the dotted line BC the density calculated, assuming the observed temperature of 220° Abs. at a height of 11 kilometres to remain constant up to the confines of the atmosphere. It is clear that at great heights both methods give very much higher densities than correspond to this assumption. The only reasonable interpretation of the discrepancy seems to be that one is not justified in assuming that the temperature is constant from 25 km. to 150 km. simply because it has been shown to be constant between 11 km. and 25 km. In the accompanying figures the immediate observation of the temperature extends from A to B. In view of the evidence obtained from meteors, it seems quite unjustifiable to extrapolate from B to C. The meteor results would be satisfied if one assumed that the atmospheric temperature increased at heights above about 50 kilometres to something of the same order as the earth's surface temperature or perhaps somewhat higher.

This assumption may be supported by two lines of argument: the first is that further experimental facts seem to accord with it; the second is that it is to be expected *a priori* on the ground of known physical laws.

We may first consider four empirical facts which seem to agree with the view that the temperature at great heights is considerably higher than 220° Abs., the first two based on observations of meteors, the last two upon quite independent phenomena.

As has been pointed out, meteorites consist almost without exception of two components, nickel-iron and a glassy olivine-like substance mixed in varying proportions. It has been shown that a meteor can only become visible if it evaporates; therefore the temperature in the cap of compressed gas in front of the meteor must attain a temperature at which iron or olivine evaporate if the meteor is to appear. Now the maximum temperature which gas can attain under adiabatic compression is readily calculated if one knows the initial temperature and the compression ratio. In the case we are considering it may be shown that the compression ratio is $3v^2/2V_0^2$, v being the meteor's velocity and V_0 the molecular velocity. Hence the maximum temperature at the meteor's surface can be determined in terms of the velocity of the meteor and of the initial temperature of the air. Iron and olivine will only evaporate sufficiently rapidly to give rise to a visible meteor if the temperature is above 2000°. Meteors have been observed moving at a velocity of 12 km. per sec. Our formula tells us that air compressed by a particle moving at 12 km. per sec. can only reach

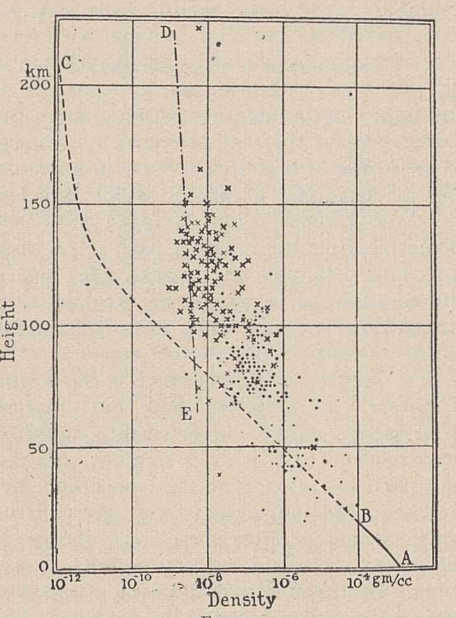

FIG. 2.

2000° if its initial temperature was 300°. This provides a very satisfactory and quite independent confirmation of the previous result.

A second somewhat more doubtful check may be found if the number of meteors which disappear at various heights is examined. It is found that whilst many meteors disappear between 100 km. and 60 km.

and many below 50 km., scarcely any disappear between 50 km. and 60 km. So far only one reason has been put forward to account for this quite unexpected fact. As we have seen, the hotter the air is, the greater the flow of heat into the meteor. For a meteor approaching the earth there should be, on our theory, a region in which the air's initial temperature falls from 300° to 220°, giving rise to a corresponding fall in the flow of heat. In this region one would expect a slower rate of evaporation and therefore diminished luminosity; this effect would, however, soon be outweighed by the increased friction and heat production due to increased air density. It is clear that such a region is the most unlikely one for a meteor to disappear; if it reaches it at all it will probably penetrate into the cooler but denser atmosphere below. The only explanation for the fact that no meteors have been observed to disappear at 55 km. seems to be that somewhere between say 52 km. and 57 km. the temperature of the air rises from the 220° of the stratosphere to the higher temperatures in the neighbourhood of 300° of the outer regions.

This view is confirmed in two very striking ways. As is well known, sources of sound are surrounded by alternate zones of audibility and silence. The distribution of these zones has been explained by the assumption that the velocity of sound increases at great heights. Recent investigations have shown that the height at which this increase should occur in order to account for the observed facts is of the order of 50 km. Clearly the well-known increase in velocity of sound with temperature would explain this otherwise inexplicable acoustical phenomenon if the view put forward above is correct, namely, that the temperature increases rapidly with height in this region.

A fourth argument in favour of this, though as yet not really a convincing one, is found in the well-known anomalies in the propagation of wireless waves. Notoriously the observed facts seem explicable only on the assumption that there is a conducting layer, the Heaviside layer, at a height varying from 50 km. at sunset to some 80 km. at sunrise. One can, with some plausibility, attribute this conducting layer to solar ionisation by day, but it seems difficult to account for its persistence at night otherwise than by assuming that the solar radiation forms some unstable compound which gradually reacts or breaks up forming ions during the hours of darkness. Such a substance is ozone, and it is clear, owing to the enormous increase in the rate of reaction with temperature, that the layer of maximum ionisation after sunset will be the lowest layer at which a high temperature exists, and that this will move up as the ozone is used up during the night to regions of lower density in which the rate of reaction is smaller. This hypothesis, of course, awaits many further checks, *e.g.* by observations at high latitudes during the polar night; but whatever the outcome, the observed fact that the height of the Heaviside layer after sunset lies between 50 km. and 60 km. seems very significant.

Finally, it might be worth while to discuss briefly the theoretical aspect of the high temperatures which observation seems to imply. Roughly speaking, above the troposphere, the region of convective equilibrium, the temperature is determined by radiation alone. Clearly a black or grey body would reach the mean temperature of the earth's surface, for this is the temperature at which emission balances absorption. The gases of the atmosphere are scarcely to be compared to black or grey bodies, however. The main constituents are, from the radiative point of view, somewhat dull and inert. Apart from the rather weak bands of oxygen in the red, neither oxygen, nitrogen nor argon has any well-marked absorption, and therefore emission bands at wave-lengths greater than 2000 Å.U., *i.e.* those to which practically all the sun's emission is confined. Infra-red absorption seems to be the function of the water-vapour, carbonic acid and the ozone. Now if one has a gas with strong absorption bands, even if mixed only in a small proportion with a neutral gas such as nitrogen, it will impose upon the whole mixture its own radiative equilibrium temperature. For the active gas will absorb radiation, and either pass it on to the neutral gas by a 'collision of the second sort' (Stoss zweiter Art) or re-emit it. Equilibrium between energy loss by impacts and gain from collisions will be established when the temperatures are equal. Hence we need only consider the 'active' gases water-vapour, carbon dioxide, ozone and oxygen.

Immediately above the troposphere, say from 10 km. to 50 km., the effect of the oxygen will be unimportant. Its absorption in the visible region is small; the rays it can absorb in the far ultra-violet will have been filtered out by the oxygen above. The influence of ozone might be more important, but it will be far outweighed by the effect of the water-vapour and the carbonic acid, the concentration of which in this region is considerable. The concentration of water-vapour at 11 km. will probably be about $2\cdot5 \times 10^{-8}$ gm./cm.^{3}, falling to about 4×10^{-10} gm./cm.^{3} at 55 km. The concentration of carbonic acid will be about $1\cdot2 \times 10^{-7}$ gm./cm.^{3} at 11 km., falling to about $7\cdot5 \times 10^{-12}$ gm./cm. at 55 km. The total amount of ozone above 11 km. amounts to about $1\cdot4 \times 10^{-5}$ of the whole amount of oxygen above this level, but its exact distribution is at present unknown. Presumably it is formed by the sun's ultra-violet radiation, which is absorbed by oxygen at wave-lengths below 2000 Å.U. In this case the amount formed per cm.^{3} must reach a maximum somewhere in the neighbourhood of 60 km. At greater heights the decrease in the partial pressure of oxygen outweighs the increase in intensity of the solar radiation. At lesser heights so much of the initial radiation of the effective wave-length has been absorbed that its loss is not counterbalanced by the increased concentration of oxygen. Hence it is above 50 km. that the concentration of ozone compared to the concentration of water-vapour and carbonic acid becomes important.

Now the equilibrium temperature of the air will be some sort of mean between the equilibrium temperatures in these three gases. The equilibrium temperature of carbon dioxide is easy to calculate. It has only one strong absorption band at $14\cdot6\mu$, and its temperature will be found by equating the emission from this band to the absorption. Since there is very little energy in this part of the solar spectrum, the carbon dioxide only absorbs energy from the layers below, more especially the earth, whilst it radiates both upwards and downwards. Its equilibrium temperature is therefore low, about 236°. The value for water-vapour is not so easy to determine, on account of its complicated absorption spectrum. It also absorbs in the infra-red only, and therefore has a low equilibrium temperature, probably between 200° and 220°. The case of ozone is even more complicated, since it absorbs not only at 9·5μ but also to a certain extent in the visible and very strongly in the ultra-violet below 3000 Å.U. Since a not inconsiderable fraction of the sun's radiation (probably more than 1 per cent.) lies in this region, this amount of heat as well as that abstracted from the visible part of the spectrum has to be accounted for in some form or other. It can only be re-emitted by pure ozone at a wave-length of 9·5μ, and its equilibrium temperature when exposed to sunlight and the earth's radiation would therefore be correspondingly high, probably well above 300°.

The general picture may therefore be drawn in outline as follows. At low heights in the troposphere we have convection and therefore an adiabatic temperature gradient. Above 11 km., at which height the temperature has fallen to the equilibrium radiative temperature, *i.e.* 220°, convection will be damped out. From here on one should have a compromise between the radiative equilibrium temperatures of the various active gases. At 11 km. the effect of water and carbon dioxide will preponderate and a low temperature will obtain, but as one ascends, the carbon dioxide disappears and the water diminishes, whilst the ozone with its high equilibrium temperature will become more and more dominant. Above 60 km. the effect of ozone should outweigh that of the other gases and the air should approach the equilibrium temperature of this gas, *i.e.* about 300°, as is indicated by the various more empirical arguments we have outlined.

Whether the agreement of all these forms of indirect reasoning is regarded as convincing is of course a matter of personal opinion. Final certainty can only be attained by direct measurement. It is much to be desired that such immediate observations be made at the earliest possible moment, but the expense and difficulty at present seem to be prohibitive.

Methods and Results of the American Museum Expeditions in the Gobi Desert, 1922-25.[1]

By Prof. HENRY FAIRFIELD OSBORN, For. Mem. R.S.

A NEW volume in the life-history of the earth, composed up to the present of twenty-four chapters (see table below), has been revealed by the discoveries of the Mongolian Expeditions of the American Museum of Natural History, under the leadership of Roy Chapman Andrews. Central Asia, and especially the region east and south-east of Chinese Turkestan, long remained the *terra incognita* of geology, palæontology, and, in a minor sense, of geography. In 1900 the lecturer predicted that the unknown high-plateau region of Central Asia, rather than the well-known Asiatic provinces on the south, such as the Siwalik Hills of India, explored by Hugh Falconer (1830–50), would prove to be the chief centre of the origin and distribution of the mammalia from which waves of north mammalian life radiated to the continents of Europe and of North America.

Andrews's expeditions in the three seasons of 1922, 1923, and 1925, have not only completely verified this prediction, but have also revealed the high Central Asiatic plateau region as the chief home of the terrestrial deinosaurian reptiles of Upper Jurassic and of Cretaceous time. In brief, these discoveries establish Mongolia as a chief centre of northern terrestrial life-history, from the close of Jurassic time onwards to the very close of Pleistocene time.

From the point of view of palæogeography, the outstanding geological discoveries of the expedition are:

First, this Central Asiatic continent of Gobia, as it has been named by Grabau, was for several millions of years extremely favourable to the evolution of reptiles, mammals, insects, and plants, and probably birds as well, hitherto known along the low-lying Cretaceous forelands of western Europe (such as the Wealden of England and Belgium), and in less degree of southern Asia. Secondly, this now terribly desert region of Gobia, traversed only by the gazelle and the wild ass, and thoroughly uninhabitable in the summer season, was abounding in life throughout Upper Jurassic, and throughout all Cretaceous and Tertiary time, sparsely forested, traversed by streams and rivers, with a limited seasonal rain-supply like the high-plateau region of Central Africa to-day. Thirdly, these dry and stimulating upland conditions of Tertiary time, as compared with the densely forested conditions of the Asiatic lowlands, have led to the recent prediction by the lecturer on returning from Iren Dabasu in 1923, that this region is the most likely one in which to search for the Tertiary ancestors of man, namely, those of Eolithic or Dawn-stone Age, though no traces of man have, as yet, been discovered by the expedition older than those of Lower Palæolithic age. The discovery of human and pre-human remains in Tertiary time has thus become one of the chief remaining objects of the expedition.

During the season of 1925 a great culture-camp, probably of Azilian-Campignian time, was discovered on the eastern slopes of the Altai Range, not far from Shabarakh, and not far from Djadokhta, where the now famous deinosaur eggs were discovered, far north of the Ordos locality explored by Licent and Teilhard de Chardin. In fact, these Upper Palæolithic artisans collected the broken shells of the deinosaur eggs with which to manufacture necklace ornaments, these perforated fossil shells serving as well as the recent eggshells of the giant Struthiolithus, the great ostrich of the Stone Age of Mongolia.

No human fossils have so far been found: the industrial levels are not as yet precisely determinable, but the chief anthropological fact is established that the Stone Age tribes spread over the borders of the Gobi Desert region during the Ice Age, establishing their quarries near the large lakes bordering the Altai Mountains on the east and fed by glacial streams. The geologists of the party have discovered traces of this glacial age along the summits of the Altai Range.

As for methods, by combining a very large caravan for the camel transport, which leaves Kalgan on December 1, and reaches the eastern base of the Altai Range on May 1, with an automobile train of five to

[1] Abstract of a lecture delivered by the author to the Geological Society of London on June 23.

seven cars, the expedition had the great advantage of speed over the previous geological explorers who crossed the Desert with camels only. The geologists and palæontologists of the party, Granger, Berkey, and Morris, with two field assistants, also had the advantage of prolonged experience in the field formations of the western United States, which, between the 50th and 40th parallels of latitude, present conditions remarkably similar to those found in the Desert of Gobi. Raphael Pumpelly in 1864, Ferdinand von Richthofen in 1872, and V. A. Obruchev in 1909, found no fossils, except the single rhinoceros-tooth brought back by Obruchev; and other geologists traversing this region have thought that there were no fossils to be found.

As to geology, the expeditions beginning on April 15, 1922, 260 miles north-west of Kalgan, and encircling in 1922, 1923, and 1925, the entire Gobi district in a 3000-mile radius, discovered no fewer than twenty-three distinct geological formations extending downwards from Lower Pleistocene time into Lower Cretaceous and Upper Jurassic. These have a thickness varying from 50 to 3000 feet, and were deposited either in the great flood-plains of ancient rivers, or in broad river-valleys, or at the base of ancient mountain-chains, or in the torrents of great sandstorms such as the Djadokhta, testifying to the secular vicissitudes of climate, mostly of rainfall, terminating with the pluvial period of the Ice Age, followed by a long period of secular desiccation.

Some of these formations prove to be closely contemporaneous with the Lower Cretaceous Wealden of western Europe, owing to the presence of large iguanodonts, equalling the famous *I. bernissartiensis* of Belgium in size. The oldest are as early as the Oxfordian and Purbeck of Upper Jurassic times. The climax of reptilian life is reached in the marvellous sand-swept deinosaur breeding-grounds (Djadokta formation) of Middle Cretaceous time, where nests of fossil eggs and innumerable skulls and skeletons of Protoceratops are found in almost perfect preservation. This is the richest deinosaur deposit thus far discovered in Eurasia.

As to the fifteen succeeding Tertiary formations, they compose so many unbroken chapters of the history of Mongolian life as extend from the basal Eocene Gashato to Upper Oligocene time, where the giant Baluchitherium occurs, as discovered also in Baluchistan by Cooper of Cambridge, and in Chinese Turkestan by Borissiak of Moscow. The Miocene and the Pliocene periods are represented by four formations.

Thus the scientific staff of the Expedition, between the years 1922 and 1925, has interpreted one of the most typically desert regions of the entire world by means of the twin sciences of palæontology and geology, and the wilderness of Mongolia now blossoms forth with its glorious story of prehistoric life, as the homeland of the greater number of known upland terrestrial vertebrates.

STONE AGE, TERTIARY, AND CRETACEOUS FORMATIONS OF MONGOLIA, IN DESCENDING ORDER.

Regions.	*Formations and Thickness estimated in feet.*		*Probable or estimated Geological Age.*	*Human Culture, Mammalian and Reptilian Life-zones.*
Altai Piedmont	Shabarakh Usu	50+	Upper Palæolithic	? Azilian-Campignian.
" "	Orok Nor	5–40	Middle Palæolithic	? Aurignacian-Mousterian.
			Lower Palæolithic	? Acheulean or ? Eolithic.
Orok Nor basin	Khunuk	27–120	Lower Pleistocene	? Equus, ? Mastodon.
Tsagan Nor basin	{Tsagan Nuru	50±	Lower Pleistocene	? Equus, ? Struthiolithus.
	{Gochu	1000±		
Eastern Altai Mts.	Hung Kureh	1000	Upper Pliocene to Lower Pleistocene	Hipparion. Camelus zone.
Iren Dabasu basin	Pang Kiang	500	Miocene; age doubtful	Rodents. ? Ochotoma.
Eastern Altai Mts.	Loh	100–1000	Middle Miocene	Mastodon (Serridentinus) zone.
" " "	Hsanda Gol	3000	Middle to Upper Oligocene	*Baluchitherium grangeri* zone.
Iren Dabasu basin	Houldjin	30–50	" " "	" " "
Orok Nor basin	Elegen	0–200	" " "	? Mammals undetermined.
Uliassutai Trail	Baron Sog	5–30	Middle Oligocene	? Large Titanotheres.
" "	Ulan Gochu	2–60	Lower Oligocene	? " "
Uliassutai Trail	Ardyn Obo	500	" "	*Brontops gobiensis* zone.
" "	Shara Murun	200±	Summit of Eocene	*Protitanotherium mongoliense* zone. *Amynodon mongoliensis.*
Shara Murun basin	Tukhum	50+	Upper Eocene	Titanotheres abundant.
Iren Dabasu basin	Irdin Manha	? 100	" "	Eudeinoceras, Andrewsarchus zone.
" " "	Arshanto	40–100	? Middle Eocene	Lophiodonts-Schlosseria zone.
Kholobolchi Nor basin	Kholobolchi	1000±	? Lower Eocene	Coryphodon zone.
Eastern Altai Mts.	Gashato	300	Basal Eocene (Palæocene)	Prodeinoceras zone. Palæostylops.
Eastern Altai Mts.	Djadokhta	500	Middle Cretaceous	Protoceratops andrewsi zone.
N.-E. of Shabarakh Usu	Dohoin Usu	200±		Deinosauria, Crocodilia, Chelonia zone.
Iren Dabasu basin	Iren Dabasu	180	Lower Cretaceous. ? Wealden	Iguanodont. Ornithomimidæ.
Oshih basin	Ashile	2000	Upper Jurassic	Psittacosaurus zone. Asiatosaurus. Prodeinodon.
Tsagan Nor basin	Ondai Sair	500	" "	Protiguanodon zone.

The British Association at Oxford.

BY the time that the present issue of NATURE is in the readers' hands, the meeting of the British Association for the Advancement of Science will be in full progress. The Sheldonian Theatre, where Mr. Disraeli made the celebrated announcement that he was "on the side of the angels," will have been the scene of yet another important gathering; and the chief social events of the meeting, namely, the receptions by the Vice-Chancellor, the Mayor, and the Dean, Canons, and students of Christ Church, will have taken place at the Examination Schools, the Town Hall, and Wolsey's great foundation respectively.

Among the institutions of Oxford which combine historical with scientific interest, not least must be reckoned the Botanic Garden on the south side of the High Street, opposite Magdalen College. This, the earliest botanic garden now existing in England, was founded by Henry, Lord Danvers, in 1621, and was intended by him to be put in the charge of John Tradescant, gardener to King Charles I., who, however, died before the appointment took effect. The scientific movement in Oxford, which began in the days of the Commonwealth under the auspices of John Wilkins and his associates, and culminated in the establishment of the Royal Society soon after the Restoration, was carried on by Elias Ashmole. It was to Ashmole that the younger Tradescant bequeathed the natural history and antiquarian collection begun by his father, and to Ashmole himself the University was indebted for the gift of the Tradescant collections, to which that industrious collector had made large and important additions.

It was not until 1669 that Lord Danby's 'physick garden,' which had failed to secure the services of either Tradescant, was equipped with a regular professor. This was Dr. Robert Morison, who delivered courses of lectures, one of which was attended in 1675 by John Evelyn. A great benefactor to the establishment was Dr. William Sherard, who left a permanent endowment for the professorship of botany. It was Sherard who invited the famous Dillenius to take up his residence in England, and provided, by the terms of his will, that Dillenius should be the first occupant of the Sherardian chair. Linnæus, who visited Oxford in 1736, was entertained by the professor, and endeavoured, though without success, to convert him to his new system of classification. In spite of their inability to see eye to eye in botanical matters, the two men formed the highest opinion of each other's merits. The Oxford professor, for his part, "detained Linnæus for a month without giving him an hour to himself the whole day long; and at last took leave of him with tears in his eyes, after having given him the choice of living with him till his death, as the salary of the professorship was sufficient for them both." The Swedish botanist declined this generous offer, but after his return home wrote, "In Anglia nullus est qui genera curet vel intelligat praeterquam Dillenius," and moreover, "founded the genus Dillenia, of all plants the most distinguished for the beauty of its flower and fruit, like Dillenius among botanists" (Gunther, quoting Claridge Druce).

The next professor, Dr. Humphrey Sibthorpe, is said to have given only one lecture, and that a bad one; but his son and successor John was a man of different stamp. Besides projecting and partly carrying out a great work on the flora of Greece, he founded and endowed the professorship of rural economy which still exists.

A new epoch of efficiency and activity dawned with the appointment of Dr. Daubeny in 1834. The energy and persistence of the new professor speedily resulted in considerable additions to the buildings and in extensive improvements in the usefulness and attractiveness of the garden. The reforms set on foot by Daubeny have been continued and developed by his successors, notably by Bayley Balfour, Sidney Vines, and the present occupant of the chair of botany, Sir Frederick Keeble.

Part of the extensive scheme devised by Acland for bringing together in one place all the various departments of natural science, with the view of "the development of a complete national education in science," involved the removal of the lecture-rooms, laboratories, and other appliances for botanical study to the neighbourhood of the new museum, while a 'garden of instruction,' some five acres in extent, would have been established in the Parks. A clever skit by Mr. Edward Chapman, of Magdalen College, cast ridicule on the scheme and did much to cause its abandonment. Many, however, will still think that the plan had great advantages; and it is to be observed that it has since been found quite impossible to carry out within the precincts of the ancient garden all the botanical teaching which has now become necessary.

A very attractive feature of the present meeting will be the opportunity of visiting, by the kindness respectively of Mrs. G. H. Morrell, Sir Arthur Evans, and Mr. Henry Balfour, their exceptionally fine gardens and grounds in the immediate neighbourhood of Oxford. The grounds of Headington Hill Hall, the residence of Mrs. Morrell, are far-famed for their beauty, their extent, and their picturesque situation on the side of the hill overlooking the city. From them can be seen the best views of the University and College buildings to be had anywhere. Youlbury (Sir Arthur Evans) and Langley Lodge (Mr. H. Balfour) have also their own points of exceptional beauty and interest. As an example of a city garden, that of Exeter College, with its boundary formed by the Divinity School and the library of Humphrey Duke of Gloucester, cannot easily be surpassed. The party to be given in these pleasant surroundings by the Rector and Fellows of the College is certain to be highly appreciated by their guests.

The conversaziones to be held at the Ashmolean and University Museums on the evening of August 10 will end the public entertainments of the present meeting. Both are likely to be especially attractive to the devotees of the arts and sciences respectively. The short lectures, demonstrations, and exhibits at the University Museum have been chiefly organised by members of the Junior Scientific Society of the University, an association the zeal and activity of which are among the most hopeful signs of present-day life in Oxford.

F. A. D.

Dr. D. H. Scott writes: "In addition to the list given in NATURE of July 31 of distinguished guests from abroad attending the Oxford meeting of the British Association, may I mention that we are also expecting Dr. R. Kräusel, of Frankfurt? In conjunction with Dr. H. Weyland, Dr. Kräusel has made important discoveries in the Middle Devonian flora, showing that the plants of that early period were considerably more advanced than had been realised before. He is giving an account of his results in the Section of Botany."

Obituary.

REV. T. R. R. STEBBING, F.R.S.

THERE must be very many students of the Crustacea scattered all over the world who will read with a sense of personal loss that the Rev. T. R. R. Stebbing is dead. Some of us who are now grey-haired look back to the time when we first discovered the unfailing kindness and patience which allowed the most ignorant beginner to dip into his endless stores of knowledge, and find it hard to realise that we can no longer 'ask Stebbing' when we come to some particularly knotty point in nomenclature or bibliography.

Thomas Roscoe Rede Stebbing was the son of the Rev. Henry Stebbing, D.D. He was born in London on February 6, 1835, and was the seventh in a family of thirteen, several of whom inherited the literary tastes and abilities of their father. From King's College School he went to Lincoln College and later to Worcester College, Oxford. His academic career was distinguished, but his studies were exclusively classical and literary. He obtained a second in *Lit. Hum.* in 1856 and a first in law and modern history in 1857. In 1858 he took orders, being ordained, it is interesting now to recall, by the Bishop of Oxford, Samuel Wilberforce. Masterships at Radley and Wellington were followed by a fellowship and tutorship at Worcester College, of which he was in turn vice-provost and dean.

Stebbing resigned his fellowship in 1867 on his marriage with Mary Anne, daughter of W. W. Saunders, F.R.S., the well-known entomologist, and took pupils, first at Reigate and afterwards at Torquay. At Torquay he became acquainted with some enthusiastic local naturalists, among whom was William Pengelly, under whose inspiration he began to take an interest in natural history. He has told how it was that, already in middle age, he was led to the serious study of zoology. "Having become much interested in Natural Science, and having also been trained in the strictest school of evangelical theology, I had conceived it to be a duty to confute the vagaries of Darwin. But, on reading the 'Origin of Species,' as a preliminary, it has to be confessed that, instead of confuting, I became his ardent disciple." He threw himself into the controversy then raging, and a volume of "Essays on Darwinism" published in 1871, as well as a letter to NATURE in April of the same year, replying to a scornful *Times* review of the "Descent of Man," drew upon him, as we may gather, a good deal of ecclesiastical hostility. From then onwards he continued his advocacy of a liberal theology in essays and magazine articles, some of which are reprinted in his "Faith in Fetters" (1919) and "Plain Speaking" published only a few months ago. Some of these essays now read like echoes of "old, unhappy, far-off things,"—so far off, at any rate, as Dayton, Tennessee!

It was a desire to become acquainted at first hand with some of the facts of Nature on which the evolution theory rested that led Stebbing to take up the study of Crustacea. After some early papers on British species he was entrusted, on the recommendation of his friend Canon A. M. Norman, with the description of the Amphipoda obtained by the *Challenger* expedition. He gave up teaching in order to devote himself to this task, and after some six years' work he produced his report (1888), which fills three of the large quarto volumes of the *Challenger* series. It is not too much to say that this report set a new standard for systematic carcinology, especially in its admirable bibliographical introduction, giving a critical analysis of everything that had been written on the Amphipoda down to the year of its publication. This report and the scarcely less important volume on the Gammaridea contributed to "Das Tierreich" (1906) are Stebbing's best-known works, but a long series of memoirs and lesser papers, extending over more than half a century, contained contributions of fundamental importance on every order of the Crustacea.

Occasional more popular articles and addresses, as well as his "History of Crustacea" (International Science Series, 1893) and the "Naturalist of Cumbrae" (1891), a biography of Dr. David Robertson, give scope for the play of a whimsical and almost boyish sense of fun.

'Scholarly' is the adjective that comes first to the pen in writing of Stebbing's work. Trained exclusively in the disciplines of the older learning and turning to the study of science only in mature life, he brought to it that feeling for antiquity, that sense of the historical perspective of knowledge, which is often wanting in those whose education has been definitely scientific. His erudition seemed boundless, but he wore it with so unaffected a modesty that rash controversialists, less well equipped, were sometimes lured on to their confusion.

Stebbing was elected a fellow of the Royal Society in 1896. He served as a vice-president of the Linnean Society, and later (1903–1907) as zoological secretary. He took a prominent part in the movement for the admission of women to the fellowship of the latter society, and his wife, an accomplished botanist, was one of the first group of ladies admitted. Of the many honours that came to him, none was more valued than the Linnean medal awarded to him in 1908.

Mr. Stebbing died at Tunbridge Wells, where he had resided for many years, on July 9.

W. T. CALMAN.

WE regret to announce the following deaths:

Dr. R. H. Clarke, formerly demonstrator of physiology at St. George's Hospital, London, author of an atlas of sections of the brain of the cat and monkey published in the *Journal für Psychologie und Neurologie* and joint author with Victor Horsley of a number of papers in *Brain*, on June 22, aged seventy-five years.

M. Albert Frouin, for many years in the physiological research laboratory of the Pasteur Institute, Paris, who has worked on the physiology of digestion, the biochemistry of bacteria, the tubercle bacillus, and particularly the antitubercular action of the salts of the rare earths.

M. Albert Viger, for thirty years president of the French National Horticultural Society, and seven times Minister of Agriculture, on July 8.

News and Views.

DR. A. W. BORTHWICK, formerly lecturer in forest botany at the University of Edinburgh and afterwards serving under the Forestry Commission, was recently appointed to the new chair in forestry at the University of Aberdeen. In his inaugural address, after a preliminary survey of the increasing utility of the products of the forest in supplying many of the everyday needs of the public, and the consequent necessity for the conservation and efficient management of forests, he dealt with the rôle of the university in connexion with the practice of forestry. He considers that a university school of forestry should have three principal aims: (1) To give instruction in the theory and practice of forestry; (2) to conduct research; (3) to advise and assist the owners of forest lands in the management of their woods. "Each of these aims," said Prof. Borthwick, "is important in itself, and not the least important is No. 3. The Department can be of direct help to owners of forests and forest lands, by correspondence, lectures, and personal inspection of woodlands, plantations and lands to be planted. In return the Department is kept in close touch with field problems as they arise, and this is bound to be of use in indicating the kind of instruction to be given to young foresters in training, and also in bringing to notice problems for the elucidation of which further research is required. By concentration on (3) such aims and correlating them into an organised unity, the Department will be kept from going to sleep, a condition only too liable to occur when an overdose of academic forestry is indulged in."

IN the above remarks Prof. Borthwick would appear to be referring to British woods alone. Whilst these are of very great utility for the more elementary portions of the practical courses given to the university forestry student (the future commissioned officer), the latter would be very inadequately equipped for his work, either in Great Britain or out in the Empire forests to which service the greater proportion of the university-trained men go, were the instructor to confine the practical work or his own studies to Great Britain. Prof. Borthwick correctly recognises the importance of this part of the work, and gives an interesting dissertation on the varied branches of forestry education. But his address does not lay stress on the necessity of giving to the future university graduate in forestry practical courses on a far higher plane than anything which Great Britain can provide. To turn out graduates for service either at home or in the Empire (where the demand is far larger) necessitates a continuous study on the part of the staff of the changing conditions and progress (alluded to by the author himself) constantly taking place in the management of the forests of the world. In practice it has been found that only by such means can the forest officer of the future be sent forth with that wide and unbiassed outlook on forestry problems which it is so desirable that he should start with—in so far as it can be implanted in the minds of young men in the all too short space of a university career.

THE Wellington correspondent of the *Times* announces that Dr. Ernest Marsden, assistant director of education, has been appointed permanent secretary of the new Industrial and Scientific Research Department that is being established in New Zealand. This action has been taken on the recommendation of Sir Frank Heath, Secretary of the Department of Scientific and Industrial Research in London, who has recently completed a tour of investigation in Australia and New Zealand. We referred in our issue of May 15, p. 697, to Sir Frank's recommendations for the reconstitution of the Commonwealth Institute of Science and Industry in Australia, and, again, in the issue of July 10, p. 57, to the Bills which have been passed by the Commonwealth House of Representatives to give effect to these recommendations. In introducing the measures, the Prime Minister, Mr. Bruce, referred to the large sums spent on research in public and semi-public institutions in the United States and stated that, for the present, the new Council for Scientific and Industrial Research in Australia will devote its attention to a limited group of problems—liquid fuels, cold storage, and the preservation of foodstuffs, forest products, animal diseases and pests, plant diseases and pests. It is to be hoped that the Council's activities will soon be extended, while the Science and Industry Fund of 100,000*l*., which has been established for providing assistance to those engaged in scientific research and in the training of students in scientific research, should prove an important step towards meeting the very real need in Australia for competent research workers.

THE personnel of the Commonwealth Council for Scientific and Industrial Research has been announced in the Australian House of Representatives by the Prime Minister. The members are: *Executive Committee*: Mr. G. A. Julius (chairman), Mr. W. J. Newbigin, and Prof. A. C. D. Rivett. *Chairmen of State Committees*: N.S.W., Prof. R. D. Watt (Agriculture); Victoria, Sir David Orme Masson (Chemistry); Queensland, Prof. H. C. Richards (Geology); South Australia, Prof. T. Brailsford Robertson (Biochemistry); Western Australia, Mr. B. Perry (Manufacturing industries); Tasmania, Mr. P. E. Keam (Agricultural and stock-breeding industries). *Co-opted Members*: Prof. E. C. Goddard, Queensland (Zoology and botany); Prof. H. A. Woodruff, Victoria (Veterinary pathology). The Council held its first session on June 22-25, and adopted general plans for work during the next twelve months. Its proposals apply chiefly to primary industries. As was foreseen by Sir Frank Heath, the operations of the Council will be hampered for some time by the lack of a supply of highly trained young investigators. Assistance will be sought from abroad, and extensive plans are being put into effect for sending promising Australian graduates to England and the United States for special training.

THE radio communication Bill, which was to regulate the use of radio in the United States, failed to pass

Congress before the long vacation. During the next six months, therefore, there is a risk of serious confusion in broadcasting development in the States. The Department of Commerce has allotted 89 wave-lengths to 528 stations, and there are 650 further applications for station licences awaiting consideration. Now, however, they are left without authority either to grant or to refuse any application. The Secretary of Commerce, Mr. Hoover, has hitherto been regulating all transmission mainly through a 'gentleman's agreement' with the broadcasters themselves. The Bill discussed in Congress expressly declared that it was the intention of the Federal Government to preserve the channels of radio transmission as "perpetual mediums under the control and for the people of the United States." Licences are limited to two years and are not available to aliens or to any applicant "who has been convicted of monopolising or attempting to monopolise the radio business." Broadcasting is apparently becoming very profitable as an advertising medium in the United States. According to the *Times* of July 27, so much as 50,000*l*. has been offered for the transfer of a licence. Licences were recently issued in Chicago to the Moody Bible Institute and the Chicago Federation of Labour. To farmers in the United States broadcasting has proved to be a great boon. Mr. Pickard, the radio officer of the Department of Agriculture, has stated that broadcasting is doing more for the farmer than any other single contribution of science during the century. Farmers living so far as 60 miles from a railway have been induced by radio lectures to change their methods of farming to more profitable systems.

ALTHOUGH windmills have been in use for more than a thousand years, yet accurate data as to their efficiency cannot easily be obtained. The Institute of Agricultural Engineering of the University of Oxford has therefore made a useful contribution to our knowledge of the subject by publishing a report on the use of windmills, more especially for the generation of electricity. A windmill experimental station was erected on the Annables estate, midway between Harpenden and Luton. The field slopes south-westward towards the Dunstable road, and seven windmill plants of various types have been erected on it. The site is a good one, as it obtains the benefit of unrestricted winds from all directions. Full results of the economic, technical and meteorological observations extending over a period of one year are given. The cost per electric unit utilised varied between 12·7 pence and 4·0 pence. By using improved wheels the cost of production for the smaller and more inefficient mills could be reduced by 30 or 40 per cent. Considering the very small dynamos used, having an output of only a few horse-power, these results are quite satisfactory. Some of the plants begin to operate when the wind attains a velocity of about six miles per hour and cease operating when the velocity falls to five miles per hour. The output increases more rapidly than the velocity of the wind. The results prove that, in districts remote from a public electric supply, small windmill power schemes might prove useful and economical. Those who already own an engine-generating set and desire to supersede or supplement it should consider adopting wind power. It is also to be remembered that on higher sites than Harpenden or on districts nearer the coast better results would probably be obtained. In Denmark and Germany considerable use is made of wind power in generating electricity.

ALTHOUGH it may be pleaded that a state of chaos in human undertakings has a certain evolutionary value, as being indicative of potential progress, the complexity of civilised life nevertheless necessitates the logical classification of a vast amount of important information as a condition of ordered progress. Bibliographies of scientific and technical literature come well within this category, and their number is constantly increasing. Collective indexes are indispensable to the scientific worker, and although they are very costly to produce, the labour and expense involved in their production cannot be obviated. Bibliographies of general subjects are less essential and have been comparatively neglected, hence we welcome the publication of "A Bibliography of Research" by the National Research Council of the United States, a small volume containing about 800 references to articles on research that have appeared in scientific, technical and trade journals during the years 1923, 1924 and 1925. To facilitate reference, the material has been subdivided into forty classes, a difficult task which has involved a considerable number of duplicate entries; thus four of five references to the National Physical Laboratory given under the heading 'Physics' are repeated in full, and with different index numbers, under the heading 'Research—General: Laboratories.' The bibliography might also be criticised from the point of view of completeness, to which, however, no claim is made. Thus only one of the annual reports of the Committee of the Privy Council for Scientific and Industrial Research is included; and there are very few references to German (11) and French (18) literatures, whilst other continental countries appear to have been neglected. Although criticisms of this kind are not difficult to make, the publication will undoubtedly be most useful to all interested in the general subject of research, and the National Research Council is to be congratulated upon its production.

IT is gratifying to note that anthropological investigations in Canada continue to be actively prosecuted under official auspices. The report of the Department of Mines for the fiscal year ended March 25, 1925, which has just been issued, contains a report of the Victoria Museum covering the work of the anthropological and the biological divisions. Apart from the work of cataloguing, arranging, and preserving specimens, the anthropological staff has been engaged on a number of field expeditions. Mr. Harlan I. Smith visited the Bella Coola Indians of British Columbia, Mr. C. M. Barbeau was engaged among the Gitksan Indians of British Columbia, Mr. D. Jenness continued his work of the previous fiscal year among the Carrier and Sikani Indians of British Columbia, and Mr. F. W. Waugh visited the

Montagnais Indians of the Lower St. Lawrence, whence unfortunately he did not return, as he disappeared mysteriously after visiting an Indian reservation in September 1924, and has not since been traced. A large number of specimens, photographs, and phonograph records were added to the Museum collections as a result of these expeditions, and records and studies of specific subjects under observation have appeared in various scientific journals.

THE growth of the regional survey movement as the geographer's special field of research and contribution to our knowledge of Great Britain has been marked in recent years. The Geographical Association in helping to foster this movement has published in the *Geographical Teacher*, vol. 13, No. 75, a list of libraries, museums, universities, and societies which have in their keeping or are undertaking surveys for their respective areas, also a long list of actual surveys and a list of civic surveys that have been published. The Association also hopes to make a special collection in its lending library of works and bibliographies dealing with special regions. A bibliography of Hertfordshire is published as a specimen. The lists given in the present number do not claim to be exhaustive, and will be added to from time to time as more information is sent to the Secretary of the Regional Survey Committee, Geographical Association, Marine Terrace, Aberystwyth. Some useful suggestions are also made for uniform systems of registration on maps.

AT a representative meeting held in March last, it was resolved to found an Institution of Fuel Technology, and a committee was appointed to prepare a constitution. A further meeting was held on July 30, when the draft constitution was formally adopted and the following officers were elected: *President*—Sir Alfred Mond; *Vice-Presidents*—Lord Aberconway, Prof. H. B. Dixon, Sir Robert Hadfield, Bart., Lord Weir, and Mr. D. Milne Watson; *Council*—Mr. R. A. Burrows, Sir Philip Dawson, Dr. F. A. Freeth, Sir William Larke, Dr. R. Lessing, Mr. M. Mannaberg, Sir Edward Manville, M.P., Mr. S. McEwen, Lord Montagu of Beaulieu, Sir Richard Redmayne, Admiral Sir Edmund Slade, Mr Wallace Thorneycroft, Dr M. W. Travers, Prof. R. V. Wheeler, Mr. W. A. Woodeson, Mr. G. R. Thursfield, Mr. T. Hardie, Mr. A. H. Middleton, and Mr. W. M. Selvey; *Hon. Treasurer*—Sir William B. Peat; *Hon. Secretary*—Mr. Edgar C. Evans, Caxton House (East), Tothill Street, S.W. An autumn or winter meeting for the discussion of papers is to be arranged.

A RATHER severe earthquake, strong enough to throw down a few chimneys and to fissure buildings, was felt in Jersey on July 30 at 2.18 P.M. In France it was felt at St. Malo and Rennes; in England, at Bournemouth and other places on the coast of Sussex and Hampshire. In strength and area of disturbance, it closely resembles two others that have visited the same district during the last half-century. The earlier of these, on January 28, 1878, disturbed an area of about 68,000 square miles, including Havre, Rouen, and Paris, as well as London, Bovey Tracey, Brighton, and St. Leonards. Its centre lies probably a short distance to the east of Jersey. Again, on May 30, 1889, another, and stronger, shock was felt over about the same area, and originated in or close to the same focus.

THE meeting of the British Association at Oxford in 1894 is probably best remembered as the occasion on which Lord Rayleigh and Sir William Ramsay, who have both since passed away, announced the discovery of the new gas argon in the atmosphere. In an article in the August issue of *Discovery*, Sir Oliver Lodge gives some reminiscences of the meeting and makes it clear that it should also take its place in the history of radio-telegraphy. At that time, Hertz had recently died and as a memorial to him Sir Oliver had repeated some of his experiments on the transmission of electromagnetic waves at the Royal Institution, using the Branly iron filings coherer and galvanometer as receiver, instead of the original point coherer and telephone. These experiments were shown again at the British Association meeting, and long and short signals corresponding to the Morse code were transmitted through the air from a neighbouring room to the large lecture theatre of the Oxford Museum, where they were demonstrated to an enthusiastic audience by the aid of a Kelvin mirror galvanometer.

WE have recently received from Prof. S. A. Forbes, Chief of the Natural History Survey Division of the State of Illinois, a reprint of a paper entitled "The Lake as a Microcosm," originally read and published in 1887. This paper, of some fourteen pages, was reprinted many years ago, but has long been out of print. The descriptions of conditions—physical and faunistic—apply especially to the lakes of Illinois, and the paper has therefore been much used by the students in the State University, while reference to problems of general interest has led to a demand for it also elsewhere, and to its reissue in the *Bulletin of the Natural History Survey* (vol. 15, article 9).

THE Ministry of Agriculture and Fisheries has recently republished its various leaflets on "Insect Pests of Farm and Garden Crops" in collected form as Section Volume No. 11. Altogether twenty-seven leaflets are reprinted and they form a volume of 111 pages, including introductory remarks on the general principles underlying the application of control measures. The production of these leaflets has greatly improved in recent years, and the illustrations are of a higher standard. The information concerning the habits and methods of combating different pests is trustworthy and up-to-date, the results of recent research being incorporated in easily understandable language. There is no doubt that many growers will welcome the appearance of so much practical information in a form more convenient than that of separate leaflets, which are easily lost unless systematically filed. The low price of 1*s*. 3*d*. (post free) should bring the volume within reach of all who are likely to benefit by consulting it. It is obtainable from the Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1.

THE "Statistical Report of the Health of the Navy for the Year 1923" is presented by the Director-General, Surgeon Vice-Admiral Sir Joseph Chambers, K.C.B., and issued by H.M. Stationery Office (5*s.* net). The returns for the total force (89,100) show a marked improvement in the general health of the British fleet compared with the previous two years, the case, invaliding and death ratios all showing a decrease. This is doubtless largely due to the preventive measures now adopted. Health lectures are given by medical officers, and the men are warned of the risks they run in drinking polluted waters, eating raw vegetables and salads, oysters and other shellfish, and the rôle of flies in the spread of disease is explained. All water taken for drinking and cooking from the shore is chlorinated, and all fresh milk used, unless the source is well known, is sterilised. The excreta of all enteric patients are examined during convalescence on three occasions at monthly intervals, so as to eliminate carriers. All officers and men detailed for the Mediterranean, East Indies, and China stations are inoculated against typhoid and paratyphoid fevers before leaving England.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A public analyst for the borough of Northampton—The Town Clerk, Guildhall, Northampton (August 16). An assistant lecturer in agricultural zoology at the North of Scotland College of Agriculture—The Secretary, 41½ Union Street, Aberdeen (August 19). Lecturers in agriculture, botany, and entomology and zoology at the Imperial College of Tropical Agriculture, Trinidad—The Secretary of the College, 14 Trinity Square, E.C.3 (August 21). An assistant lecturer in electrical engineering at the Royal Technical College, Glasgow—Prof. S. Parker Smith, Royal Technical College, Glasgow (August 23). A research assistant for work in connexion with colliery wire ropes, and a junior research assistant for work on materials and structures used for the support of underground workings—each under the Safety in Mines Research Board—The Under Secretary for Mines, Establishment Branch, Mines Department, Dean Stanley Street, S.W.1 (August 25). A technical officer for design of wireless apparatus for service aircraft and aerodrome use—The Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (August 28, quoting No. A.121). An instructor in bee-keeping in the department of Agriculture of the University of Leeds—The Registrar (August 28). An assistant in the botany department of the University of Aberdeen—The Secretary (August 30). A head of the Department of Industrial Administration and a lecturer in the same subject at the Manchester Municipal College of Technology—The Registrar (September 20).

Our Astronomical Column.

SUNSPOT ACTIVITY.—Of the two naked-eye spots, Nos. 7 and 8, which were on the sun's disc together during the last week of June, the first had entirely disappeared when its position came again into view, and the second had diminished to a relatively small spot. A new group of considerable size has, however, been seen recently in transit across the disc and was a conspicuous naked-eye object to those observers who habitually watch these large spots. In a refracting telescope of 3 or 4 inches aperture, much interesting detail could be seen in the penumbral filaments. In type the group conformed fairly closely to that of a 'normal' stream, with a well-defined circular leader, a composite follower 12° in longitude behind, and a cluster of small unstable spots between. The axis of the stream was inclined about 15° equatorwards. Both the leading and following spots were large enough to be visible separately to unaided vision, especially on July 29, when their separation of 12° solar longitude was equivalent to nearly 4′.

The latitude of the group should be noted. Hitherto, no important group has appeared this cycle so near the sun's equator. In previous cycles, the first very large spots in latitudes so low as 10° have occurred about two years before the respective maxima. Data of position and area (expressed as a fraction of the sun's hemisphere) of the recent spot are as follows:

No.	Date on Disc.	Central Meridian Passage.	[Latitude.	Area.
9	July 24-Aug. 5	July 30·0	11° S.	1/550

NAMING OF MINOR PLANETS.—The three planets that commence the second thousand have received names that recall the circumstances of the discovery of Ceres, the first member of the family, about a century and a quarter ago (*Astr. Nach.* No. 5454). Number 1000, discovered by Reinmuth, has been named Piazzia, after the discoverer of Ceres; 1001, discovered by Beljavsky, has been named Gaussia, after the calculator of Ceres' orbit; and 1002, discovered by Albitzky, has been named Olbersia, after the detector of Ceres at its second opposition. These appropriate names were given by Mr. B. Asplind of Karlstad, Sweden, with the consent of the discoverers.

LUNAR AND PLANETARY TEMPERATURES.—The results of an investigation of planetary temperatures by Menzel, Coblentz and Lampland by means of the radiation transmitted through a water cell, are described in the *Astrophysical Journal*, vol. 63, p. 177. The theory of the method has previously been given by Menzel (*Astroph. Journ.*, vol. 58, p. 65), and rests on the fact that the solar energy reflected from a planet is of short wave-length, whereas the radiated planetary energy is of much longer wave-length. The water-cell transmission gives a measure of the ratio of the short-wave solar energy to the total energy, and hence of the amount of planetary radiation which is able to pass through our atmosphere. This atmospheric transmission depends on the spectral distribution of the radiation, and therefore, finally, upon the planetary temperature. The results of the latest work seem to show that the temperature of Mars may reach 10° C. at perihelion, but with large diurnal fluctuations (the night temperature being probably below −85° C.). The bright areas on Mars appear to be at a lower temperature than the dark areas, and the temperature of the south polar cap ranges from −100° C. to −15° C., suggesting ice or snow as a possible cause. Some results are also given for the moon, Venus, Jupiter, Saturn, and Uranus. There seems to be no evidence of internal heat in any of the giant outer planets.

Research Items.

ROYAL COSTUME AND RACE IN ANCIENT EGYPT.—In *Ancient Egypt* for June, Miss M. A. Murray examines details of the dress of kings of the early dynasties of Egypt and suggests that certain inferences bearing upon cultural origins may be drawn from the results. On the slate palette of Narmer, the king is shown wearing a belt at the back of which is an animal's tail with long rippled hair—a bull's tail. Sir Flinders Petrie has pointed out that the bull's tail was a promoter of fertility. While the king was typified by two creatures, the falcon and the bull, he was more truly falcon. The falcon Horus conquered the country, but his religion was exotic, belonging to the king only. Egypt was and remained a cattle-worshipping country, and therefore the king had to become a bull. This was accomplished by a ceremony in which the outward and visible symbol, the bull's tail, was attached to his person. The Sed festival was connected with the tail of the king; but Prof. Newberry has suggested that this was a marriage ceremony. In Crete, when bull-worship was introduced, the queen, through whom, as in Egypt, descent was transmitted, was disguised as a cow for the celebration of the Sacred Marriage with the bull. In Egypt the Sed festival may represent the making of the foreign falcon into a bull at the time of the marriage to the queen of the bull-worshippers. The royal head-dress may suggest the provenance of these rulers. The crowns appear to be turbans. The Red Crown of Lower Egypt is of a form now worn by the Marwaris of Rajputana. This head-dress in Egypt is worn only by the king and by foreigners. It is indigenous in Asia and especially Persia and northern India. The connexion between early Egypt and Elam is established and, in view of the connexion between India and Sumeria, it is possible that there may have been a common centre influencing Egypt.

THE LAST FOREST PHASE IN BRITAIN.—Mr. O. G. S. Crawford in *Man* for July discusses the implication of certain conclusions of geologists and meteorologists which bear directly upon archæology. From 3000 B.C. until 1800 B.C. the climate of Britain was drier than at present. Further, the land stood 60 feet higher than at present, with forest and fen in the area now the North Sea, and forests on the southern and western coasts. This last forest phase may be equated roughly with the British neolithic period, which has two stages, an earlier with no pottery and no agriculture, and small implements, many resembling palæolithic types, and a later, megalithic, stage, with agriculture and many surviving implement-types which show little change. There is no evidence that the people of the first stage are descended from our palæolithic population, and it is possible that they spread across the fen, which is now the North Sea, from Denmark. On the other hand, the megalith builders were a distinct people. The distribution of megaliths arranged in order of development suggests an eastward migration. This is supported by the legendary connexion of Stonehenge and Ireland and the Irish character of Middle Bronze Age pottery in Pembrokeshire. In eastern Wales and in England south-east of the Severn and south of the Humber, later types of megaliths preponderate over the earlier. This suggests, therefore, that an eastward migration occurred at the close of the dry period when the west was becoming appreciably more moist and difficult for agriculture. Were climatic conditions also responsible for the departure of the megalith builders from their homes in France and Spain?

WINTER CLIMATE AND THE INCIDENCE OF PULMONARY TUBERCULOSIS.—The view has been expressed that the poor ventilation of houses consequent upon a rigorous winter climate may be an important factor in the causation of pulmonary tuberculosis. Thus, the higher incidence of phthisis in Sweden compared with England and the high incidence of the disease among the Esquimaux have been attributed to the influence of this factor. J. R. Miner has subjected this hypothesis to examination (*Amer. Review of Tuberculosis*, vol. 13, No. 4, 1926, p. 366), taking as his data the mortality statistics for the white population of the United States Registration Area, which covers a wide range of climate, yet refers to a population fairly homogeneous racially, and highly homogeneous in customs and social environment. The death-rates from tuberculosis of the lungs and acute miliary tuberculosis in the various registration States have been grouped according to January mean temperatures. After the application of various corrections, the result emerges that the white death-rate from pulmonary tuberculosis in the United States is higher in those States with a mean January temperature between 30° F. and 40° F. than in colder or warmer regions. No evidence is found to support the view that severe winter climates, or poor ventilation resulting therefrom, are important factors in the etiology of pulmonary tuberculosis.

SCOTTISH SEA TROUT.—Mr. G. H. Nall gives us interesting information on the sea trout of the River Ewe and Loch Maree (Fishery Board for Scotland. Salmon Fisheries, 1926, No. 1. (Edinburgh and London: H.M.S.O., 1926.) 4*s*. 6*d*. net), as a result of measurements and scale readings of a very representative number of fish, 1512 in all. Included among these are examples representing the hatches of 12 consecutive years, 1912–1923, fish ranging in size from 3 oz. to 10 lb. and in age from 2½ years to 13 years. Nearly three-quarters of these undertook their smolt migration after three years' river life, thus tending to confirm the theory that length of parr life depends on food supply, northern streams having comparatively low food resources, which leads to long parr life. The record of two fish remaining as parr for six years is interesting, being the first such case recorded for the British Isles. Of the Ewe trout, the scales of which showed spawning marks, 48·8 per cent. spawned for the first time in the second winter after smolt migration and 40·6 per cent. in the third winter. The main runs begin in mid-July and last until autumn. The great majority of fish spawned in successive years. The oldest fish in the collection had spawned eight times and was thirteen years old. In condition, as measured by the standard K, these sea trout were good. Sea trout have previously been studied in the River Forth by Menzies and the River and Loch Hope by Nall, who, in this paper, makes interesting comparisons between the fish from the various regions.

STUDIES IN DE-DIFFERENTIATION.—Prof. J. S. Huxley has described reduction phenomena in *Clavellina lepadiformis* (*Pubblicazioni della Stazione Zoologica di Napoli*, vol. 7, 1926), in which he confirms Driesch's discovery that whole individuals of this species will undergo de-differentiation or reduction as readily as pieces of the animal. Examination of some of the morphological changes occurring during the process shows that the pharynx and atrium are reduced much more rapidly than any other organs. The nervous system passes through a stage in which the anterior portion is hollow. The heart remains differentiated and active for a long period, but is finally suddenly reduced to a mass of de-differentiated cells. The gonads may be represented at a late stage by a single hollow vesicle. The digestive loop usually remains very little changed until late stages. The atrium may be converted into two separate vesicles by the breaking and subsequent resorption of its dorsal cloacal portion. The epicard is relatively resistant, and in advanced stages of reduction shows horn-like processes which may be attached to the peribranchial cavities. Some organs may disappear, apparently by cell-migration. The view is put forward that the changes cannot be supposed to represent reversions to stages passed through in embryogenesis. The resemblance to such stages is accidental, and is brought about chiefly by mechanical means.

SPERMATOGENESIS IN SPIDERS.—In a paper on the spermatogenesis of the spider, *Tegenaria domestica* (*Bull. Internat. de l'Acad. Polonaise des Sci. et Lettres*, Série B. No. 3-4), Mme. Julia Sokolska shows that the number of chromosomes in the male is 18 pairs, together with an unpaired heterochromosome or X-chromosome composed of three equal bodies, which are separate during meiosis, but all usually pass to the same pole in the reduction division. The two resulting types of sperm can be identified by the visible presence or absence of these three bodies from the spermatids. Abnormal cases were found, however, in which two of the three elements of the X-chromosome separate from the third in the heterotypic division, as well as cases in which four such bodies were present. These clear-cut results contrast in some respects with those of Dr. E. Warren (*Annals of the Natal Museum*, vol. 5, part 3) on the habits, oogenesis, and early development of a South African spider, *Palystes natalius*. After describing the spinning of the egg-sac and the 'psychological behaviour,' a detailed description of the egg development is given. The author falls readily into the old snare of amitosis, and his observations on this head are unconvincing. In the maturation of the egg two polar bodies are formed, but the second is retained within the egg. The author admits that these divisions are mitotic, but in the five cases observed the chromosomes 'averaged' 16 for the first polar body and 9 each for the second polar body and the egg nucleus. Chromosome counts are now, however, of little value unless they are exact. It is to be hoped that an effort will be made to get more precise results.

STUDIES ON A PARASITE OF THE HESSIAN FLY.—C. C. Hill contributes (*Journ. Agr. Res.*, Washington, vol. 32, No. 3, 1926) an account of *Platygaster hiemalis*, one of the most widespread and effective parasites of the Hessian fly in the United States. In the eastern wheat-growing regions, this Hymenopterous parasite kills annually from 16 to 40 per cent. of the autumn generation of the fly. The eggs are deposited in the egg of the fly and develop polyembryonically (by twinning) or monembryonically; the resulting yield in adults is about a 50 per cent. increase over the number of eggs deposited. The larva consumes the contents of the host, but the latter, before succumbing, usually succeeds in forming a puparium. Within this the cocoons of the parasite are formed, and an average of six adult parasites emerge from each host. The adult is about 1 mm. long, very active, flies readily, and is positively phototropic. The female is able to reproduce parthenogenetically, and impregnated females usually deposit both fertilised and unfertilised eggs at each oviposition. Approximately 66 per cent. of the adults are females. The female lays from one to eight eggs at a time, and shows marked ability to recognise eggs of the fly in which she has already oviposited. In one instance a female, crawling over a leaf which bore 42 eggs of the fly, oviposited in 24 of these in fairly regular order on the first tour; on the return she brushed all the eggs with her antennæ and attacked two that had not previously been pierced, but only one of those previously visited was pierced a second time. Females have been observed to examine with their antennæ the area on a wheat leaf from which the egg of the Hessian fly had been removed, and even to attempt to oviposit thereon. It would appear that chemotropism plays an important part in the location of the host egg. *Platygaster hiemalis* passes the winter and early spring in the embryonic stage; by the end of August the adults are ready to emerge from their cocoons during the oviposition period of the Hessian fly in the fall of the year.

WEST INDIA HURRICANES.—An important publication upon the hurricanes of the West Indies has been issued by Father Sarasola, Director of the newly organised National Observatory of Colombia ("Los Huracanes de las Antillas." Notas Geofisicas y Meteorologicas Num. II., Bogota, 1925). In addition to marshalling a large number of facts about these destructive visitations, he discusses methods of forecasting and reviews current theories regarding the origin of tropical cyclones. It is pointed out that whereas the cyclones of temperate latitudes are most severe in winter when 'polar front' discontinuities of temperature and humidity are sharpest, tropical cyclones are most active in the warmest season. The view is favoured that tropical cyclones are fundamentally connected with the conflict of air currents, and in this connexion it seems a pity that the author appears to overlook what is really very convincing evidence that this view is correct. Tropical cyclones occur mainly in late summer and autumn towards the margin of the tropics on the western sides of the oceans in both hemispheres, precisely when and where one Trade system having crossed the equator encounters currents from the opposing Trade system, the one exception to the rule being the South Atlantic, which is hurricane-free in the absence of a seasonal migration of the North-east Trade across the equator. This is the significant geographical background of tropical cyclones, and should be observed by all writers who investigate the structure of these storms in detail. Whether there is anything corresponding to the 'discontinuities' of temperate latitude cyclones on 'polar front' principles is not yet clear, but it is likely that there are considerable differences of humidity, if not of temperature, between the opposing currents feeding a tropical hurricane. Father Sarasola's work contains much local detail in relation to the storms of the Caribbean Sea; the wider influences bearing on the subject are not neglected, a good deal of attention being given to solar activity in relation to the weather.

WIND AND SPEED OF WAVES.—In a paper entitled "Observations of Wind, Wave and Swell on the North Atlantic Ocean" in the *Quarterly Journal of the Royal Meteorological Society*, vol. 51, No. 218, Dr. Vaughan Cornish records his observations on the relationship between velocity of wind and waves. He found a close agreement between the wind and the velocity of the waves under the conditions of the final stage reached after a prolonged wind. The discrepancies between the two figures which were apparent in some observations were almost entirely due to swell. A crossing swell effects considerable reduction in the speed of the waves, a concurrent swell little reduction in speed and a diminution in height of the waves. When two sets of swell cross the waves, their effects in reduction of wave speed are additive. This would explain the rapid rise of waves with wind on large lakes and inland seas when there is little swell to hamper the wave-making action of the winds. Dr. Cornish gives his figures in full and describes the methods he devised to measure the velocity of the wind.

SUBSIDENCE OF KILAUEA VOLCANO.—A rough estimate has been made of the total volume of subsidence of Kilauea during the years 1921–24 (*Volcano Letter*, No. 74, May 25, 1926). At Halemaumau the amount of subsidence in this interval was 13 or 14 feet, and at a distance of twenty miles to the north-east it was little more than an inch. Assuming that the subsidence was symmetrical about Halemaumau as a centre, the total volume of subsidence would be about one-seventh of a cubic mile.

COLOURS DUE TO IRON IN MINERALS AND ROCKS.—In the *American Journal of Science* for July 1926 Mr. G. R. MacCarthy presents the results of a comprehensive study of the colours produced in rocks by various types of iron compounds. It is shown that the natural yellows, browns and reds are due to the presence of ferric compounds. Hydrous ferro-ferric minerals are blue in colour, and are responsible for the blues frequently exhibited by clays and shales. The suggestion that these tints are produced by disseminated organic matter is refuted. Greens are considered to be the result of mixtures of iron-blues and iron-yellows, for no evidence of the existence of any single green compound has been found. The chocolate-red of hæmatite sometimes approaches purple, but the true purple colours of shales and slates are ascribed to mixtures of iron-reds and iron-blues. Anhydrous ferro-ferric compounds produce only greys and blacks, like the carbonaceous matter that is generally present in black argillaceous rocks. The rôle of iron as an inorganic colouring agent has thus been rationally extended over the whole range of colours found in sediments.

CONTRASTED TYPES OF MUD-CRACKS.—Continuing his valuable work on the structural features of sediments, Mr. E. M. Kindle has published and described a most instructive suite of photographs of various types of mud-cracks (*Trans. Roy. Soc. Canada*, 20, sec. 4, 1926, p. 71). A series from the playas of north-western Nevada shows polygonal shrinkage cracks (*a*) with flat tops, (*b*) with curled-up edges, (*c*) with rounded margins, and (*d*) with a reticulation of small polygons within the larger ones. The curling-up tendency is associated with the presence of abundant colloidal matter in the clay, while the downward rounding of other mud-cracks indicates a notable percentage of sodium chloride in the material undergoing desiccation. Another series of desert mud-cracks shows a number of radiating rosette-like fissures, due probably to convection currents in the oozy mud during the initial stages of desiccation. In another type, from Jervis Island in the Pacific and from Southern Australia, the ordinary polygonal cracks are not open fissures, but are outlined by narrow ridges composed largely of alkali sulphates and other salts. It is thus clear that the muds of saline lakes, fresh-water lakes and the seashore, develop shrinkage cracks of sharply contrasted types, and the recognition of similar features in older sediments may therefore provide valuable evidence bearing on the origin of the latter, and particularly of continental facies of sediments.

RANGE OF α-RAYS OF THORIUM C + C′.—Experiments with a modified form of the Wilson cloud apparatus, enabling a large number of photographs to be taken one after another under conditions which made it possible to measure the range of the α-rays accurately, are described by Fraülein L. Meitner and Herr Kurt Freitag in the *Zeitschrift für Physik* of June 16. Altogether three thousand photographs were taken. Thorium C breaks up partly into thorium C′ with emission of a β-particle and partly into *C″* with emission of an α-particle, the mean range of the latter being 4·8 cm. Thorium C′ sends out an α-particle with mean range 8·6 cm. and gives thorium lead. The ratio between the numbers of these two classes of α-particles was determined by counting to be 34·3 : 65·7, which agrees well with the value obtained by Marsden and Barratt using the scintillation method. The ranges in different gases were determined and the mean relative braking power of these gases calculated. The variations of the range on either side of the mean were determined in the different gases and compared with the values deduced by Bohr from the classical theory; good agreement was found. The existence of a group of α-rays with 11·5 cm. range in air discovered by Rutherford and Wood was confirmed and a new group with 9·5 cm. range was found. There were on the average 200 of the 11·5 cm. range particles and 70 of the 9·5 cm. range to 10^6 ordinary thorium C′ α-particles. The existence of α-particles of greater range than 12 cm., announced by Bates and Rogers has not been confirmed; particles with longer range than this are clearly shown to be hydrogen rays.

DRAWING INSTRUMENTS.—Among other sets of instruments manufactured by Messrs. Harling, 117 Moorgate, London, E.C.2, at their new factory in Upper Clapton is a wallet case, B.E. 114, which we have had the opportunity of testing. This case contains a 4½-inch divider with hair-spring adjustment and movable needles; 3-inch bow pen compass and a bow pencil compass of the same size, both instruments having double knee joints, while the ink point of the pen is made of stainless steel. All these instruments are made of hand-drawn electrum; the head joints work on steel cones and are fitted with a device for maintaining the handle upright. The case also includes a set of three spring bows, the steelwork of which is made of stainless steel; these instruments have central screw adjustments, and are both light and rigid in use. There are also a 6-inch drawing-pen, made of stainless steel with a lift-up nib permitting of cleaning and instantaneous resetting to the same width of line, and another 6-inch drawing-pen, also of stainless steel, but without the lift-up arrangement. A pricker is included. All the above described instruments are thoroughly well made; the design is good and the instruments are suitable in a high degree to the work of an engineer's drawing office. The last instrument in the case is a portable beam compass with divider, pen, and pencil points. The duralumin beam of this instrument is made in three lengths with push-in joints, and makes up to 29½ inches. The travelling heads are driven by means of milled rollers. The section of the beam is wedge-shaped, and each head has a spring which presses the head into the wedge and also presses the roller against the top side of the beam. The design is good, the heads move easily, and are rigid whilst circles are being drawn. Unfortunately, sufficient care has not been taken in manufacture to get all three bars of exactly the same cross-sectional dimensions; two of the bars in the set submitted for examination are very good in this respect, and the heads pass easily over the joint of these bars. The other joint is bad owing to the defect mentioned, and the head requires assistance to pass the joint.

Kammerer's Alytes.

(1) By Dr. G. K. NOBLE, American Museum of Natural History, New York, N.Y.

THERE is in existence, resulting from the much-discussed experiments of Kammerer (1919, *Archiv. f. Entwicklungsmechanik*, 45, pp. 323-370, pls. x.-xi.), only a single specimen said to show the modifications described by him. This specimen is preserved in the Biologischen Versuchsanstalt, Vienna, and is the one which Kammerer recently brought with him to England and used to support his contention that he had produced heritable modifications in the midwife toad (Kammerer, 1923, NATURE, 112, pp. 237-238).

Although this specimen had presumably been carefully studied in England—for Kammerer (*loc. cit.* p. 237) claims: "Dozens of scientific men have seen the pads and are now convinced"—a preliminary examination of it by me in Vienna revealed such unexpected features that Dr. H. Przibram and I have found it advisable independently to make a thorough macroscopic, histological and chemical examination of the critical features of the specimen.

It will be remembered that Kammerer claimed to have produced heritable nuptial pads in a batrachian which normally lacks them. I found the specimen to have its left manus blackened both on its dorsal and ventral surfaces, the extent of the darkened area being fairly well shown in a photograph of the specimen made in Cambridge (Kammerer, 1924, "The Inheritance of Acquired Characteristics," New York, Fig. 9). A slight blackening was also to be seen on part of the right manus. Neither manus had the appearance of possessing nuptial pads, but both seemed to have been injected with a black substance, for the blackening included some of the capillaries.

An examination of the blackened areas under moderate magnification with a binocular microscope revealed that the colouring was not epidermal; that is, in epidermal spines, but in the derm. No trace of spines, points, brushes or other asperities could be seen on the integument of the prepollex, or surrounding region of either hand. The left wrist of the specimen had been lacerated. A slight pushing aside of the muscles revealed that the ventral wrist muscles and part of the palmar muscles were surrounded by a black colouring matter on all sides. This substance was in such abundance that it readily washed out in the dissecting dish water which filled the spaces between the exposed muscles. It was clear that these blackened areas were not nuptial pads; that is, patches of pigmented asperities, for the epidermis was not thrown into spines. Further, the colouring matter was not epidermal, but was distributed in great masses under the skin, between the muscles, and even in many of the capillaries on both dorsal and ventral surfaces of the left manus.

Dr. Przibram and I have independently made sections of the integument from the prepollex region of the left manus of the specimen under discussion. This is the region which in the water-breeding Salientia most frequently bears asperities. It is at the base of the first finger. Further, it was the region of maximum blackening in Kammerer's specimen. Although the specimen was poorly fixed, the epidermis in this region was intact, except along one edge where it was beginning to be shed. No suggestion of asperities are visible in my sections. The surface of the epidermis is perfectly smooth. The black colouring matter is seen to lie in great masses in the derm and among the muscle fibres, while some of the capillaries are choked with the same substance. It is therefore clear that no modifications occur in the prepollex region of Kammerer's specimen, other than those produced by poor fixation and the black substance. Dr. Przibram has confirmed from his own sections my observations that no suggestion of asperities are present in this specimen.

The black substance, so irregularly distributed through the muscles, has the appearance of India ink, for under the highest powers the granules are black, not brownish black (or lighter) as most amphibian melanins. However, a critical test as to the nature of this substance is necessarily a chemical one. Oppenheimer (1909, "Handbuch der Biochemie des Menschen und der Tiere," Jena), in describing the properties of melanin, states that it may be changed into a lighter-coloured substance by treating it with concentrated nitric acid. Further, this product is soluble in alkalis. I have carried out a series of experiments with different kinds of amphibian integuments, some injected with India ink, and others merely fixed in alcohol or formol, and have found the test to be critical in distinguishing melanin from India ink. With Dr. Przibram's permission I removed a piece of integument from the palm of Kammerer's specimen at the base of the second finger. A large mass of black substance adhered to the dermal portions of the skin. The piece was cut into three parts and each treated for different periods, first in concentrated nitric acid, and after washing, in concentrated ammonium hydroxide. In spite of this variety of treatment, known to be critical in all cases, the black colouring matter remained intact, while the few small and widely separated melanophores readily observable under the binocular, disappeared. In this resistance to the treatment the colouring matter resembled the India ink masses in our controls. Dr. Przibram has carried these experiments further, and writes: "The black substance has also been subjected to the treatment with antiformin and withstood this reagent, which dissolves all melanins known to now." We may conclude that the substance which gives the dark appearance to the left manus of Kammerer's specimen is not melanin.

It has therefore been established beyond the shadow of a doubt that the only one of Kammerer's modified specimens of Alytes now in existence lacks all trace of nuptial pads. The question remains: Might not this specimen at one time have possessed them? There are available three kinds of evidence bearing on this point: (1) sections said to have been made from the pad of the modified specimens; (2) photographs showing more or less clearly some indication of the pads; and (3) testimony of observers who believe they saw asperities in the modified specimen.

Kammerer (1919, *op. cit.*, Pls. x. and xi.) has produced figures of histological preparations said to be made from the nuptial pad region of his specimens, or to be more exact, (translation) "through the skin of the first (inner) finger." Similar preparations were sent by Dr. Kammerer some time ago to Dr. E. Uhlenhuth, who has kindly loaned them for examination. Further, other microscopical preparations similar to those described by Kammerer are preserved in the Biologischen Versuchsanstalt in Vienna, as a material result of Dr. Kammerer's studies. Both sets of preparations agree fully with the description given by Kammerer. The controls figured by Kammerer, as well as those in Vienna and New York, exhibit a smooth epidermis, while that labelled as coming from the modified individual is thrown into numerous cornified and pigmented spines. It has been claimed that these spines are distinctive in form, and hence the pads must have been produced experimentally in Alytes.

Now, it is a well-known fact that the nuptial spines (and also the pad glands) vary enormously in size within a species. Champy (1924, " Les Caractères Sexuels," Paris, Fig. 104) has well shown how these may vary within the species *Rana temporaria*. My sections of the nuptial pads of *Bombinator igneus* differ enormously from those figured by Lataste of the same species (Kammerer, 1924, *op. cit.*, Fig. 11, sketch 8), for my animal was a terrarium animal in not very good health before it was killed. However, I have attempted in a series of forms to discover breeding pads which agreed in histological detail with the sections sent Dr. Uhlenhuth. My sections of *Bombinator maxima* agree most closely with Kammerer's sections. There is no difference in the height of the spines, their distance from each other, their form, the character of the cores within the spines, etc., between some parts of the pad in this species and parts of the sections sent Dr. Uhlenhuth. But the spines differ in proximity and height in different parts of the pads, which only goes to show that the exact form of these spines is of no value in distinguishing many species of frogs. Kammerer's sections fall within the range of variability shown by the genus Bombinator (more properly called Bombina).

The second group of evidence is to be derived from the photographs. I fail to find anything distinctive in the photograph of the specimen made in Vienna (Kammerer, 1919, *op. cit.*, Pl. x.) or that taken in Cambridge (Kammerer, 1924, *op. cit.*, Fig. 9). Dr. Przibram believes that still a third photograph, one made in Vienna (see the following note) proves conclusively that asperities were present. This photograph is not available to me, but I do not understand how asperities so small as those in Kammerer's sections would show up as Dr. Przibram points out. What proof have we that these " two or three spines " are not foreign bodies; and why do they not show up in the rather good photograph made in Cambridge (Kammerer, 1924, *op. cit.*, Fig. 9) ?

In marshalling the third group of evidence, Dr. Przibram has brought together some distinguished names. With all deference to these gentlemen, I would say that the epidermis of Kammerer's specimen which is underlaid by the black substance appears, in part, slightly irregular. This appearance is probably due to the unequal distribution of the black substance below. At least, it required on my part the most careful manipulation of the lighting to prove that these irregularities were not in the epidermis. Further, I fail to see how any one qualified to pronounce on the presence or absence of nuptial pads could have examined the black discolorations on the forelimbs of Kammerer's specimen without noticing their artificial character.

A final objection which might be raised to the conclusions reached above is that some evidence has been recently presented (Kändler, 1925, *Jen. Zeitschr. f. Naturw.*, 60, pp. 175-240, Pls. 9-10) to show that the male Alytes may sometimes produce an incipient breeding pad. It is not my purpose to discuss whether the slight crenulations in the surface of the epidermis can be interpreted as an incipient pad. The breeding asperities Kammerer claims to have produced are true nuptial spines similar to those of Bombinator and cannot be compared with the epidermal irregularities of the prepollex or surrounding regions in an occasional male.

The only specimen resulting from the experiments of Kammerer has been the source of much heated argument in NATURE. By describing accurately, for the first time, the modifications in this specimen, we have proved conclusively that no pads are present. Whether or not the specimen ever possessed them is a matter for conjecture.

(2) By Dr. HANS PRZIBRAM, Biologischen Versuchsanstalt, Vienna.

It is clear from the foregoing account that the only one of Kammerer's experimentally modified Alytes still preserved cannot in its present state be regarded as a valid proof of the nuptial pads artificially produced in this species. We must endeavour to decide if the state the specimen is in now agrees with the state at the time of its preservation and before. The specimen is poorly fixed and preserved. Moreover, the epidermis is at several places ready to be shed or even shedding. It is a known fact, as Prof. Franz Werner, of Vienna, asserts, that during repeated handling and shaking the nuptial asperities get lost easily. The specimen has made the voyage to England and back again, and it does not look the better for it. Fortunately, there are photographic plates in existence showing the state of the specimen before it left Vienna for Cambridge and during its stay in England. One of these photographs was taken in the presence of Dr. J. H. Quastel in the atelier of Reiffenstein (Vienna), and the negative travelled with Dr. Quastel to England and has been in the possession of Mr. M. Perkins (Trinity College, Cambridge) since April 1923. A reprint of it is given in Kammerer's " Neuvererbung," Stuttgart-Heilbronn, W. Seifert-Verlag, 1925 (Abb. 9, facing p. 20).

Dr. Quastel asserts in a letter to me, dated Trinity College, Cambridge, March 27, 1926, " with confidence that in the large negative of Alytes (taken by Reiffenstein) there are no traces of any manipulation or retouching of the actual image of the Alytes." Since he is not an expert in photographic matters, he has had the negative examined by an expert photographer, Mr. W. Farren, who gives the following statement : " 76 Regent Street, Cambridge, March 26, 1926.—I have examined carefully the negative of Alytes, and while it appears to have been intensified and a string across the background retouched, there are no signs of any retouching or interference with the image of the specimen itself, or of that part of the background with which it is in contact." Mr. Perkins writes (March 20, 1926) : " The only retouching which the plate has ever shown is a certain obliteration of the thread which supports the specimen, and the fact that retouching has been applied to this, in order to make it uniform with the background, enables one to state positively (from comparison) that neither the image of the specimen itself nor any point of its outline has ever been interfered with by retouching or any other process ; more particularly does this apply to the external (concave) margin of the palm, where two or three spines are obviously and clearly visible. In April 1923 I had many opportunities of examining the specimen, and was always able to see the spines, whether by means of a lens or a dissecting microscope, exactly as in the photograph in question." Dr. Quastel also testifies that the copy represents the state of the specimen when it was photographed in Vienna. There seems, therefore, to be no doubt of the genuineness of the negative and photograph. Moreover, many other zoologists had examined the specimen during its stay in England, some of whom Prof. MacBride gives a list of in a recent letter to me (dated February 26, 1926, Imperial College of Science, South Kensington, London) : E. Boulenger, H. M. Vevers, Cannon, F. S. Harmer, J. Stanley Gardiner, Borradaile, and F. Potts.

Further proofs that the Alytes in question has borne nuptial callosities in the epidermis may be found in the microscope sections of the skin that had been removed from the same specimen during the height of the breeding season from the other (right) hand. The comparison both of Kammerer's pictures in his original paper (*A. f. Entwickl. mech.*, 45, 323, 1919, Pls. x., xi.) or in his "Inheritance of Acquired Characteristics," Boni and Liveright, New York, 1924 (Figs. 10-11, facing p. 62) and of the section photographed in America with nuptial pads of other Anura, show clearly that the callosities differ from all other known pads, resembling most those of other Discoglossidæ, as Bombinator, but still *Discoglossus pictus* (after Lataste; see Kammerer, 1924, Fig. 11 N. 3). This had already been pointed out by Mr. Perkins (NATURE, August 18, 1923, p. 238). Lastly, it may be mentioned that quite recently the possibility of Alytes developing nuptial pads has been shown in a specimen found in Nature and examined by R. Kändler (*Jenaische Z.*, 60, 175, 1924, Pl. 10, Fig. 12). Although it is only just a beginning of callosities in one male taken in Westfalen (Germany), when compared with the usual smooth surface of the Alytes hand it becomes significant. Kändler found the callosities in this one male on the palmar and dorsal side of the thumb, on the inner side of the third and fourth finger. The callosities resemble those which Kammerer figured for the F_2 generation of water-bred Alytes (*l.c.* Pl. xi. Fig. 4). There were no typical nuptial pad-glands. Kändler also questions if those described by Kammerer were of this character, as Kändler's females showed the same type of gland with granular content too. But no females showed callosities. Kändler has also figured the nuptial pad of other Anura, *i.e. Bombinator igneus* (Pl. 10, Figs. 8A, 9). This figure is in accordance with that of Lataste.

Whilst it is possible to come to a probable solution with respect to the spiculæ, we have not been able to elucidate the origin of the black substance. It is clear that it has nothing to do with the black pigment often seen in nuptial pads of Anura other than Alytes, or with the patches described and in the progeny of non-egg-carrying Alytes males by Kammerer, 1909. The only possibility we can think of is that some one has tried to preserve the aspect of such black nuptial pads in fear of their vanishing by the destruction of the melanin through exposure to the sun in the museum case, by injecting the specimen with India ink. Kammerer himself was greatly astonished at the result of the chemical tests, and it ought to be stated that he had been asked and had given his consent to the chemical investigations. He would suggest that somebody had made such injections to get him into difficulties were it not that he remembers the black substance to have been in the same place and amount even in the living animal (letter to Przibram, February 18, 1926). So the case remains obscure.

We may conclude as a result of these observations:

(1) The only one of Kammerer's specimens of Alytes still preserved is not valid as a proof of the nuptial pads, at least not in its present state of preservation.

(2) No asperities are to be seen now, but by photographs taken before the specimen was sent to England it must be inferred that the spiculæ have been lost through the shaking of the voyage and repeated handling.

(3) Photomicrographs of the sections said to have been prepared from the skin of the same specimen some time before its preservation in the height of the breeding season show in several points different characters from nuptial pads of other Anura, even of Bombinator, coinciding more closely with those of Discoglossus (next relative to Alytes), and the picture of a rudimentary nuptial pad found on a male Alytes in Nature by Kändler (1924).

(4) The black substance in the whole specimen has nothing to do with melanin and is not restricted to a nuptial pad region.

(5) With this conflicting evidence it is greatly to be desired that the experiments of Kammerer on Alytes may be taken up again by some one of equal skill in rearing Anura.

The Progress of Geological Survey in Great Britain.

THE area described in the first[1] of the Memoirs of the Geological Survey of Great Britain referred to below lies in Ross-shire and Sutherland. The north-western corner is occupied by Lewisian, Torridonian and Cambrian rocks, all of which have been involved in the great Caledonian thrusts of the N.W. Highlands. Of special interest are the alkaline igneous rocks of Loch Ailsh. They form a composite laccolith of post-Cambrian and pre-thrusting age, made up of types ranging from perthosite (a new type composed principally of perthite) to pyroxenite, and resembling in many ways the well-known Oslo suite of rocks made classic by Brögger. Convincing evidence is adduced to show that the alkaline character is original, and quite independent of the intimate association of the intrusion with the Cambrian dolomites. Another feature of petrological importance is the description of the newer igneous rocks, which here present clear evidence of permeation and hybridisation.

The area dealt with in the second memoir[2] in our list, Golspie, lies to the east of the preceding, and includes the coast of Sutherland from Dornoch to Helmsdale. The earlier chapters are devoted to the physical features, and to the schists and gneisses belonging to the Moine series and the older and newer igneous rocks associated with them. The marginal complex of injected and other metamorphic rocks around the Rogart granite is fully described, and hybrids like those alluded to above also occur. The Old Red Sandstone covers considerable areas in the sheet, and along a narrow coastal strip Mesozoic rocks are present, ranging from the trias to the Kimeridgian. The final chapter gives an account of glacial phenomena, peat deposits, and raised beaches.

Iona and Staffa are visited every summer by an increasingly large number of tourists, and those who are interested in geology will appreciate the publication of a Memoir referring to this region.[3] Those who are not will become interested despite themselves, for the islands abound in geological features which are part of their attraction. The famous Ardtun Leaf Beds and Macculloch's Tree are fully described; and the columnar basalts of Fingal's Cave and other parts of Staffa are discussed on the lines followed in the recent Memoirs on the Isle of Mull.

The account of the geology of the extreme north of England given in the Memoir on Berwick and the neighbouring country[4] is welcome as a sign that the

[1] The Geology of Strath Oykell and Lower Loch Shin. (Explanation of Sheet 102 of the Geological Map of Scotland.) By Dr. H. H. Read, J. Phemister and G. Ross, with contributions by C. H. Dinham and M. Macgregor. Pp. vi+220+2 plates. 6s. net.

[2] The Geology of the Country around Golspie, Sutherlandshire. (Explanation of Sheet 103 of the Geological Map of Scotland), including a description of the Mesozoic Rocks of East Sutherland and Ross. By Dr. G. W. Lee, Dr. H. H. Read, G. Ross and J. Phemister. Pp. vi+143+1 plate. 3s. 6d. net.

[3] The Geology of Staffa, Iona, and Western Mull. (A Description of Sheet 43 of the Geological Map.) By E. B. Bailey and E. M. Anderson, with contributions by G. A. Burnett, J. E. Richey, Dr. G. W. Lee, W. B. Wright and G. V. Wilson, and Petrological Notes by Dr. H. H. Thomas. Pp. iv+107+1 plate. 3s. net.

[4] The Geology of Berwick-on-Tweed, Norham and Scremerston. (Explanation of New Series One-inch Sheets 1 and 2.) By A. Fowler. Pp. ix+58+2 plates. 1s. 6d. net.

re-survey of Northumberland is now well under way. The chief points of interest are the descriptions of the Scremerston coalfield and the very striking coast sections to the north of the Tweed. Memoirs on the sheets to the south are due for early publication, and should be of importance in so far that they will contain references to the northern boundary of the Whin Sill. It is in itself significant that this Memoir, the first of the promised series, contains no mention of any igneous rocks.

The greater part of the Pottery coalfield of North Staffordshire is included in the sheet described in the Memoir on Stoke-upon-Trent.[5] An account of the coal measures with their important coal seams and iron ores naturally takes first place. There is also a valuable chapter on faults and folds; and as a feature appearing for the first time in this edition, descriptions of the post-Triasic Bullerton dyke and of the other intrusions of the area are given. It is interesting to notice that Dr. Scott, who has studied the Tertiary and Carboniferous alkaline rocks of Scotland, directs attention to the petrological affinities of the former with the intrusive rocks of North Staffordshire. He thinks that the Rowley Regis and Clee Hill rocks are likely to be also of Tertiary age.

Passing now to Epping Forest and the eastern suburbs of London,[6] we find only Eocene, Pleistocene and later deposits. The Chalk, however, underlies the whole area, and the question of deep-seated water supplies is discussed, and illustrated by a contour map of the sub-Tertiary Chalk surface. On the south the subsoil consists mainly of the deposits made by the Thames; the central part is chiefly London clay; while to the north the region is diversified with hills capped with Bagshot sand and glacial deposits. These beds are discussed with special reference to sanitation and agriculture.

[5] The Geology of the Country around Stoke-upon-Trent. (Explanation of Sheet 123.) By Dr. Walcot Gibson, with contributions by C. B. Wedd and Dr. A. Scott. Third edition. Pp. vii+112. 2s. 6d. net.

[6] The Geology of the Country around Romford. (Explanation of Sheet 257.) By H. G. Dines and F. H. Edmunds. Pp. xiii+53+2 plates. 1s. 6d. net.

London and Edinburgh: H.M. Stationery Office; Southampton: Ordinance Survey Office, 1925 and 1926.

Air Pollution and its Prevention.

THE citizens of Leeds, under the auspices of the Mayor and City Council, have instituted a campaign against smoke to commemorate in a practical form the tercentenary of the granting of the statute to the city. In connexion with this effort, a pamphlet entitled "Clean Air for Leeds" has been prepared by a Committee, of which Prof. J. B. Cohen is chairman, formed on the invitation of the Lord Mayor to consider the question of "a cleaner city on the lines of smoke abatement." The pamphlet has been prepared for free distribution, and aims at informing the public as to the present condition of the smoke problem.

Leeds is to be congratulated on facing her own smoke problem in this way. A visitor, unless from another Midland city, cannot help being struck by the prevailing sooty blackness of the buildings. It is surely a merciful provision of Nature that people adjust themselves so easily to environment; had this not been so, life in some of our smoke-blackened cities must appear scarcely worth living. It is, however, this adjustment to environment which blinds our eyes more or less to the true condition of affairs. Leeds has a useful field for effort here. The pamphlet gives a short analysis of the problem of smoke abatement and the remedies available. The sources of air pollution, cause, nature, and effects of smoke are all dealt with briefly.

The general conclusions of the Departmental Committee on Smoke Abatement are quoted, and it is clear enough that this committee had no hope of a solution of the problem by the initiative of local authorities unless subject to the stimulus of Government. The new Bill now before Parliament must provide the necessary stimulus or it will not go very far towards a solution.

The Leeds pamphlet should be of great use in keeping the problem before the public mind. Reference is made on page 24 to the standard gauge used by the Advisory Committee on Atmospheric Pollution, and the Leeds committee criticises this gauge on the grounds that "the amount of solid matter is largely dependent on the situation with regard to the wind and the nature of the ground on which the gauge rests." The Committee then proceeds to recommend a method devised by Prof. Cohen many years ago, involving the exposure, in different localities, of glass plates, upon which some of the deposited matter adheres. These plates are afterwards washed in running water under a tap, and the deposit estimated by its opacity, or other means. The Advisory Committee, we believe, had this method before it when considering the most suitable means for measuring deposited impurity, and the method was discarded as not fulfilling the necessary conditions. While the exposed plate method has all the drawbacks attributed by the Leeds committee to the standard deposit gauge, it has also others of its own, which influenced the Advisory Committee in deciding to adopt the gauge method. The plates cannot be any more independent of position or wind than the gauges, while the deposit retained by the plates is not the total but some unknown and variable fraction of it, depending on the stickiness of the deposit, whether the plates are wet or dry, the weather, and so on. It may also be supposed that a plate which has received a first deposit of tarry soot will be more effective as a trap than one which starts with a less sticky layer of ash or grit. The only sound procedure is to catch in some way the whole of the deposit—hence the Advisory Committee's standardised gauge.

It is to be hoped that Leeds will not depart from this method of measuring deposit, as a great part of the value of the results lies in their being comparable with those from other cities.

The open coal fire is discussed in the pamphlet, and the conclusion is given that raw coal cannot be burnt in an open grate without the production of smoke. The use of smokeless sources of heat is recommended, of which gas, coke, and electricity are specifically mentioned and discussed. The advantages of the gas fire, its cleanliness and cheapness, are referred to, while the use of coke in domestic fires is advocated; but, as the pamphlet goes on to say, "it is not every kind of fireplace nor every kind of coke which is suitable for burning in an open fire." The relative costs of heating by coke, coal, gas, and electricity are discussed; the figures arrived at indicate coke to be much the most economical source of heat.

A section at the end deals with the law relating to the smoke nuisance, and the new Government Bill is discussed. The committee, in its final recommendations, lays great stress upon the need to educate the public in the use of smokeless methods, and, on the whole, it is to be congratulated on its public-spirited efforts to clean the air of Leeds.

University and Educational Intelligence.

CAMBRIDGE.—The trustees of the Busk Studentship in Aeronautics, founded in memory of Edward Teshmaker Busk, who lost his life in 1914 whilst flying an experimental aeroplane, have awarded he studentship for the year 1926–7 to Mr. P. B. Walker, of Peterhouse.

LONDON.—The Rogers Prize of 100*l.* for 1926 has been awarded to Dr. Robert Coope for an essay entitled "The Value of the Various Methods of Investigating Diseases of the Pancreas."

The University Studentship in Physiology for 1926–1927, of the value of 50*l.* and tenable for one year in a physiological laboratory of the University or of a school of the University, has been awarded to Mr. E. T. Conybeare, who proposes to undertake research in physiology at Guy's Hospital, particularly on the clinical side, and possibly also to extend his work on anæthesia in relation to its clinical application.

The University College Committee will shortly appoint either a full-time assistant or two part-time assistants in the Department of History and Method of Science. Candidates must be graduates either in biology, or in physics, or in astronomy. A good working knowledge of at least two foreign languages is desired.

MISS HELEN MASTERS has been appointed Head of the Domestic Science Department and the Training College for Teachers of Domestic Science of the Battersea Polytechnic, London, S.W.11, in succession to Miss Marsden, who is retiring after nearly twenty-seven years' service. Miss Masters holds the King's College Post Graduate Diploma in Household and Social Science, and has been, for the past fifteen years, on the staff of the Household and Social Science Department of King's College and has acted as examiner in domestic science for the University of London.

THE secretary of the Council on Medical Education and Hospitals of the American Medical Association has contributed to *School Life* for April an article on "Rural Schools as Centres of Medical Service and Community Life." The position of the country doctor in the United States has for many years been becoming more and more precarious owing to an increasing tendency on the part of residents in country districts to resort to town practitioners. Meanwhile the rural school consolidation movement has been proceeding apace. The consolidated and improved rural school has definitely proved its worth and gone far beyond the experimental stage. The plan, which is being rapidly adopted throughout the States, involves the transportation of pupils from all parts of a large district to and from the consolidated school in motor omnibuses, and this makes it necessary also that the roads leading to the school from all directions should be kept in fair condition. "Why," asks Dr. N. P. Colwell, the writer of the article, "should not the locations of these schools become rural community centres for other than educational purposes?" A health centre or clinic either in the school or in a separate building could serve not only the children attending the school but also other people living in the district, and the motor omnibus service could doubtless be induced to co-operate. Such a scheme, either by itself or in conjunction with a guarantee by a number of influential residents, would, it is suggested, suffice to secure for the district the services of a competent physician.

Contemporary Birthdays.

August 10, 1865. Sir Charles Frederick Close, K.B.E., F.R.S.
August 10, 1862. Prof. William Joseph Hussey.
August 11, 1852. Prof. Harold Baily Dixon, C.B.E., F.R.S.
August 12, 1860. Sir Sidney Gerald Burrard, K.C.S.I., F.R.S.
August 13, 1861. Prof. Herbert Hall Turner, F.R.S.
August 13, 1879. Dr. Philip Gosse.

Sir CHARLES CLOSE, formerly an officer in the Royal Engineers, was Director-General of the Ordnance Survey from 1911 until 1922. He is an active general secretary of the International Geographical Union.

Prof. HUSSEY, director of the Detroit Observatory of the University of Michigan, was born at Mendon, Ohio. From 1911 until 1917 he was director of the Observatorio Nacional de La Plata, Argentina. He has done excellent work in choice of sites for observatories in Southern California, Arizona, and Australia, working for the committee on observatories of the Carnegie Institution. Prof. Hussey was awarded the Lalande prize of the Paris Academy of Sciences in 1906 for double star discoveries and investigations. He is a foreign associate of the Royal Astronomical Society.

Prof. H. B. DIXON was educated at Westminster School and Christ Church, Oxford. His life's work was carried out at Manchester as occupant of the chair of chemistry in the University there, in succession to Sir Henry Roscoe. The Royal Society awarded Prof. Dixon a Royal medal in 1913, on the ground of his eminence in physical chemistry, especially in connexion with explosions in gases. He was president of the Chemical Society, 1909–11. Prof. Dixon, it may be recalled, was president of the chemical section at the last meeting of the British Association held in Oxford, namely, that in 1894. He gave an address on "An Oxford School of Chemists."

Sir SIDNEY BURRARD was Surveyor-General of India from 1910 until 1919; formerly he held office as Superintendent of the Trigonometrical Survey of India at Dehra Dun. Whilst in charge he was responsible for the success of the most extensive system of geodetic triangulation ever inaugurated. His works on the geography and geology of the Himalayas and Tibet (in conjunction with the late Sir Henry Hayden); on the effect of the Himalayas on the plumb-line in India; and on isotasy, have given him special repute as a scientific investigator.

Prof. TURNER was born at Leeds, and was educated at Clifton College, and also at Trinity College, Cambridge. Formerly chief assistant at the Royal Observatory, Greenwich, he was next appointed Savilian professor of astronomy in the University of Oxford. He has done yeoman service for the British Association, having been one of the general secretaries from 1913 until 1922. He was president of the Royal Astronomical Society, 1903–5. Prof. Turner is Hon. D.Sc. Leeds and Sydney, and a corresponding member of the Paris Academy of Sciences.

Dr. GOSSE is the grandson of that engaging personality, Philip H. Gosse, F.R.S., who died in 1888, author of works on marine zoology, and on the microscope. Educated at Haileybury and St. Bartholomew's Hospital, Dr. Gosse is assistant superintendent of the Radium Institute. He acted as naturalist to the FitzGerald expedition to the Andes (1896).

Societies and Academies.

PARIS.

Academy of Sciences, June 28.—A. **Lacroix**: The fused veins of meteorites and their analogy with the 'pseudotachylites' of distorted terrestrial regions.—Charles **Moureu**, Charles **Dufraisse**, and Paul Marshall **Dean**: A dissociable organic peroxide: rubrene peroxide. The hydrocarbon rubrene described in an earlier communication, when exposed to sunlight in benzene solution, rapidly absorbs oxygen, thereby losing both colour and fluorescence. From the solution a white crystallised product containing solvent of constitution is obtained, which dissociates on heating into solvent, rubrene and oxygen. It is pointed out that the existence and dissociation of this peroxide is of great theoretical interest.—Léon **Guillet**: The cementation of steels by silicon. The object of these researches was to obtain a film of high silicon steel on a mass of mild steel retaining the mechanical properties of the mild steel with a chemically resistant skin. In all of the experiments cited the cemented skin was too fragile.—**Neymann**: The laws of probability which tend towards the law of Gauss, remaining infinite in the neighbourhood of a point.—Jules **Drach**: The integration of the equations $r+f(s, t)=0$.—Silvio **Minetti**: The radius of convergence and the singularities of a class of analytical functions defined by Taylor's development.—R. **Gosse**: A special class of equations of the form $s=f(x, y, z, p, q)$.—G. **Alexitch**: Conjugated trigonometrical series.—André **Charrueau**: Some geometrical properties of surfaces of equilibrium relative to a liquid mass of revolution, in uniform rotation round its axis of revolution.—J. **Villey**: A simple model of electrometer of low capacity.—H. **Pelabon**: Detection (of electromagnetic waves) by metallic contacts. A symmetrical detector. A stable detector can be made from two steel balls of the same diameter (3 cm.) suspended from an insulating support by copper wires 15 cm. long. The effect appears to be independent of the nature of the interposed dielectric.—**Volmar**: The photolysis of the alcohols. The photochemical decomposition of the alcohols under the influence of the radiation of the quartz mercury vapour lamp takes place in two stages, the dehydrogenation of the alcohol giving aldehyde and ketone and the photolysis of the latter.—Henri **Belliot**: Experiments on photographic inversion.—Victor **Henri** and Sv. A. **Schou**: The ultra-violet absorption spectrum of the vapour of formaldehyde. New type of spectrum of Y-shaped molecules. The movements of rotation of an asymmetric molecule possessing three unequal moments of inertia cannot be resolved mathematically, but when two of the moments are equal an expression for the energy of the molecule can be found (Sommerfeld, Born, Reiche). The vapour of formaldehyde is composed of such molecules, and a study of the absorption spectrum shows that its structure corresponds very exactly with the formulæ for symmetric molecules having two different moments of inertia. Other substances which may be expected to show similar spectra are phosgene, thiophosgene, acetone.—**Consigny**: The influence of metallic screens on the form of the ionisation curves of the α-rays.—R. **Mellet** and M. A. **Bischoff**: Chemical reactions and volumetric titrations in Wood's light. The fluorescence of the solution is used as the indicator; possible uses of the method are given.—M. **Bourgeaud**: The electrometric study of the allotropic forms of mercuric sulphide.—P. **Job**: Some applications of the spectrographic method to the study of complexes in solution. The substances examined were a solution of iodine and potassium iodide in alcohol, potassium mercurichloride in aqueous solution, and the double bromide of cadmium and potassium. In the first of these the iodide of potassium behaved as though present in triple molecules, giving the complex $(KI)_3$.—J. **Errera**: The polarisation of a medium and its molecular structure. The electrical moments of the dihalogen derivatives of benzene.—Edmond **Vellinger**: The rotatory power of organic bodies as a function of the pH: glucosamine. A curve is given showing the rotatory power of glucosamine as a function of the pH. It resembles the curve obtained by Mlle. Liquier for asparagine. A formula is developed from theoretical considerations which corresponds closely with the experimental results.—A. **Travers** and **Houot**: The tempering of type-metal alloys. The dilatometric study of monotype and stereotype alloys shows clearly, after three months, the influence on these alloys of time elapsed after tempering. The contraction appears to be mainly due to the proportion of tin.—G. **Flusin** and H. **Giran**: The estimation of calcium carbide in calcium cyanamide. The acetylene produced by the action of water on the calcium carbide present is passed into ammoniacal silver nitrate solution, the mixed precipitate of silver acetylide and sulphide treated with hydrochloric acid, the chloride dissolved in ammonia, and the solution titrated with standard potassium cyanide.—A. **Kirrmann**: Magnesium reactions starting with 1 : 3 dibrompropylene. The reaction of this dibrompropylene with methyl magnesium bromide is very complex, and the following products have been isolated: ethane, erythrene, bromobutene, octadiene, and a hydrocarbon which is probably $C_{10}H_{18}$.—Paul **Baud**: The pulp of the agave as a source of industrial alcohol.—P. **Idrac**: Records of the electrical field of the atmosphere up to a height of 20,000 metres. Results of experiments made at the Trappes Aerodynamical Observatory with captive balloons. There are some irregularities, but on the average the electrical field decreases up to 9000 metres. The mean result gives a field of 10·4 volts per metre at 4000 metres, 5·6 volts at 6000 metres, and 2·3 volts at 8000 metres. At higher altitudes the values are much higher, being 30 or 40 volts per metre in the neighbourhood of the isothermal layer (10,000 to 12,000 metres).—Georges **Corroy**: The Spiroferideæ of the European Lias.—H. **Colin** and A. **de Cugnac**: The various types of the grass family according to the nature of their reserves of hydrocarbons.—S. **Metalnikow** and V. **Chorine**: Conditional reflexes in immunity.—A. **Alivisatos** and Fernand **Mercier**: The action of crystallised violet on the cardio-vascular apparatus of the dog. Crystallised violet (hexamethylpararosaniline chloride) appears to act on the heart in a manner resembling the digitalis alkaloids. It exerts a stimulating action on the pneumogastric nerve, to which is added a specific action on the myocardium, producing an augmentation of the tonus and energy of the heart.—J. J. **Thomasset**: The presence of cells in the dentine of some elasmobranchs.—Paul **Chabanaud**: The frequency, symmetry and specific constancy of external hyperostoses in various fishes of the family of Sciænoides.—P. **Portier**: The genesis of the secondary nucleus of natural pearls.—Mme. Anna **Drzewina** and Georges **Bohn**: The action of metallic silver on the sperm and larvæ of the sea urchin. A discussion of the sterilising action of silver vessels.—H. **Barthélémy**: Biometrical and experimental researches on the hibernation, maturation, and supermaturation of *Rana fusca*.—A. **Vandel**: The relations between sexual reproduction and parthenogenesis in the terrestrial Isopod *Trichoniscus* (*Spiloniscus*) *provisorius*.

Cape Town.

Royal Society of South Africa, May 19.—E. L. **Gill**: An early embryo of the blue whale. The embryo was taken from a blue whale (*Balænoptera sibbaldi*) at Saldanha Bay and is at the stage reached by the human embryo at about the twenty-eighth day. Though still in the main a generalised vertebrate embryo, it shows hints of cetacean characters in the small eye, large jaw elements, short neck and reduced branchial arches, large genital papilla, and close segmentation. The fore-limb bud is large, but there is no visible trace of a hind limb. In size (about 6·5 mm.) it agrees closely with other embryos of the higher vertebrates (*e.g.* chick, rabbit, man) at the same stage of development.—C. von **Bonde** and D. B. **Swart**: The structure of the plathander (*Zenopus lævis*) (Pt. i.). The animal presents many primitive features, being related ecologically with the Dipnoi and morphologically with the Anuran and Urodelan amphibia. Notable points with regard to the external features are (*a*) the abundance and properties of the secretion of the slime glands; (*b*) the presence of definite groups of dermal sense organs; (*c*) the presence of an eye tentacle in the adult; (*d*) the cloacal lips in the female.—L. **Mirvish** and L. P. **Bosman**: Note on the calcium content of blood. The effect of the injection of extracts of various body tissues, including ovarian and luteal extracts, upon the calcium content of blood has been examined.

Sydney.

Linnean Society of New South Wales, April 28.—J. **McLuckie** and A. H. K. **Petrie**: An ecological study of the flora of Mount Wilson. (Part iii.) The vegetation of the valleys. The plant communities represented are the Ceratopetalum-Doryphora association, the *Eucalyptus goniocalyx-E. Blaxlandi* association, the *Eucalyptus piperita* consociation, and the *E. hæmastoma* var. *micrantha* consociation.—C. **Barnard**: Preliminary note on branch fall in the Coniferales. The development of foliar shoots and the associated shedding of branches can be correlated with the phylogeny of the tribes of the conifers. The presence of distinct dimorphism in the branches of conifers seems to be a primitive feature, gradually lost in higher types.—H. J. **Carter**: Revision of the Australasian species of Anilara (Buprestidæ) and Helmis (Dryopidæ), with notes, and descriptions of other Australian Coleoptera.

Vienna.

Academy of Sciences, June 10.—R. **Weiss**, A. **Spitzer** and J. **Melzer**: On tri-phenyl-methanes, the benzol nuclei of which are bound to each other (ii.). Trimethylene - triphenylmethane - triketondicarbonacids.—O. **Wettstein**: A new race of mice in Austria, *Evotomys glareolus ruttneri*.—O. **Koller**: Two new forms of fish from the Island of Hainau, a species of Cyprinid and a subspecies.—J. **Schorn**: History and results of seismology in Northern Tyrol.—A. **Defant**: Primary and secondary, free and forced, pressure waves in the atmosphere.—A. **Schedler**: Air pressure waves and correlations over the North Atlantic Ocean.—A. **Roschkott**: Studies on oscillations of air pressure in the region of the Azores highlands.—F. M. **Exner**: Relations of air-pressure anomalies on the earth to each other.—R. **Rotter**: On condensations of unsaturated compounds with diazo-methane.—F. **Knoll**: The differential geometry of the spacial vector field.

Washington, D.C.

National Academy of Sciences (Proc. vol. 12, No. 6, June).—William **Hovgaard**: Bending of a curved tube of circular cross section. A formula is developed which when applied to pipe bends gives results in good accord with experiment.—E. O. **Salant**: The heat capacity of solid aliphatic crystals (ii.).—R. J. **Havighurst**: (1) The effect of crystal size upon the intensity of X-ray reflection. With a crystal having a linear dimension greater than 10^{-5} cm., intensity is modified by 'extinction,' which may be primary (due to each little block acting as a perfect crystal) and secondary (due to shielding of the inner blocks by those near the surface). Work on powdered sodium chloride, calcium fluoride and calcite indicates that primary extinction is absent in crystals grown from solution and less than 10^{-3} cm. in thickness, so intensity measurements can be used to determine electron distributions. Single crystal measurements of the alkali halides require correction for secondary extinction. (2) The intensity of reflection of X-rays by lithium, sodium and calcium fluorides. Measurements of intensity enable the relative value to be calculated of a factor, the "atomic structure factor," which at small angles of reflection approaches the number of electrons in the atom. This factor is plotted against sin θ (where θ is the angle of reflection) and, finally, atomic scattering curves are drawn; those for fluorine from the different salts are nearly alike, suggesting a force field of constant magnitude, while those for sodium from the chloride and fluoride differ considerably. The total number of electrons gives only a rough idea of the order of the atoms as regards scattering power.—J. H. Van **Vleck**: Note on the postulates of the matrix quantum dynamics. The Hamiltonian equations, the commutability relations, the Bohr frequency condition and the conservation of energy equation can be taken as the fundamental postulates. The Ritz combination principle and the quantum conditions become not merely *sufficient* but also *necessary* for the last two postulates.—Joseph Miller **Thomas**: Conformal invariants. A complete set of integrability conditions which express the laws of transformation of a set of conformal invariants are obtained.—Helen **Barton**: Generalisation of Kronecker's relation among the minors of a symmetric determinant. Kronecker's relation is a special case of a more general relation.—Oliver D. **Kellogg**: On the classical Dirichlet problem for general domains.—Ernest W. **Brown**: The evidence for changes in the rate of rotation of the earth and their geophysical consequences (*v.* Nature, July 31, p. 170).—Christine **Ladd-Franklin**: The reddish blue arcs and the reddish blue glow of the retina: seeing your own nerve currents through bioluminescence. A band of bright red light thrown on a screen in a dark room appears to have slightly reddish-blue arcs projecting from it on both sides. What is seen, as an entopic phenomenon, is certain fibres of the optic nerve on the surface of the retina. These fibres, when stimulated, seem to give off an 'emanation' which causes fluorescence in the retina.—Thorne M. **Carpenter**: The metabolic effect of enemata of alcohol, dextrose and levulose in humans. Ethyl alcohol is rapidly and nearly completely absorbed; it promotes the elimination of water without removing other constituents of the tissues, increases pulse rate and lowers the respiratory quotient, indicating that alcohol is utilised in the tissues. Dextrose and levulose are not absorbed so rapidly or completely; the respiratory quotient increases with the former, indicating increased utilisation of carbohydrate. Levulose caused the greatest decrease in nitrogen elimination. It is suggested that, administered by rectal injection, these substances are metabolised throughout the body in a manner similar to that in which material is utilised in muscular work.

Official Publications Received.

Statens Skogsförsöksanstalt. Skogsförsöksanstaltens Exkursionsledare, 11: The Experimental Forests of Kulbäcksliden and Svartberget in North Sweden. 1: Geology (Description and Maps), by Olaf Tamm; 2: Vegetation (Description and Maps), by Carl Malmström. Pp. 87. 2 kr. Statens Skogsförsöksanstalt Flygblad, No. 35: Skogsträdens Fruktsättning år 1925. Av Gösta Mellström. Pp. 22. Skogliga rön, No. 4: Några Riktlinjer för Torrläggning av Norrländska Torvmarker. Av Carl Malmström. Pp. 26. Skogliga rön, No. 5: Ett Observandum vid Skogsodlingar. Av O. Eneroth. Pp. 7. (Stockholm: Centraltryckeriet.)

Ministerio da Agricultura, Industria e Commercio: Directoria de Meteorologia. Boletim Meteorologico, Anno de 1921: Observações meteorologicas feitas no Observatorio do Instituto Central, do Rio de Janeiro, e nas Estaçoes da rêde Nacional. Pp. vi+159. (Rio de Janeiro.)

Report of the Director of the Royal Observatory, Hongkong, for the Year 1925. Pp. 16. (Hongkong.)

Proceedings of the Royal Society of Edinburgh, Session 1925–1926. Vol. 46, Part 2, No. 21: The Slow Oxidation of Phosphorus Trioxide. Part 2: The Production of Phosphorus Tetroxide by direct Oxidation of Phosphorus Trioxide. By Dr. Christina Cruickshank Miller. Pp. 239-244. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 9d.

Transactions of the Royal Society of Edinburgh. Vol. 54, Part 3, No. 13: A Study of the Hokien and the Tamil Skull. By Prof. Gordon Harrower. Pp. 573-599+1 plate. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 4s. 6d.

Regenwaarnemingen in Nederlandsch-Indië. 1: Java en Madoera, 1923. Pp. 127. (Weltevreden: Landsdrukkerij.)

Transactions of the Royal Scottish Arboricultural Society. Vol. 40, Part 1, March. Pp. x+69+26+4 plates. (Edinburgh: Douglas and Foulis.) 3s.

Proceedings of the United States National Museum. Vol. 68, Art. 17: The Minerals of Obsidian Cliff, Yellowstone National Park, and their Origin. By William F. Foshag. (No. 2618.) Pp. 18+4 plates. Vol. 68, Art. 18: Revision of the American Leaf Hoppers of the Jassid Genus Typhlocyba. By W. L. McAtee. (No. 2619.) Pp. 47+6 plates. Vol. 68, Art. 19: A Revision of the American Lice of the Genus Pediculus, together with a Consideration of the Significance of their Geographical and Host Distribution. By H. E. Ewing. (No. 2620.) Pp. 30+3 plates. Vol. 68, Art. 22: Descriptions of new West Indian Longicorn Beetles of the Subfamily Lamiinae. By Warren S. Fisher. (No. 2623.) Pp. 40. Vol. 68, Art. 24: A Collection of Pleistocene Vertebrates from Southwestern Texas. By Oliver P. Hay. (No. 2625.) Pp. 18+8 plates. (Washington, D.C.: Government Printing Office.)

Verhandlungen der Schweizerischen Naturforschenden Gesellschaft. 106 Jahresversammlung vom 8 bis 11 August 1925 in Aarau. Pp. 141+187+54. (Aarau: H. R. Sauerländer et Cie.)

Aeronautical Research Committee. Reports and Memoranda, No. 992 (Ae. 203): The Measurement of Torque Grading along an Airscrew Blade. By Dr. G. P. Douglas and L. P. Coombes. (A.3.d Airscrews 83—T. 2102.) Pp. 11+10 plates. 9d. net. Reports and Memoranda, No. 994 (Ae. 205): The Variation of the Performance of an Aeroplane with Wing Loading. By W. S. Farren. (D1. Special Technical Questions 142—T. 2128 and A.) Pp. 22+10 plates. 1s. 6d. net. Reports and Memoranda, No. 1002 (Ae. 210): An Experimental Investigation into the Properties of certain Framed Structures having Redundant Bracing Members—Report No. 4. By Prof. A. J. Sutton Pippard and G. H. W. Clifford. (B.2.g. Strength and Design-General, 68—T. 2189.) Pp. 11+2 plates. 6d. net. Reports and Memoranda, No. 1003 (M. 33): On the Concentration of Stress in the Neighbourhood of a small Spherical Flaw; and on the Propagation of Fatigue Fractures in 'Statistically Isotropic' Materials. By R. V. Southwell and H. J. Gough. (M.C. 27.) Pp. 22+3 plates. 1s. 3d. net. Reports and Memoranda, No. 1005 (E. 17): Note on 'Detonation' Temperatures in Closed Vessel Explosions, by R. W. Fenning; Work performed at the National Physical Laboratory for the Engineering Research Board of the Department of Scientific and Industrial Research. (I.C.E. 519.) Pp. 4+1 plate. 6d. net. (London: H.M. Stationery Office.)

Proceedings of the Society for Psychical Research. Vol. 36, Part 98, June. Pp. 79-170. (London: Francis Edwards.) 6s. net.

United States Department of Agriculture. Department Bulletin No. 1393: The Granary Weevil. By E. A. Back and R. T. Cotton. Pp. 36. 10 cents. Farmers' Bulletin No. 1483: Control of Insect Pests in Stored Grain. By E. A. Back and R. T. Cotton. Pp. ii+30. 10 cents. (Washington, D.C.: Government Printing Office.)

Department of the Interior: Bureau of Education. Bulletin, 1925, No. 43: Motivation of Arithmetic. By Prof. G. M. Wilson. Pp. iii+60. (Washington, D.C.: Government Printing Office.) 10 cents.

Smithsonian Miscellaneous Collections. Vol. 78, No. 2: Mexican Mosses collected by Brother Arsène Brouard. By I. Thérior. (Publication 2867.) Pp. 29. (Washington, D.C.: Smithsonian Institution.)

The North of Scotland College of Agriculture. Guide to Experiments and Demonstration Plots at Craibstone, 1926. Pp. 56. Bulletin No. 31: Report on Drying of Hay by Heated Air. By Prof. J. Hendrick. Pp. 12. Report on the Work of the North of Scotland College for the Year 1924–25. Pp. 30. (Aberdeen.)

Mysore Geological Department. Records, Vol. 23, 1924, Part 2. Pp. v+37-128. (Bangalore: Government Press, 1926.) 2 rupees.

Journal of the Indian Institute of Science. Vol. 8B, Part 2: The Aluminium Anode Film Dielectric. By M. Subramaniam. Pp. 11-21+9 plates. 1 rupee. Vol. 9B, Part 1: Double Synchronous Speed Alternators. By K. P. Roy. Pp. 7+4 plates. 1 rupee. (Bangalore.)

Memoirs of the Department of Agriculture in India. Chemical Series, Vol. 8, No. 10: Silage Experiments at Nagpur. By Dr. Harold E. Annett and A. R. Padmanabha Aiyer. Pp. 189-209. (Calcutta: Government of India Central Publication Branch.) 10 annas; 1s.

League of Nations. Health Organisation: Malaria Commission. Report on the First Results of Laboratory Work on Malaria in England. By Dr. S. P. James, assisted by P. G. Shute. (C. H./Malaria/57 (I).) Pp. 30. (London: Constable and Co., Ltd.)

Records of the Survey of India. Vol. 20: The War Record, 1914-1920. (Published under the Direction of Col.-Comdt. E. A. Tandy.) Pp. xxv+155+27 plates+9 maps. (Dehra Dun.) 3 rupees; 5s. 3d.

Nyasaland Protectorate. Annual Report of the Geological Survey Department for the Year 1925. Pp. 7. (Zomba.)

Mines Department. Fourth Annual Report of the Safety in Mines Research Board; including a Report of Matters dealt with by the Health Advisory Committee, 1925. Pp. 63. (London: H.M. Stationery Office.) 1s. net.

Experimental Researches and Reports published by the Department of Glass Technology, The University, Sheffield. Vol. 8, 1925. Pp. iii+190. (Sheffield.)

Report for 1925 on the Lancashire Sea-Fisheries Laboratory at the University of Liverpool. Edited by Prof. James Johnstone. Pp. 63. (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd.) 2s. 6d.

Joint Board of Research for Mental Disease, City and University of Birmingham. Annual Report of the Laboratory for the Year ended March 1926. Pp. 12. (Birmingham: Asylums Department, The Council House.)

Engineering Abstracts from the Current Periodical Literature of Engineering and Applied Science, published outside the United Kingdom. New Series, No. 28, July. Pp. 260. (London: The Institution of Civil Engineers.)

Abisko Naturvetenskapliga Station. Observations météorologiques à Abisko en 1923. Rédigées par Bruno Rolf. Pp. iv+68. Observations météorologiques à Abisko en 1924. Rédigées par Bruno Rolf. Pp. iv+66. (Stockholm.)

Meddelanden från Statens Meteorologisk-Hydrografiska Anstalt. Band 3, No. 8: Zur Thermodynamik der Kondensation an Hygroskopischen Kernen und Bemerkungen über das Zusammenfliessen der Tropfen. Von Hilding Köhler. Pp. 16. 1 kr. Band 3, No. 9: Mälarens vattenstånd åren 1887-1925. Av Folke Bergsten. Pp. 20. 1.50 kr. (Stockholm.)

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium. Vol. 22, Part 9: Studies in American Phaseolineæ. By C. V. Piper. Pp. viii+663-701. (Washington, D.C.: Government Printing Office.) 10 cents.

Report of the Aeronautical Research Institute, Tôkyô Imperial University. No. 16: Some Experiments on Motion of Fluids, Parts 1, 2 and 3. By Torahiko Terada and Kunio Hattori. Pp. 87-112. 1.20 yen. No. 17: Linien konstanter Strömungsgeschwindigkeit. Von C. Wieselberger. Pp. 115-125. 40 sen. (Tôkyô: Maruzen Kabushiki-Kaisha.)

The Quarterly Journal of the Geological Society. Vol. 82, Part 2, No. 326, July 3rd. Pp. 101-331+plates 7-21. (London: Longmans, Green and Co., Ltd.) 7s. 6d.

Russian Society of the Amateurs of the Universe's Knowledge (Mirovédenie): Bureau of Scientific Observations. Report on the Phenological Observations from 1925. (In Russian.) Pp. 63-98. (Leningrad.)

The Institute of Physics. Report of the Board for the Year 1925. Pp. 16. (London.)

Board of Education. Report on the Science Museum for the Year 1925. Pp. 24. (London: H.M. Stationery Office.) 1s. net.

Diary of Societies.

AUGUST 6 TO 11.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at Oxford).

Friday, August 6.—At 10 A.M.—Addresses by Sectional Presidents: G.—Sir John Snell: The Present and Future Development of Electricity Supply.—L.—Sir Thomas Holland. Discussion (Section C): Problems of the Thames Gravels.—Discussion (Section M): Agricultural Education.

At 11 A.M.—Discussion (Section L): Scholarships.

At 11.30 A.M.—Addresses by Sectional Presidents: D.—Prof. J. Graham Kerr: Biology and the Training of the Citizen.—J.—Dr. J. Drever: Psychological Aspects of our Penal System.—Discussion (Section K): Sex Determination in Plants.

At 2.30.—Discussion (Section I): The Relationship of Vitamin B to Bios.—Discussion (Section L): The Cinema in Education.

At 3.15.—Discussion (Section I): The Meaning of the Symptoms of Beri-beri.

At 3.30.—Discussion (Section L): Wireless in Education.

At 8.—Prof. A. S. Eddington: Stars and Atoms (Evening Discourse).

Monday, August 9.—At 10 A.M.—Addresses by Sectional Presidents: A.—Prof. A. Fowler: The Analysis of Spectra.—H.—Prof. H. J. Fleure: The Regional Balance of Racial Evolution.—M.—Sir Daniel Hall: The Limits of Agricultural Expansion.—Discussion (Section B): Tautomerism.—Discussion (Section L): Recent Advances in Educational Science.

At 11 A.M.—Discussion (Section K): Vegetative Propagation.—Discussion (Section D): The Training of a Zoologist.

At 2.—Discussion (Sections D, H, J): Heredity in its Physical and Mental Aspects.

At 8.—Prof. H. F. Osborn: Discoveries in the Gobi Desert by the American Museum Expeditions (Evening Discourse).

Tuesday, August 10.—At 10 A.M.—Prof. J. S. Huxley: The Study of Growth and its Bearings upon Morphology (Lecture).—Discussion (Section L): The Public School System.

At 11 A.M.—Discussion (Sections C, D, K): The Conception of a Species.

At 11.30 A.M.—Discussion (Section M): The Feeding of the Dairy Cow.

At 12 noon.—(Section I) by Dr. J. S. Haldane: Acclimatisation to High Altitudes (Lecture).

At 2.—Conference of Delegates of Corresponding Societies.

At 2.30.—(Section J) by Miss W. Spielman: Recent Progress in Vocational Selection (Lecture).

At 5.—Sir F. Keeble: The Nervous System of Plants (Lecture).

Wednesday, August 11.—At 11 A.M.—Discussion (Section E): Regional Work in Geography.

At 12 noon.—Concluding General Meeting.

Supplement to NATURE

No. 2962 AUGUST 7, 1926

Scientific Research and Service.[1]

By H.R.H. The Prince of Wales, K.G., D.C.L., F.R.S.

My first duty, as president of our great Association, must be to read to you the following message from His Majesty The King:

I am sensible of the distinction conferred upon my dear son, The Prince of Wales, in presiding at this year's meeting of the British Association for the Advancement of Science; for I realise that no member of my family has occupied this position since my grandfather was president in 1859. I cannot do better than repeat the assurances then made by the Prince Consort on behalf of Queen Victoria, and express my deep appreciation of the all-important and ceaseless labours in the cause of science of those eminent men who enjoy the membership of your world-renowned society.

I propose on behalf of the Association to forward the following reply to this message:

The members of the British Association for the Advancement of Science assembled at Oxford humbly beg to express to Your Majesty their loyal appreciation of the patronage extended to the Association by your Father and Yourself, and of Your Majesties' repeated expressions of personal interest in its work.

The advancement of science is the constant object of the British Association; to give a stronger impulse and more systematic direction to scientific inquiry, to promote the intercourse of those who cultivate science in different parts of the British Empire with one another and with foreign philosophers, to obtain a greater degree of national attention to the objects of science, by removing those disadvantages which impede its progress, for the well-being of Your Majesty's realm and the general good of mankind.

My second duty is to try to tell you—if this be possible—something which you do not know already. I must admit frankly that, for a long time, the prospect of attempting this has weighed on me heavily. For a man who, along with the great majority of his fellow-creatures, can lay claim to no intensive scientific training, it is no light responsibility to be called on to address the annual gathering of the British Association. But, believe me, I do not intend to shirk that responsibility; for it seems to me that only by discharging it as well as I possibly can, shall I be able to show you how highly I value the great honour you paid me when you added my name to those of the distinguished men who have been your presidents in past years.

At first sight it might appear a hopeless task for any one who knows nothing of science to talk to you, who know everything about science. But those who work in the scientific field will be the first to admit that no task is really hopeless, and, when I approached this one, I began to think I might perhaps find a few topics in which I could interest you. For, after all, science is only another name for knowledge, and any man who goes about the world with his eyes open cannot fail to acquire knowledge of some sort, which, if he can express it, must appeal to any audience.

To adapt one of our most familiar sayings, the onlooker can see a great deal of the game. I, for example, though I claim no insight into pure science, can fairly claim an onlooker's experience of very many practical examples of science as applied to the needs of our civilisation to-day. For some years past, in war and in peace, I have been privileged to have countless opportunities of examining, at close quarters, the concrete results of such applied science. In things military and naval, in factories, workshops, mines, railroads, in contact with the everyday problems of education, health, land-settlement, agriculture, transport or housing—in all such varied departments of human life—it has been borne in on me more and more that if civilisation is to go on, it can only progress along a road the foundations of which have been laid by scientific thought and research. More than that, I have come to realise that the future solution of practically all of the domestic and social difficulties with which we have to grapple nowadays will only be found by scientific methods.

It is from this experience, and with the convictions it has brought, that I should like to tell you something of my general impressions of the bearing of scientific research on the daily life of the community; and to show how that relationship can be developed by the mutual co-operation of scientific workers and the State. I cannot better embark on this attempt than by quoting to you the words of my distinguished

[1] Presidential address delivered to the British Association at Oxford on August 4.

predecessor, though without the hope that what follows will maintain the high standard which he set in his presidential address at the last meeting.

Prof. Lamb, on that occasion, expressed confidence that the efforts of scientific workers "have their place, not a mean one, in human activities, and that they tend, if often in unimagined ways, to increase the intellectual and the material and even the æsthetic possessions of the world. And in that assurance," he continued, "we may rejoice that science has never been so widely and so enthusiastically cultivated as at the present time, with so complete sincerity, or (we may claim) with more brilliant success."

This claim, by no means exaggerated, invites reflection upon the intimate association of the results of scientific research with the daily lives and affairs of every one of us. It is a good thing to reflect upon this, even for those who have no sort of direct contact with scientific research, if only because the doing so may dispel an attitude towards science, which personifies it somewhat as the ancients personified the powers of darkness, and invests it with some of their sinister attributes. Such an attitude of mind is fortunately less common than it used to be. Prof. Lamb, in the address already quoted, referred to a certain feeling of dumb hostility toward science and its works, which still survives. No doubt it does; but at least it has ceased to be vocal, as it was in the earlier days of the Association. It became loud, for example, at two of the meetings in this very place. The later of these two occasions was the Oxford meeting in 1860, and the field of battle was the Section of Botany and Zoology, in which the theories put forward in Darwin's "Origin of Species" were debated, in a manner which has passed into history, between Wilberforce, Bishop of Oxford, on one hand, and Huxley and Hooker on the other.

The earlier occasion, however, more appropriately illustrates, by contrast, the modern realisation of our debt to science. The second meeting of the Association, in 1832, took place in Oxford. The University was not, at that time, without distinguished cultivators of science. The invitation to Oxford came from Charles Daubeny, who combined the professorships of chemistry, botany, and rural economy, and the president was William Buckland, then Canon of Christ Church and professor of mineralogy and geology. A strong body of opinion resented the recognition of science by the University when carried to the extent of conferring honorary degrees upon four of the distinguished visitors. The famous Keble, moved for once to anger, referred to those who were thus honoured as a "hodge-podge of philosophers." Their names were David Brewster, Robert Brown, John Dalton, and Michael Faraday. Each of these men has left in the history of his own special branches of science an outstanding memorial. Brewster's researches into optics were his greatest scientific achievement; to our own gratitude he has an especial claim as the leader among the founders of our Association. Brown's services to botany were unsurpassed; perhaps that of widest appeal is his very thorough investigation of the flora of the coastlands of Australia, made during the voyage on which he accompanied Flinders in 1810–14—an early example of what may be termed imperial research. Dalton's name is identified for ever with the atomic theory, and he placed meteorology on a scientific footing. Faraday's labours provide one of the most wonderful examples of scientific research leading to enormous industrial development. Upon his discovery of benzene and its structure the great chemical industries of to-day are largely based, including, in particular, the dyeing industries. Still wider applications have followed upon his discovery of the laws of electrolysis and of the mechanical generation of electricity. It has been said, and with reason, that the two million workers in Great Britain alone who are dependent upon electrical industries are living on the brain of Faraday; but to his discoveries in the first instance many millions more owe the uses of electricity in lighting, traction, communication, and industrial power.

Oxford, then, was not dishonoured in the hodge-podge of philosophers whom she recognised in 1832. Nor will she recall with any disfavour the singularly doubtful compliment paid her on that occasion by another distinguished visitor, in whose mind the opposition must have rankled; the University, he said, had prolonged her existence for a hundred years by the kind reception he and his fellows had received. The Association will scarcely make that claim to-day; but its visiting members will have ample opportunity to learn how, through her museums and laboratories, Oxford, within the hundred years thus tolerantly allotted to her, has kept pace with the scientific development of the period. It need surely be no matter for regret if science has worked for and is taking a place, not only in the university but also in the schools, complementary with that occupied by the humanities. For complementary these two branches of learning must ultimately be. All the greatest exponents of scientific learning have been men of attainment also in letters.

The services rendered to mankind by the labours of outstanding figures in science, such as Faraday, or Kelvin, or Pasteur, or Lister, are matters of too common knowledge to need insisting upon in this place. What is perhaps less generally appreciated is the extent to which, through the efforts of very numerous workers, the results of scientific research have been brought to bear upon many of the most pressing domestic and industrial problems of the day, and that the co-operation between the laboratory and the State (which means the community) has been greatly strengthened of recent years. The British Association has always supported such co-operation. One of its principal aims, as stated by its founders and maintained ever since, is "to obtain more general attention for the objects of Science and the removal of any disadvantages of a public kind which impede its progress." In an article contributed by Brewster to the *Quarterly Review* in 1830, he asserted frankly that "the sciences of England" were "in a wretched state of depression, and their decline is mainly owing to the ignorance and supineness of the Government" as well as to various other causes which he detailed. The same theme (if less forcibly stated) recurs in some of the earlier addresses from the chair of the Association: the Prince Consort, for example, as president in 1859, thus indicates his view of the situation at that time: "We may be justified in hoping," he said, "that by the gradual diffusion of science, and its increasing recognition as a principal part of our national education, the public in general, no less than the legislature and the State, will more and more recognise the claims of science to their attention; so that it may no longer require the begging-box, but speak to the State, like a favoured child to its parent, sure of his parental solicitude for its welfare; that the State will recognise in science one of its elements of strength and prosperity, to foster which the clearest dictates of self-interest demand."

It may be fairly said that the position foreshadowed in those words is now, in a large measure, attained. The progress towards it was visible, if slow, down to the end of the last century; but the beginning of a new era was then marked by the establishment of the National Physical Laboratory. This was at first set up in Kew Observatory, a building which, as a laboratory for magnetic and meteorological observations, and for the standardising of instruments, owed its maintenance to the British Association for thirty years from 1841, when, as a Royal Observatory, the Government decided to dismantle it. The building proved incapable of extension to accommodate the whole of the work, and in 1900 Bushy House, Teddington, was placed at the disposal of the laboratory by the Crown. The Laboratory, at its inception, was divided into departments dealing with physics, engineering and chemistry, and it possesses also the famous William Froude experimental ship tank. The investigations with which it has been so largely concerned—the testing and standardisation of machines, materials, and scientific instruments, researches into methods of measurement with the utmost accuracy, work on scale-models of ships, and the like—while of the first importance to Government Departments concerned with such applications of science, have also achieved many valuable results for industry in improving standard qualities, in indicating scientific methods applicable throughout a variety of manufactures, and thus in bringing about an improvement in the quality of their output for the benefit of consumers—which is to say, ourselves.

In historical sequence among the events which have strengthened interaction between science and the State, there follows the establishment of the Development Commission in 1908. Until that date the only agency for agricultural research in Great Britain was the classical experimental station at Rothamsted, a private benefaction; and the expenditure of the State on this prime factor in national economy was trifling. Since 1908 the Rothamsted station has been expanded to cover the whole field of nutrition and disease in the plant, while other institutes have been founded to deal with other aspects of agriculture such as plant breeding, the nutrition and diseases of animals, agricultural machinery and the economics of the industry. Not only are these institutes providing knowledge for our own farmers, but they also form the training-ground for agricultural experts required by the Dominions, India, and the Crown Colonies, which need no longer look abroad for their advisers. At the plant-breeding institute at Cambridge, Sir Rowland Biffen has provided several new wheats, of which two are generally grown throughout England; the extra yield and value of these wheats must already have more than repaid the whole expenditure on agricultural research since the institute was founded.

Among other examples of the value of research there may be mentioned the discovery of a variety of potato immune from the ineradicable wart disease, which a few years ago threatened the principal growing districts. The clearing up of the confusion into which commercial stocks of fruit trees had fallen has ensured that growers may plant orchards upon uniform stocks suitable to the soil and climate. Among the most important inquiries are those into the production and cleansing of milk, which have resulted in an entire reform of rationing, increasing the yield of each cow by one to two hundred gallons a year, and in freeing milk from the risk of contamination with disease.

Research into fisheries, which are administratively associated with agriculture, has become a matter of necessity in the light of evidence that even the vast resources of the sea have their limit, and can be injured if they are not exploited with due care and knowledge. Great Britain, acting in co-operation with the other nations who share with us the northern seas, has accomplished much in ascertaining the causes of the fluctuating herring supply, and has contributed notably to the study of the methods by which the stocks of plaice can be maintained. Research again is active in finding methods by which we can mitigate one of the consequences of our dense population—the pollution of our rivers and estuaries—and a method has been found whereby great supplies of shell-fish that had been condemned are once more available as food. Many know, too, of the remarkable results obtained from the scientific study of the habits of the salmon. Though fishing has been described as "a fool at one end of a string and a worm at the other," the subject is not without its personal interest, I believe, to many learned men.

Reverting to the historical sequence, it is appropriate to recall, with gratitude for its labours, the constitution of the Medical Research Committee in 1913, under the Insurance Act of 1911: this has since (in 1919) been transferred to a committee of the Privy Council under the name of the Medical Research Council, and its funds are directly voted by Parliament instead of being drawn from the contributions made by or on behalf of insured persons.

Research alone could provide the knowledge on which must be based all wise and effective legislation or administrative action in the interests of the nation's health. Yet until 1913 the State had played at best a subsidiary part in the organisation of such research and the provision of its material support. Under the new conditions, the State is actively concerned with the promotion and co-ordination of medical research towards conquest of those infirmities with which ignorance has afflicted humanity. A few only may be mentioned, which have rightly appealed to wide public interest. Insulin, a gift to science and to humanity from young enterprise and enthusiasm in the Dominion of Canada, is not only saving lives that were threatened, and restoring almost to normal health and enjoyment many that were crippled by weakness and restriction, but also, as a tool of investigation, is shaping new knowledge that will influence all our ideas of the functions of the body, in health or disease. The discovery of the vitamins, those still mysterious and minute constituents of a natural diet, has brought understanding of various defects of health and of development, created for us largely by the blindness of civilisation to dangers accompanying its progress, dangers which science can avert.

Closely linked with the discovery has been the more recent development of knowledge concerning the need of sunlight for health, in man and his fellow animals as in plants. We know now that crippling deformity appears in the growing child unless he receives his proper share of the vitalising rays of the sun, either directly or through the presence in natural foods of vitamins which these rays have produced. Sunlight, or its artificial equivalents, have some importance already in the treatment of disease; but a realisation of its significance for health has a much greater importance in preventive hygiene. There can surely be no plainer duty, for a State charged with the health of an industrial civilisation, than to promote with all its resources the search for such knowledge as this, as well as to provide for its application when obtained.

Among diseases which painfully affect the popular imagination, cancer has an evil pre-eminence, largely on account of its mysterious, and therefore seemingly inevitable nature. For many years past a volume of investigation, supported by private benefactions and organised charity, has patiently accumulated knowledge of the beginnings of cancer and the conditions of its growth. Now, at length, there are signs of more rapid progress towards a penetration of its secret. Patience and caution are as necessary as ever; a new and exacting technique is still in development; but there is a new spirit of hope and enthusiasm. It is reassuring to know that in this, as in other directions, the State is giving its direct support to investigation, and co-operating with the foundations due to private generosity.

Looking backward a dozen years or so, one may say that science was definitely, by that time, a working part of the machinery of the State, though, as we see now, not a part working at full power. The War caused a broadening, so to speak, of the scientific horizon, for men of science themselves in some measure, but for the layman in a measure far greater. We all were brought to recognise the applications of science as adding, it may be, in certain respects to the distresses of warfare; but also as immensely alleviating the sufferings caused by it, and as indicating many methods of strengthening the arts of defence—some of which methods are no less valuable in strengthening the arts of peace. The creation of the Government Department of Scientific and Industrial Research was an act which falls, historically, within the period of the War; but as an outstanding incident in the scientific advancement of national affairs, it certainly is not to be regarded as merely a war measure; it was once described as a near relative of "Dora," but that was a mistake. Nevertheless, by an odd freak of history, it needed the whole period of a century between one great war-time and the next—between the Napoleonic and the World Wars—to mature the conception of a State department of scientific research. Some idea of this kind was clearly present in the mind of Brewster, and certain of his contemporaries, concurrently with his idea of the foundation of our own Association in 1831; and later, in 1850, when he addressed the Association from the chair, he claimed a strong advance in scientific and public opinion toward his views. Five years later a concrete proposal for the creation of a Board of Science, possessing "at once authority and knowledge," was put forward by the Parliamentary Committee of this Association (a committee no longer existing); but our Council at the time considered that the proposal had "yet to receive sanction from public opinion, and more especially from the opinion of men of science themselves."

It was not, in fact, entirely owing to lack of prevision on the side of successive Governments that the developments which have been outlined were so long delayed. There was an element of mutual distrust between science and the State—now, it may happily be believed, almost if not quite wholly removed. A strong body of scientific opinion was avowedly afraid, as Sir George Airy phrased it, of "organisations of any kind dependent on the State." It is to be hoped that modern developments have removed that fear. The progress of science cannot be kept wholly within training-walls, and no one wants to try to keep it so. The waters of a river may be guided artificially to do the work of irrigation; but not at their sources, nor yet where, at the last, they percolate the soil. The guidance of scientific research, in its inception, lies with the genius of the individual; its results for the future may lie far beyond the realisation even of the scientific workers themselves. The Oxford meeting of the Association in 1894 supplies a simple example of this. There was a discussion on flight, in the Section of Mathematics and Physics, opened by Hiram Maxim; and no less a leader in science than Kelvin afterwards described Maxim's own flying machine as a child's perambulator with a sunshade magnified eight times. Yet it was not many years before research in aeronautics had become the care of the State as well as of the individual; and the work carried out before 1914 under what is now the Aeronautical Research Committee led on to our wonderful development of aircraft during the War.

A recent report of the Committee of the Privy Council for Scientific and Industrial Research shows that under the Department there are eleven research boards, some of which direct the work of committees to the number of three dozen in all. These boards co-ordinate and govern researches in chemistry, fabrics, engineering, and physics, radio, building, food-investigation, forest-products, and fuel; and to these are to be added the board of the Geological Survey and the executive committee of the National Physical Laboratory. Under the general supervision of the advisory council there are upwards of twenty industrial research associations, formed in alliance with the same number of the principal industries of Great Britain, for the purposes of scientific investigations connected with those industries.

No attempt can be made here to review the whole field of work of these various bodies; but a few examples may be chosen for the purpose of pointing out what may be called their homely application. First, then, as to the building of the home. The Building Research Board was created in 1920, and in 1925, at the request of the Ministry of Health, considerably extended its activities. Researches are concerned with the study of materials from the chemical and geological aspects, their strength, weathering, moisture condensation on wall coverings, acoustics, and various other problems; these inquiries, together with the collection and supply of information both by publication and through an intelligence bureau, represent, as the report states, "an attempt to create a real science of building, to explain and supplement the traditional knowledge possessed to-day in the industry." It can scarcely be questioned that industrial Britain inherits a legacy of discomfort in the housing of its workers, with all which that implies, dating from a period when the building of the home lacked scientific as well as æsthetic guidance. We need that guidance no less to-day, when the saving of labour is one of the main objectives of the 'ideal home' and its fitments.

Next, a further word as to our food supplies. The Food Investigation Board directs committees concerned with meat and fish preservation, fruit and vegetables, oils and fats, and canned foods. There is also a committee for engineering problems associated with the investigations; conditions of storage have been investigated on ships between Great Britain and Australia, and problems of heat conductivity at the National Physical Laboratory, while chemical substances suitable for refrigerants have been studied at the Engineering School in Oxford. At Cambridge a low-temperature research station has been established on ground given by the University, and is working in co-operation with the University biochemical, botanical, agricultural, and other laboratories. As for the investigations upon fruit and vegetables, the report may again be quoted, for it illustrates in a sentence something approaching the ideal of scientific co-operation brought to bear upon one particular home necessity, and, what is more, upon a particular and important branch of Imperial commerce. "There is," it says, "a closely knit scheme of work, which rests, on the one hand, in university schools of botany, and, on the other, in commercial stores scattered all over the country, where accurate records of results and conditions have been kept, and extends to the conditions of transport by ship, and overseas so far even as the Australasian orchards."

Other directions of research which touch upon commonplaces of our daily life are those concerned with fuel, with illumination, with the deterioration of fabrics and the fading of coloured stuffs, and—perhaps most homely example of all—with the application of scientific methods in the laundry industry. This will be good news to those of us who may have suffered, or may even be suffering now, from the torture of a collar which comes back from the wash with an edge like a surgical saw.

It must be clearly understood that the few examples mentioned represent only a small fraction of the present activities of science in co-operation with the State, and, expressed as they are here expressed, they may appear to wear an aspect even of triviality, because they deal with common things. But it is precisely because they do deal with common things that they are not trivial. There may be matter for amusement in the fact that science is concerning itself with the contents of the clothes-basket; but there is also matter for congratulation, and there may, in the future, be matter for sincere gratitude. Scientific research, properly applied and carried out, is never wasted. It may prove that a thing can be done, or that it can not be done; but even the proof of a negative may save the waste of further effort.

This attitude of the State toward science makes for an easing of the paths for the advancement of science in many directions; it marks a definite step in human progress, taken after long hesitation, but in itself new; and because it is new, we may believe with some reason that we live, not merely in an age of science, but at the beginning of it. The movement for co-operation which we have been discussing is not confined to Great Britain. It has borne fine fruit already in other lands; and in particular it is active in our own Dominions. The Indian Empire stands in a somewhat different category from these: there is here a tradition, so to say, for the application of science in its government, and the scientific results of its census investigations, its surveys, its agricultural, forestry, and other administrative departments have long been famous. This is not to imply that brilliant scientific work has been wanting in the Dominions—far from it—but the co-operative movements with their governments have followed that in Britain and with a laudable promptitude.

The trend of developments following upon all these movements has been similar, broadly speaking; it is sought to take a comprehensive survey of the natural resources and industrial opportunities of each Dominion, to explore the means by which science may be best applied to their exploitation, to provide, whether in State institutions or in university and other laboratories, for the pursuit of the necessary researches, to co-ordinate the work, and to ensure the dissemination of knowledge acquired. The nature of the researches themselves is conditioned to a large extent (though by no means wholly) by geographical circumstances in the respective territories: agricultural, pastoral, and forestry problems, for example, are not identical in all of them, and that very fact adds to the interest and value of co-ordinating the results of research work throughout the Empire. While problems may differ, solutions may point to a common end. Nothing but good can follow from personal contact between scientific workers in different parts of the Empire. Nothing but good can follow from their researches if they add, as gradually they must add, to the wider knowledge of the Empire not only among the workers themselves, but ultimately among the whole body of informed Imperial citizenship; not only in the overseas territories, but also at home. For us at home the Empire is worth knowing. Our knowledge of it begins with the school lessons in geography and history—or should do so; no doubt the ideal here is yet to be attained. Such knowledge may become later of vital importance to those who wish to join the stream of overseas migration.

The British Association, in pursuit of its policy of obtaining from time to time "reports on the state of science" in one department or another, has recently, through a committee of the Section of Educational Science, been collecting evidence as to the facilities existing in our schools for training boys and girls for life overseas. In the crowded curriculum of most schools these facilities, at any rate in their particular Imperial application, are not conspicuous. Yet any labour which time allows us to spend, whether in school days or after them, upon the advancement of scientific knowledge of the Empire, of the means and manner and environment of life in its component territories, must be well spent. The British Association has played its part in this advancement since, in 1884, it admitted the principle and established the practice of holding occasional meetings overseas. Those of our members who travelled from Great Britain to take part in these meetings have had peculiar opportunities to meet and discuss each his own scientific problems with fellow-workers in the Dominions—and it should be added with particular reference to those meetings which have been held in Canada that they have provided almost unique opportunities for personal contact between British workers in science and their American colleagues.

Our travelling members have been able to see how science is cultivated in the universities of the Dominions and in many other institutions; they have gained first-hand acquaintance with the special problems of one territory and another; and when they have returned home they have talked—as any one who travels the Empire is impelled to talk. I have myself been guilty of giving way to this impulse on more than one occasion. Opportunities for travel are none too common for most of us, but most of us can at least cast our minds back to the exhibition at Wembley. Science herself, as an exhibitor, took a place there befitting her natural modesty. The scientific exhibit arranged by the Royal Society, admirable as it was, was confined to two rooms of the Government Pavilion. But was not a very large proportion of the entire exhibition, in point of fact, an exhibition of applied science?

It is impossible in the Imperial connexion to overstate the case for science. Sir William Huggins, in his presidential address to the Royal Society in 1901, said that "assuredly not only the prosperity, but even the existence of this Empire will be found to depend upon the more complete application of scientific knowledge and methods to every department of industrial and national activity." To-day we see that application in much fuller progress than when Huggins spoke only a quarter of a century ago, and already we know how truly he prophesied.

It is not for a moment to be supposed, because the State has come to take a more active and practical interest in scientific research, that there is therefore any occasion for the lessening of interest on the part of societies and individuals. The State interest involves that other interest, and invites it. It can never become the exclusive function of the State to aid the individual research worker. The State may, and does, co-operate in aiding him, as, for example, through the universities and the Royal Society. Nevertheless, there are whole departments of research which do not come within the range of public assistance, but are no less valuable because they do not. Therefore the support of science remains the concern of our scientific societies, educational institutions, industrial organisations, and private benefactors, no less than it ever did; nay, the very fact that the State has lent its aid should encourage them to continue their aid and to reinforce it—indeed, there is satisfactory evidence that this actually happens. One example will suffice which indicates, incidentally, that from the purely materialistic point of view scientific research is not a luxury; for the community it is probably the cheapest possible form of investment. The Government's fuel research station has not yet proved the commercial possibility of the low-temperature treatment of coal which would result in the more economical production of smokeless fuel, oils, and gas; but in attempting this difficult task it has already, by results unforeseen when the task was undertaken, shown at any rate the possibility of economies for the State and for some of its major industries which are well in excess of the cost of the research itself.

There are parallels in many respects, as has been often pointed out and as often forgotten, between the periods of our history following the Napoleonic Wars and the Great War. The application of science in industry and daily life received impetus in the earlier of these periods in such directions as the introduction of steam motive power; it is receiving it now, as it has been attempted here to show. The auspices now are more favourable. Science is more powerful. Men more adequately and more generally recognise its power, and therein should lie a certain ethical value for it as offering a new point of view, in the manifold interest of which all can share. Should not the application of science, for example, offer a new field for community of interest, not only between one industrial organisation and another, but also within the whole body of workers in any single organisation?

In order, however, that the community may fully realise all that it owes, and all that it might owe, to the advancement of science, the channels of communication between research and the public mind have to be kept clear, maintained and widened. The non-scientific public is accustomed to view science as it might view a volcano; prepared for the eruption of some new discovery from time to time, but accepting the effects of the eruption without realising the processes which led up to it during the preceding period of quiescence. The period of preparation by research before science can offer the world some new benefit may be long, but the scientific machine is always running quietly in the laboratory. There is an example ready to our hands. We recall the introduction of wireless telegraphy and telephony as a scientific gift of quite recent years. Do we all realise that it was here in Oxford, at the meeting of the British Association so long ago as 1894, that the first public demonstration of wireless signalling by means of electro-magnetic waves was given by Sir Oliver Lodge? It was the work of science to develop the methods then demonstrated until they have been brought to their present marvellous uses. On the other hand, it is often the case, whether in industrial or agricultural, domestic or whatever application, that science has knowledge at command, awaiting use, long before mankind can be brought actually to apply it. Though we have quickened, we are not yet so quick in the uptake of the results of applied scientific research as, for example, some of our commercial competitors. The public support of scientific research, upon all these grounds, should be accorded freely, with understanding, and with patience.

Views and Reviews.

Summaries of Addresses of Presidents of Sections.[1]

The Analysis of Line Spectra.

In his presidential address to Section A (Mathematics and Physics), Prof. A. Fowler refers especially to recent developments in the analysis of the more complicated types of line spectra. The way to the analysis of such spectra was opened up by Catalán's discovery, in 1922, that in the spectrum of manganese and certain other elements there are terms of higher multiplicity than the triple terms previously recognised. Systems of terms with multiplicities up to octets have been found, and the main features of the structures of the spectra of a large number of elements have been worked out by Catalán, Meggers, and others. No exceptions to the law of alternation of even and odd multiplicities in passing from element to element across the periodic table have been found, and the first spark spectrum of an element has the same even or odd multiplicity as the arc spectrum of the preceding element. The types of the spectroscopic 'ground terms,' representing the deepest energy levels of the respective atoms, have also been identified for numerous elements, though their actual values are not always determinable.

The more recent results of the analysis of complex spectra have thus provided an ordered knowledge of a multitude of facts which have an important bearing upon the theory of spectra and on the arrangement of electrons in the outer parts of atoms. Theoretical workers have kept pace with the experimental progress, and the deeper spectroscopic terms can be calculated for any specified electron arrangement by means of formulæ developed by Hund. The scheme of electron distribution suggested independently by Main Smith and Stoner can now be applied with considerable confidence to all the elements from 1 to 92, and the theoretical predictions as to the characteristics of the spectra will doubtless be of great assistance in the analysis of spectra which have not yet been disentangled.

Reference is made to some of the experimental methods of spectroscopy, from which it would appear that the present resources are adequate for the elucidation of the majority of the outstanding problems.

The Scope of Organic Chemistry.

Prof. Jocelyn Thorpe discusses the field which lies before the organic chemist in his presidential address to Section B (Chemistry). During the fifty years that have elapsed since van 't Hof published the theory on which modern structural organic chemistry is based, great and important advances have been made in our knowledge of the chemistry of carbon. The tetrahedral theory of carbon structure provided a means of attack which has enabled the organic chemist not only to gain an insight into the conditions underlying the formation of simple molecules, but also has rendered it possible for him to prepare synthetically many of the products formed during life processes. Nevertheless, he is still far from gaining a knowledge of the mechanism underlying Nature's chemistry. The van 't Hof theory has served the chemist well and has carried him far, but he is now seeking another lead to carry him still further forward.

Structural organic chemistry must conform to the modern views of the physicist regarding molecular structure, and it is clear that some form of the electronic hypothesis will have to be adopted; but at present, although there are many such hypotheses, they all have one feature in common—they are qualitative not quantitative—they explain but they do not predict. In this respect, therefore, they differ fundamentally from the great conceptions of Dalton and of van 't Hof.

The scope of organic chemistry includes biochemistry, but the modern tendency is to approach biochemical problems from the biological side rather than from the point of view of structure. If biochemistry is to justify its name, greater efforts will have to be made to develop the science from the organic chemical side, otherwise any reasoned system of advance will be impossible. Our forest products need far more attention. Originally most of the useful organic products were derived from materials obtained from the plants and grasses present in our forests. By means of these substances it was found possible to correlate structure with physiological action and to produce compounds of enhanced value synthetically. It is certain that many such substances still remain to be discovered.

The scope of organic chemistry includes also the dyestuffs and petroleum products. The former constitutes probably the most remarkable example of the application of the van 't Hof theory to scientific and ultimately to commercial needs, and teaches a lesson which no one can afford to ignore. Great and successful efforts have been made during the past ten years to render Great Britain self-contained as a dyestuff producing centre, but the need for fundamental research must not be overlooked. Petroleum stands sadly in need of scientific treatment if the wasteful and uneconomical processes engendered by the abundance of this material are to be replaced by the economical and frugal methods which can only be determined by systematic scientific research. Moreover, the modern tendency to construct engines of increased compression ratio means that there will be an increasing demand for the higher boiling hydrocarbons as motor fuel. Polymerisation and depolymerisation must therefore be made the subjects of systematic investigation.

The Lower Carboniferous (Avonian) Rocks of England and Wales.

After reference to the death at Oxford nearly ten years ago of that brilliant worker on the Lower Carboniferous rocks, Arthur Vaughan, Prof. S. H. Reynolds in his presidential address to Section C (Geology) summarises the progress of knowledge on a variety of geological topics, which are unrelated, except in so far as they are concerned with the study of the Avonian.

The subdivisions of the Avonian rocks are first

[1] The collected presidential addresses delivered at the meeting are published under the title "The Advancement of Science: 1926," at 6*s.*, or obtainable at the bookstall at Oxford by members at 4*s.* 6*d.*

discussed and Vaughan's earlier and later views are indicated. There has been considerable increase in our knowledge of the unconformities and breaks in the succession of the Carboniferous rocks, and the phasal equivalents were dealt with in some detail; suggestions are made in the hope of lessening the confusion which has arisen from the inconsistent use of certain symbols. Though the Millstone Grit lies outside the scope of the address, its relations to the underlying strata are described, and the varying relationships to the rocks below of the Millstone Grit (*sensu lato*) in the Bristol district, South Wales, and the Yorkshire Dale country respectively were indicated.

The problem of the classification and nomenclature of the Dibunophyllum zone (*sensu lato*) and its equivalents in the north of England is a controversial one. The goniatite work of Mr. W. S. Bisat has, however, led to the rocks of the Culm or shaly phase being known with an accuracy which is sometimes lacking in areas where the rocks are of the calcareous type.

Our knowledge of reef-knolls, pseudobreccias, and algal limestones is summarised, and the address concludes with sections devoted to dolomitisation and chert.

Biology and the Training of the Citizen.

Prof. Graham Kerr, in his presidential address to Section D (Zoology), emphasises the condition of dangerous instability occasioned through the evolution of the modern civilised State not having been accompanied by a corresponding evolution in the training of its citizens. One of the chief dangers lurks, curiously, in what was one of the most important factors of human evolutionary progress, namely, the development of language, for this, through modern applications of science such as printing and radio telephony, has come to interfere with the natural working of the principle of leadership—upon which human progress is so dependent. The natural leaders in communal advance throughout the ages have been the men of outstanding constructive ability; leadership has now, however, been made accessible to those whose ability is not constructive but is rather that of the advocate.

The great dangers of the position so arising can only be avoided by immunising the citizens by means of education, and Prof. Kerr urges the importance of including a grounding in the main principles of biology in the reformed educational system. A grasp of such main principles as evolution, inheritance—including the fact of its incompleteness, *i.e.* what is ordinarily called variation—the struggle for existence, communal evolution, and the inter-communal struggle, would, by inducing in the citizen's mind the biological outlook, broaden his vision and enable him to see his way round dangerous obstacles in the path of social advance. He would appreciate the biological aspect of economics, and, realising that the wealth of the community lies in the capacity of its citizens, would recognise how greatly it is to the commercial interest to increase that capacity by the training of the individual. Mass production in industry depends for its success on uniformity of raw material; such uniformity is absent in the human raw material, and therefore the principle of mass production should, as regards the education of the citizen, be confined within the narrowest limits consistent with practical considerations. With the limitation of mass education would come a quickening into renewed life of the primitive relations of parent and offspring—the deadening of which is one of the deplorable phenomena of existing conditions. The quickened interest in the training of his individual child would stimulate the interest of the parent in our whole system of education—the lack of such interest being again one of the great weaknesses of our present-day democracy.

It is a necessary feature of advance in civilisation that the individual citizen, his abilities, mental and physical, no longer kept up to the highest pitch by the pressure of the struggle to exist, tends to degenerate and depend to a greater and greater extent upon the community. This increased dependence carries with it increased obligations of an ethical kind towards the community—discipline, self-sacrifice, patriotism, loyalty. The shackling of personal liberty in the bonds of duty to the community would again be a return to ancient custom dictated by biological principles.

In conclusion, Prof. Kerr urges that the biological view of society which, while recognising differences in detail, whether in ability or in manners, never loses sight of the fact that behind these lies a human nature fitted out with the same common strengths and trammelled by the same common weaknesses, greatly conduces to the smooth working and onward progress of the social mechanism.

The Economic Development of Tropical Africa.

The task of developing Africa is complicated, as is shown by the Hon. W. Ormsby-Gore in his presidential address to Section E (Geography), by two factors, climate and the wide differences in traditions and capacities between the white ruling race and the native population. As a result of climate manual labour cannot be undertaken by Europeans. The African is the most adaptable of all the races of the human family; but the changes which have been produced so far are not more than skin deep. We know little of the history and mental traditions and aptitudes of the African native. Year by year anthropology is adding to our knowledge, but we are still at the stage of collecting data, and it is difficult to ensure that scientific investigation shall keep pace with the practical day-to-day running of Government administration and economic development. Nevertheless, we must clear our ideas on certain fundamental questions.

The first problem is the health of the African population. It is difficult to say with certainty what is the effect of European impact on vital statistics. In tropical Africa, though there are no scientific data, there can be little doubt that the population diminished between 1900 and 1924. This is due mainly to sleeping sickness and venereal disease; but the principal cause is infant mortality, which under the age of twelve months in the purely native area of Tanganyika has been estimated to be so high as 400 per 1000.

Rapid economic development has given rise to a number of social problems as a result of the accession of wealth among native producers. It has affected the notions of land tenure, and the individual has become emancipated from communal control. The nature and sanctions of tribal authority are undergoing rapid change, especially spiritual and moral. In the coast towns a large portion of the native populations has become entirely detribalised. They are imitating Western civilisation and demanding Western education; but in education the real needs of the people and the right methods of bringing out their innate capacity on modern scientific lines have not been studied. The disrupting tendencies in Africa to-day are so many that constructive thinking is urgently necessary, if African communities are not to be reduced to disorganised mobs. The introduction of new arts and industries has created a class of wage earners unknown in the old Africa; but the incentives to labour are small. There is danger of degeneration unless the young men are trained to work either as direct producers or wage labourers.

There are four main duties upon which we have to concentrate. First, the various problems of 'public health'; second, the improvement of the standard of the natives as producers of food and economic crops; third, to further transport facilities; fourth, to educate the native in such a way that he may advance in the scale of civilisation and assimilate such new moral controls as will fit him to withstand the dangers and make the best use of increasing wealth.

Inheritance as an Economic Factor.

The purpose of Sir Josiah Stamp's address to Section F (Economic Science and Statistics) is to consider the whole subject of inheritance in its relations to economic science and the community. The conclusions reached are as follows:

1. In the past century unprecedented economic advance has been due in the main to the greater use of invention and fixed capital. This has, in turn, made new accumulation of savings possible, and has been made possible by the growing fund of accumulation. In this accumulation the principle of inheritance or bequest has played an important part. Where there has been freedom from the shackles of a family diffusion system the greater progress has been possible. The individual motives which are operative under such a system are stronger than ever, but operate over a diminishing part of the field; they are also stronger over a short period, and of diminishing effect over a long period of time. In other words, communal saving *via* company reserves (not subjected to the individual volition for saving against spending), and *via* repayment of debt through funds derived from taxation, and *via* large capital efforts (housing, etc.) partly financed through taxation, is an increasing proportion of the total. Although some of the values set up by such collective sums may figure in individual estate values, they are not created or destroyed by interference with, or promotion of, the right of inheritance.

2. The remaining considerable section of capital accumulation is still powerfully affected by inheritance rights, and would be more affected than heretofore by interference with rights in the direct line, though less affected than hitherto by rights out of that line.

3. The sense of 'social injustice' is directed against inequality of wealth, of which inequality through inheritance is not now the larger part. This sense, if limited to inheritance features, has less economic reaction than is generally supposed. In any case, it is a sense which is not scientifically based. It is probable that the average man has a slightly smaller *proportionate* share of the aggregate than he would have had if there had been no inheritance system, but a substantially larger *absolute* amount, because he shares a larger aggregate or better standard of life than he would have had under a system with no such aid to accumulation.

4. The particular claims for unlimited rights of bequest, as settling the best economic direction and control, are gradually losing their force.

5. The principles upon which death duty taxation is at present based might be improved. The actual sum now being raised is not necessarily more harmful economically than a similar sum raised by additional income-tax, but it is more repressive in accumulation than the same sum would be if a less sum were raised at lower rates on the first succession, and the balance were raised at higher rates on succeeding successions.

Position and Prospects of Electricity Supply.

Sir John Snell, the president of Section G (Engineering), is giving an address on the present and future development of electricity supply. His predictions about the future are based on the latest and most accurate data, and they summarise the results of many lengthy and laborious calculations. Sir John gives first a historical résumé of the progress that has been made during the past forty years. He lays special stress on the work done by Ferranti and Crompton. It is interesting to remember that although Sir Charles Parsons perfected his steam turbine only about thirty-five years ago, yet of the total prime movers now used in electrical generating stations, less than 10 per cent. are reciprocating engines. He points out that the average load factor, that is, the ratio of the actual power delivered to the maximum possible power, is, in Great Britain, less than 25 per cent. Hence the capital expenditure is four times as great as it would be if the plant worked continuously at full load. For economy, therefore, it is of vital importance to have a high load factor. Stress is laid on the importance of having common sources of supply for power, light, and railway traction. In this way a high load factor can be obtained.

The present output of the public generating stations in Great Britain is 7000 million units annually. Government publications estimate that in fifteen years the output will be three times as great. This is a low estimate, as no account is taken of the great probable future extension of railway electrification. The electricity returns record an average rate of increase in the sale of electricity between 1913 and 1924 of 25·8 per cent. per annum. If this continue, the progress of the industry will be extremely rapid.

It is necessary, therefore, to take long-sighted views of the future. In an industrial country like Britain, in order to live and continue to exist as a great nation, it is essential that abundant power be available. The bulk of this power must be derived from coal. In Scotland and North Wales large hydro-electric systems are in operation. In the Grampians, in Ayrshire, and in Lanarkshire water-power systems are being erected. Detailed investigation is being made as to the tidal power available in the Severn estuary. It is estimated that a 1000 million units of electricity could be distributed from this source alone. Compared with other countries, however, Britain is poorly endowed with water power.

The importance of economising the consumption of coal is emphasised. Some of the devices suggested only economise fuel at the expense of undue capital expenditure. Increasing the size of the plant and employing bigger stations will undoubtedly economise coal. Sir Charles Parsons has shown that with a steam pressure of 500 lb. per square inch and a 97·5 per cent. vacuum, a full load thermal efficiency (steam to electricity) of 33½ per cent. is available. With an initial steam pressure of 1000 lb. per square inch, a thermal efficiency of 35 per cent. can be obtained. It is probable that in a few years electricity will be generated at large stations at a cost not exceeding 0·3*d.* per unit. This would mean that if the price of coal be about 20*s.* per ton, the *average* price paid by a consumer would, in a few years' time, be about 2*d.* per unit for lighting and 1*d.* per unit for power. Some consumers in remote districts will have to pay more and others less than this. Although a steady development is discernible, it is certain that there is a great future before electricity supply. It is our duty to lay down suitable lines along which the industry may develop so that succeeding generations may reap a bountiful harvest from our foresight.

The Regional Balance of Racial Evolution.

Prof. H. J. Fleure in his address to Section H (Anthropology) tries to interpret the present-day distributions of physical characters of man on evolutionary lines rather than on the more purely taxonomic lines that have been generally recognised in earlier studies. The general evolution of man is touched only lightly to suggest relations between lengthening of prenatal life on one hand and increased brain growth and decreased hair and jaw development on the other. Attention is concentrated upon men of modern type, known from the European Aurignacian period onwards, and comparative survey suggests that certain skull changes accompanied the evolution of modern types, that evolution probably occurring over a broad zone from Cap Verde to Persia. The arguments for this area are partly palæoclimatic. Early drifts southward from this early home are held to have given rise ultimately to the pigmy peoples (heads not lengthened), Bushmen and Tasmanians (heads often lengthened), Australians (heads much lengthened), with diversities of colour and hair. It is suggested that the people on the northern fringe of the early home, like some on the southern fringe, may have escaped the head lengthening seen in others, and that from these, better grown and less dark than those on the south, the sub-brachycephalic and ultimately the brachycephalic peoples of the world's highland zone may have originated.

The way northward between the Elburz Mountains and the Hindu Kush is held to have been opened up to modern men with the final retreat of the ice, and drifts through it went mainly northeastwards leaving the high Mongolian plateau and Tibet on the right. The extreme conditions of the high Mongolian plateau in their probable relation to racial evolution and drifts into China, etc., are mentioned, and the question of race types in Europe is argued out on similar principles. It is suggested that evolutionary change owes a great deal to cumulative changes of environmental influences in plastic infancy. As, however, no two embryos are exactly alike, the hereditary units in some may vary towards, in others away from, the new standards arising from the cumulative changes of environmental factors and as a consequence health and growth and survival may be affected. In other words, 'selected' germinal variations may follow after somatic variations and may thus help to secure the newly gained features to the race.

Function and Design.

Prof. J. B. Leathes' presidential address to Section I (Physiology) deals with the interesting subject of function and structure in the living organism. The parts of which a living organism is composed assist in the maintenance of its life. For physiology, which studies the manner of their ministrations, their morphological structure is organic design. This structure, essentially chemical, serving in the maintenance of life, must always display the peculiar property distinctive of matter in which the phenomena of life are exhibited, that of transforming adjacent matter which is not alive into its own similitude and so, perishable though it be, maintaining itself by spontaneous self-regeneration. A chemical structure so designed as to perpetuate a perishing existence is a necessary hypothesis for biology.

Twentieth-century chemistry, which already, by defining the catalytic nature of enzymes and the general nature of the material of life, has shown the immensity of the field to be explored, may yet also dispel some of the obscurity that covers it by indicating structures that have in some degree the property which the hypothesis requires, structures that assimilate the disposition of adjacent foreign matter to their own, and so in spite of their instability tend to perpetuate themselves. Of all degrees and qualifications that chemistry can put after or before its name, 'biological' will then be that of which it will have most occasion to be proud.

Living material constituted so as to behave in this way appears to be largely, though certainly not entirely, protein in character. The almost infinite number of forms that protein substances may take, even without changing the proportions in which the amino acids of which they are composed occur in them, fits with the variability of forms of living matter. If some of these variations, retaining the power of self-regeneration, are sensitive to recurring external disturbances, and react to them in such a way as to favour the manifestation of this power, these variations are more likely to survive.

The evolutional history of life must express the behaviour of the chemical constituents of the material that lives, the distinctive property of which is that of spontaneous self-regeneration. A modification of living matter which retains this property, if it assists in the maintenance of life, must persist; function alone can give permanence to structure. Modifications without organic design, that obstruct or merely do not assist, must share in the decay, but cannot share in the reconstruction of living matter.

Psychological Aspects of our Penal System.

Dr. J. Drever points out in his address to Section J (Psychology) that the evolution of punishment and a penal system exhibits four phases, which may be designated the vindictive, the retributive, the protective or deterrent, and the reformatory. The vindictive phase is not punishment in any strict sense. Nevertheless, it represents the psychological origin of punishment. An individual who has suffered at the hands of another responds with the impulse of anger, which is satisfied by the infliction of some hurt on the culprit. The hurt inflicted may bear no direct relation, either in kind or in degree, to the injury done, but merely to the intensity of the anger. When some crude notion of justice comes into existence and determines the kind of hurt that may be inflicted on the wrongdoer, the vindictive passes into the retributive phase. This in turn passes into the deterrent phase, when it is realised that punishment looks to the future as well as the past, and that its function, from the point of view of society at least, is to protect against the repetition of a delinquency. As civilisation advanced it began also to be realised, at least in theory, that no amount of wrongdoing on the part of the delinquent absolves society from responsibility for the results produced on him and on others by the way in which he is treated by its representatives, acting under social laws. The realisation of this truth, and the perception at the same time of the fact that one way in which society may protect itself against wrongdoing is by the reform of the delinquent, marks the transition to the reformatory phase.

At the present time it will be generally agreed that, so far as society uses punishment at all, it ought to do so with some definite end in view, and therefore with an eye to the future rather than the past. It would also be generally agreed that this end is primarily its own protection, and, as subsidiary to this, the producing of such a psychological change in the delinquent that the wrongdoing will not be repeated. Some writers have suggested that we ought to regard the action taken by society as treatment rather than punishment, the suggestion involving the view that delinquency should be considered as the outcome of something not unlike disease. There is, however, really no warrant for excluding either the idea or the fact of punishment, which exercises an important influence in the direction of reform in various ways. At the same time, it is true that if, and as, society progresses, we may expect the need for special emphasis on the deterrent influence of punishment gradually to diminish, and the reformatory aim to come more and more into the foreground.

If punishment looks to the future rather than to the past, it is evident that the vitally important psychological problems of punishment are not those involved in the question of criminal responsibility, which is really a question inherited from an outworn penal philosophy, and not, from the social point of view, an urgent practical problem at all. The important psychological problems are rather those involved in a thorough knowledge of the psychological situation with which we are faced in dealing with the individual delinquent, and of the psychological effects likely to be produced by the action taken in the name of society. The first step in penal reform at the present time should be to provide for the securing of such knowledge by the institution of psychological clinics for the examination of delinquents, and more particularly juvenile delinquents.

Changing Aspects of Botanical Science.

Prof. F. O. Bower, in his presidential address to Section K (Botany), refers first to the calamity which has fallen upon the Section, in the sudden death of the president-elect, Dr. William Bateson. Instead of attempting to fill the broad biological rôle which would have been natural to Bateson, Prof. Bower centres his address round the dates of the previous meetings in Oxford. After a brief reference to the stormy meeting of 1860, he points out from recent writings how Darwin's views, as stated in "The Origin of Species," still stand in essentials as a great philosophical pronouncement. He directs particular attention, however, to Ray Lankester's introduction of the conception of homoplasy, which followed as a natural sequel to it. This was applied first in animal morphology, but Prof. Bower illustrates it by reference to homoplastic likeness even in internal tissues of plants, an aspect that is still in its infancy.

Passing to 1894, the central feature of that meeting was Strasburger's enunciation of his generalisation on the periodic reduction of chromosomes. It fell like a bomb-shell upon the old controversy on alternation in plants. But it was soon recognised that here was something more fundamental than somatic alternation. Like the fabulous genie let loose from its bottle, the conception of a nuclear cycle in all plants that show sexuality dominates ever more and more the field of morphology. That cycle may be regarded as the foundation upon which somatic development may or may not be imposed. Provided the events of syngamy and meiosis be constant, the alternating generations must have always been distinct: if not, then there is a possibility of alternation not by 'interpolation' but by 'transformation.' The resolution of this problem can be given only by close comparison of facts derived from nearly related organisms. But until this final resolution comes, it is possible to hold either a theory of 'transformation' or of 'interpolation.' Prof. Bower still thinks that the greater probability appears to lie with the latter, as regards green archegoniate plants. It is open to anybody to see in the Archegoniatæ a separate evolutionary problem from that of any of the great lines of Algæ. Wide homoplasy may be invoked, and an origin of the sporophyte in land plants contemplated by interpolation. The discovery of the Rhynie fossils has strengthened this view by providing early synthetic links between Bryophytes and Pteridophytes, and by thus drawing the Archegoniatæ more definitely together.

As to the botany of the present period in Britain, its relation to previous periods can best be traced through the pages of the *Annals of Botany*—that stately series of forty volumes which have since August 1887 emanated from the Oxford Press. The first volumes bear evidence of a preponderance of organographic and systematic interest. Then anatomy and cytology followed in increasing proportion, and later there has been a preponderance of memoirs relating to physiology. The drift of research has clearly been from systematic and descriptive science to a prevalent study of function. Doubtless time will right the balance of opinion again: but meanwhile a cool philosophical outlook will estimate no one branch of the science as of greater importance than another.

Man and Method in Scientific Education.

Sir Thomas Holland's presidential address to Section L (Educational Science) discusses two questions relating to scientific education: first, the best arrangement of curricula and examinations, and secondly, the cultural value of education in scientific subjects. Under the Royal College of Science system, to which the name 'tandem' system has been given, one subject is studied at a time, two subjects for half a year in each academic year during the first two years of the course, and one subject at an advanced stage during the third year. Examinations are held at the end of each course and closely follow the teaching. The alternative system, based on the University of London examinations, involves simultaneous study of three or four subjects during the first year, leading to the Intermediate Examination, followed in the case of pass students in science by two years of simultaneous study of three subjects, or, in the case of honours students, to the intensive study of a principal and a subsidiary subject.

Sir Thomas Holland's favourable opinion of the 'tandem' system is confirmed by the opinion of many professors who have had experience of the system in the first instance as teachers. He recommends it especially for students who are to devote their lives to scientific research. "Our professors," he says, "still adhere to the tandem principle, although one detects in the time-tables a slight yielding to the demands of the more complex life; but an extension of the course from three to four years in most of the 'schools' has helped still to preserve the simplicity of the students' night thoughts." It is not easy to quote the merits of the two systems. For those who are to find a career in business or administration in which many unrelated questions will have to be handled daily and with promptness, mental mobility may be increased, or, at any rate, more rigidly tested, by the composite system of training and examination. The 'tandem' system, as carried on at the Royal College of Science, has been formally approved by the University of London. Whatever other merits it may have, it has induced the University to relax its cast-iron regulations. Sir Thomas Holland points out that the 'tandem' system is applicable not only to different subjects, but also to different sections of the same subject, such as the petrological and palæontological groups in geology.

The remainder of Sir Thomas Holland's address is devoted to the question of 'humanising' scientific education. Are we not inclined to forget that the Renaissance, the great world-revolt from formalism and theological bondage, was a revival not only of literature and art but also of 'the spirit of research' regarding natural laws? In course of time, classical learning tended towards specialisation in its linguistic, grammatical, and rhetorical aspects. "Its main object became obscured and stricken with a formalism and even pedantry." Nevertheless, Sir Thomas pays generous tribute to the classical curriculum in which our chief public men and our army of administrators, at home and overseas, who have made the British Empire what it is, have been nurtured; and insists that while in scientific education attention must be given to the professional and vocational aspects, we must see to it that science and technology are taught in a way which will develop character and capacity for affairs.

Food Supply and Population.

In 1898 Sir William Crookes directed attention to an approaching scarcity of wheat in the world owing to the exhaustion of the nitrogen in the soil. Crookes's prophecy may seem to have been wholly falsified, but none the less we cannot continue to ignore Malthus's conclusion that the food supply of the world must eventually begin to lag behind the increase of population. Mr. Keynes has given reasons for the conclusion that the course of wheat prices and real wages since the War already indicates the approach of scarcity, and though Sir William Beveridge has rejoined that the limits of agricultural expansion are still remote, it is desirable to examine the fundamental relation between land cultivated and population maintained. This is done by Sir Daniel Hall in his presidential address to Section M (Agriculture).

By various means of approach it can be shown that, under existing conditions of farming, about $2\frac{1}{2}$ acres of cultivated land are employed for the maintenance of one unit of population—man, woman or child. This area varies in different countries, according to the quality of the land and the system of agriculture followed. It may be so low as $1\frac{4}{5}$ acres in Denmark with its intensive arable farming: so high as 4 acres in Spain with great areas of poor pasturage.

In the ordinary way, however, expansion of the population demands a corresponding increase in the cultivated area, and the gigantic increase in the world's population during the nineteenth century was the direct outcome of the settlement of the Americas, Australia, and kindred 'new countries.'

Reasons can be given for supposing that an expansion of the area corresponding to the present rate of increase in the white population cannot be continued. Suitable land is no longer available in quantity commensurate with the demand. It remains to increase the production from the existing farmed area, and though possibilities in this direction are enormous, because, for example, the great wheat-producing areas of the world are farmed at a very low level of yield per acre, such increase of production will involve higher cost of production per unit. The only means of escaping from higher costs lie in the applications of science, such as the improvements due to the plant breeder, or the cheapening of fertilisers brought about by the manufacture of synthetic nitrogen products. The low returns derived from agriculture at the present time militate, however, against intensification of production; indeed, in most civilised countries a 'flight from the land' of both men and capital is manifest because its earning capacity is low compared with that derived from industry and commerce. Intensification of production is only likely to begin when stimulated by a definite rise in the prices of agricultural produce, but this must occur as the land available for settlement proves insufficient to absorb the present surge of population before the checks that are in action prove effective.

Printed in Great Britain by R. & R. Clark, Limited, *Edinburgh.*