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Mathematical and Physical Sciences.

President: PROF. ALLAN FERGUSON, M.A., D.Sc.

TRENDS IN MODERN PHYSICS.

PROF. ALLAN FERGUSON commenced his Presidential Address to the Section A of the British Association by referring to the losses which Physical Science had suffered during the previous year by the death of McLennan, Glazebrook, Petavel and Pearson. McLennan was a versatile and energetic investigator and director of research, whose contributions ranged from cosmic radiation and spectroscopy to cryogenic work and radium therapy. Glazebrook was a veteran of a previous generation whose fittest monument was the National Physical Laboratory. The work of this great Laboratory was further developed by Petavel, who, though known as an engineer, was also a contributor to Physical Science. Pearson will always be remembered in connection with his development of statistical method and its application to biometrical investigation. His *Grammar of Science* develops a point of view which should not prove unhelpful to the student of to-day who would fain remain a physicist without of necessity becoming a metaphysician.

Turning now to the subject of the address, Prof. Ferguson characterised nineteenth-century science and particularly Victorian Science as showing a simple realism not wholly unrelated to that simple realism of to-day which sees in an α-ray track evidence for the existence of an atom of the same order as that furnished by a diffraction photograph (or, for that matter, of our own eyes) for the existence of a star. The classic outlook was based on the notions of velocity, acceleration, momentum and force which were formed into an ordered scheme by the genius of Newton. The physical science of the eighteenth and nineteenth centuries was occupied in extending and clarifying these concepts, although the formation of a society at Cambridge "to inculcate the principles of pure *d*-ism and to rescue the University from its *dot-age*" was required before the British physical school could rival the advances of their Continental brethren. In spite of these attempts at clarification, fundamentals remained obscure enough: thus mass was the product of volume and density while density could only be defined as mass divided by volume.

The nineteenth century also saw the rise of atomic theories and the many successes of extrapolating the laws which described the motion of planets to the indescribably small atoms. It is an odd fact that in the modern days of probability and indeterminacy we should also see atomic constants determined with greater accuracy than before. However, the British could remember with pride that it was Joule who first evaluated a molecular constant, *viz.*, the mean speed of a Hydrogen molecule at 0 °C. as 6055 ft./sec. in a paper published in 1848. Joule was also responsible, as is well known, for the recognition of the equivalence of heat and energy. Another outstanding feature of the 19th century was that success of the ether theories which led Kelvin to say "This thing we call the luminiferous ether... is the only substance we are confident of in dynamics. One thing we are sure of, and that is the reality and the substantiality of the luminiferous ether." However, the end of the century already saw this conviction totter in the presence of the problem of the distribution of energy amongst the various wavelengths comprising the radiation from a black body. A satisfactory theory could only be given by "quantising" the energy of an oscillator, *i.e.*, by restricting its values to integral multiples of a unit $h\nu$, as was shown by Planck. Another phenomenon which was inexplicable on classical lines but could immediately be explained by means of Quantum Theory was the photoelectric effect. The discrete lines of the spectrum of hydrogen, for example, could only be explained by assuming that electrons were confined to prescribed orbits in which they did not radiate as required by classical theory. The success of this theory of Bohr and its extension by Sommerfeld was large but the more complex spectra required the notion of spin and Pauli's principle before a model capable of explaining them could be found.

In the meanwhile the discovery of the Compton effect emphasised the corpuscular nature of light, while interference, diffraction and polarisation were still explicable only by means of a wave concept. This duality was successfully extended to matter particles by de Broglie who attributed a wavelength h/mv to a particle of mass m and velocity v. This dualism between particles and waves has in recent years been interpreted by correlating the amplitude of the wave at any place with the probability of finding the particle in that position. The particle conception is still at the bottom of all the attempts made to bombard atoms with fast moving projectiles. To the number of such projectiles there have been notable additions in the form of accelerated protons and, more recently still, fast and slow neutrons. The investigation of cosmic rays has led to the discovery of the positive counterpart of the electron, *viz.*, the positron. In all the nuclear transformations studied, Einstein's law of the equivalence of mass and energy has been amply verified with great accuracy. Very recently, however, the validity of the law of conservation of energy in individual atomic processes has been called in question as a result of experiments on the Compton scattering of γ-rays.[1]

Another remarkable discovery is that of artificial radioactivity. Thus while Rutherford showed in 1919 that on bombarding nitrogen with α-particles we get oxygen and a proton, Curie and Joliot have shown that on bombarding aluminium with α-particles, neutrons are emitted and the remaining isotope of phosphorus is radioactive giving out positrons. Neutron bombardment also produces new radioactive elements which emit positrons or electrons and sometimes γ-rays also and are thus β-active.

The theoretical side has seen the enunciation of the much discussed uncertainty relations, *viz.*, that the product of the errors in two conjugate quantities like energy and time or position and momentum can never be less than the quantum h. It seems however that the word "indeterminism" applied to this principle is based on an extension of the strict meaning of that word. The word "observable" has been similarly treated. The "observable" as understood to-day, such as the frequency of a spectral line, is as far from being a direct percept as an electron-state which is dubbed an "unobservable". It is, therefore, more profitable to develop a canon to serve as a guide through the maze of new perceptual facts by adopting the method discussed in the *Grammar of Science* with some reservations and additions. The term "causality" as discussed by philosophers like Locke, Hume and Mill connoted an unconditional invariability of succession. The trend in physics is to devise a conceptual world of atoms and molecules to assist us in correlating the huge mass of our perceptions to get a simple description. But so long as these concepts do not become objects of perception it is useless to discuss their reality. Thus Planck, who defines an event as causally conditioned if it can be accurately predicted, escapes from a denial of causality on account of the necessarily uncertain character of predictions allowed by Quantum Theory by assuming causality to hold in a conceptual world where accurate predictions are possible. A conceptual world of quantum physics is framed in which a strict determinism reigns. This, however, is not so similar to our conceptual world as one consisting of billiard-ball atoms was. Accordingly the hard-pressed physicist of to-day is on safe ground only so long as he does not confuse the concept with the percept. Further, since Japolsky has developed a theory of the elementary particles on the basis of classical electrodynamics, the solution offered by quantum physics is not final.

Concluding, Prof. Ferguson referred to the remarkable advances made in industrial applications of physics, such as the flotation process for the separation of minerals which depends on a nice application of a knowledge of surface constants such as the angle of contact. He referred also to the observation of the Brownian movement of delicately suspended balances, the study of surface structure by means of electron diffraction, and the progress of low-temperature research. Finally he touched upon the "Impact of Science on Society" and said that a snobbish distinction between cultural and vocational values could not be maintained and the fact must be faced that there are dysgenic applications of science. Therefore the scientist must cease his worship of what Prof. Hogben calls the "Idol of Purity" and must be prepared to discuss all the social implications of his work and to educate himself as well as his less fortunate brethren in a knowledge of these implications.

1 [Recent work by a number of investigators has shown that the doubt is unfounded.]

Chemistry.

President: PROF. J. C. PHILIP, O.B.E., D.SC., F.R.S.

THE TRAINING OF THE CHEMIST FOR THE SERVICE OF THE COMMUNITY.

THOSE who may be harrowed by the horrors of civil strife in Spain, the temporary breakdown of the League of Nations and the contemplated possibility of a war to end civilisation, will find in the presidential address of Professor Philip a soothing palliative. Placidly, and at uniform speed we are led through a survey of the services rendered to the community by the chemist, to consideration of the most appropriate professional equipment with which the chemist should be furnished. In fact, the only suggestion of current alarms is a comical picture of popular misconception in regard to chemical research as applied to warfare.

On this point, and on this point only, Professor Philip allows himself some justifiable display of dignified irritation. "The truth is that the employment for other than beneficial ends of substances discovered by the chemist is due, not to his especial wickedness, but to the weakness and backwardness of the human spirit." The truth, having regard to the decorous limits imposed by a presidential address, could scarcely be stated more concisely. He fortifies it by reminding us that the dangerous and poisonous materials produced by chemists arose in the general quest for knowledge, and that many have applications both legitimate and valuable; nitrates and phosgene for example. He could have added that mustard gas, discovered in 1860 by Guthrie, remained a chemical curiosity until July 1917, when it was first used as an offensive agent by the Germans at Ypres: and that chlorine, discovered in 1774 by Scheele, was widely used for bleaching, disinfection and artificial dye-manufacture during decades before the Germans broke their promise, and began the whole disgusting business on April 22, 1915. Actually the pre-War production of chlorine for peaceful purposes in the United States alone averaged 900,000 pounds *per day*.

It is the peaceful purposes to which chemists apply their craft that Professor Philip emphasises, and from the tranquil paragraphs of his address the general reader will gain sorely needed information thereon. He notes with satisfaction the increasing interest shown by the State in the prosecution of these purposes, illustrated by the foundation of the Department of Scientific and Industrial Research followed by the Chemical Research Laboratory at Teddington where, under the skilful direction of Sir Gilbert Morgan during the past ten years, the study of synthetic resins, low-temperature tars, high-pressure reactions, metal-corrosion, chemo-therapy and water softeners, has been pursued by a large staff of trained chemists. Even the State is not yet fully informed on the functions of chemical practitioners, however, and if it can be said to possess knuckles, these are discreetly rapped by Professor Philip with reference to a recent lively wrangle that sprang from the drafting of rules for manufacture of pharmaceutical preparations containing poisons.

The lofty ideal of the medical profession, "serving the community," is quoted as a seemly example for the chemist, and even if this has acquired now-a-days a slightly advertisemental air, it is nevertheless a wholesome slogan. Most chemists who have leisure to extend their analytical habits to their own feelings, however, would probably find that their principal non-profit motive is to serve chemistry; and that if one of the by-products be serving the community, so much the better. Elimination of the profit-motive, especially among servants of the community so notoriously underpaid as chemists, is not so easy; and even Professor Philip himself would seem to be slightly infected with it when, in the next paragraph, he calls for a corporate body to "stand for the common interests of chemists as a whole".

On this question also the address is informative and sound. Tracing the history and purposes of the three large chartered bodies, the Chemical Society, the Institute of Chemistry and the Society of Chemical Industry, and mentioning the numerous ancillary organisations more recently springing from divergent activities, Professor Philip shows how the Chemical Council has arisen, in the ultimate hope of unifying the profession, acquiring adequate premises and establishing a complete register of trained chemists. This rosy prospect has been given seven years—two of which have already passed—for fulfilment, and it is to be greatly hoped that, even if the licensed hours require slight extension, the lions and the lambs will ultimately lie down together. Meanwhile, the Council contents itself with uniting the chemical profession and the chemical industry in support of publications and a central library.

There follows a thoughtful survey of the preparation essential to qualification as a registered chemist, non-pharmaceutical. Its basis must be a broad, general education for character, culture and citizenship, with due regard for accuracy in observation and statement. Professor Philip will have many supporters in regretting the absence of biology from this early stage of training, which he ascribes to the greater facility with which elementary instruction in the physical sciences can be arranged. His urbanity debars him from characterising this omission as laziness, and it is in fact more probably owing to the unfortunate action of London University in changing biology, for the Intermediate Science examination, from a compulsory to an optional subject. This was a real disaster, because even a zoological horizon limited to dissection of the frog, rabbit, dog-fish and earthworm enables you at least to glimpse the theatre of biochemical changes to be studied later, although it is merely a gallery-view.

Professor Philip scents danger at a further stage. Graduates in chemistry "can talk, at length about nuclear spins, valency angles, electron sinks, energy levels and so on, but are astonishingly uncertain about more elementary and practical matters". Coming from a physical chemist these words are innocent of bias, and are followed by passages of wisdom relating to co-ordination of knowledge and action in university training; these include a survey of requirements by seekers after training in chemical engineering, which will soon become a degree-subject in the University of London.

Nobody interested in the training of chemists, or, indeed, of science-students in general, should fail to read Professor Philip's address. Besides a plenitude of information and common sense, it offers a refutation of the gibe, unhappily sometimes warranted, that men of science cannot write good English, and in this respect also is an admirable example of an address that is really presidential.

Geology.

President: H. L. HAWKINS, D.Sc., F.G.S.

PALAEONTOLOGY AND HUMANITY.

TO the layman Palæontology is a comparatively unknown science and the work of the Palæontologist is looked upon more with curiosity than conviction. The responsibility for this rests upon the system of education obtaining at the present day and it is the purpose of this address to demonstrate that even Palæontology has a message of vital importance to deliver to mankind.

The object of Palæontological work is to unravel and decipher the records of past life and thus to enable us to adequately appreciate and establish its continuity since early geological times.

Although the time is now past when men in their senses looked upon fossils as freaks of nature, thunderbolts or even ascribed their origin to astrological conjunctions, still old prejudices die hard. But as summed up by Breynius in 1732, a person who would even now deny the true nature of fossils must "assuredly have a fungus for a brain". It was late in the 18th or early 19th century that students of Geognosy, instead of confining themselves to museums and libraries, began to work in the field and to investigate fossils of their own collection. Thus sprang up two sciences and "geology, as we understand it to-day, found in fossils the link that gave continuity to a mass of disconnected observations;" while "Palæontology took its place as the science of the succession of life." The discovery that strata could be correlated and their relative geological ages established is one of the greatest of modern times, for to it we owe our conception of geological time and the fact of evolution.

There are difficulties that the Palæontologist has to face, difficulties due to the imperfection of the geological record, to the breaks in the stratigraphical succession marked by unconformities and to our own imperfect understanding of the available evidence. There are gaps due to biological factors, for animals and plants without hard parts are completely destroyed.

On account of these limitations the taxonomic divisions proposed by the Palæontologist are bound to be different to those of the Zoologist, who is able to study both the soft and hard parts of the organism. But the biological palæontologist is less concerned with genera and species than with series and trends. In large measure the subdivision into genera and species is tentative. "It gives convenient, but often false, means of expressing morphological qualities. Such familiar 'genera' as *Gryphæa* and *Exogyra* can be shown to represent stages in the morphogeny of oyster-shells belonging to manifestly different lineages."

By a detailed study of the fossil specimens and the nature of the matrix in which they are embedded, or by comparison with related organisms living to-day, we can deduce the physical conditions relating to climate—temperate, tropical or arid, and environment—marine, freshwater, fluviatile, etc., prevalent at the time of their burial several thousand or even million years ago. It is also known that the survival periods are not the same for the different groups. Some groups are short lived, others have survived throughout the known range of geological time almost since the Cambrian onwards.

It has been fairly established that simplicity of structure combined with efficiency is associated with durability, while specialisation is a sure sign of early decay and possible extinction, for if the environment changes, the organism is unable to adapt itself rapidly enough to changing circumstances. To cite instances, the genus *Cidaris* has persisted with no important modification from the Triassic period to the present day. *Echnocystis* is limited in range to the Upper Silurian. *Heterosalenia* lasted from the Upper Jurassic to the Upper Cretaceous only. Now *Echinocystis* and *Heterosalenia* were both much more elaborate in structures than *Cidaris* so that their short ranges illustrate the generalisation made above. But there are exceptions.

While environment exerts an important influence on the organisms, the major physiographical paroxysyms are often responsible for their decline, but with the decline of one group, the rise of some other group often occurs as an attempt by nature to maintain the equilibrium of life, as it were. Thus the fall of the Nautiloids was compensated by the rise of the Belemnoids, that of the Reptiles was followed by the advance of the Mammals. This may be explained on the ground that the extinction of one group diminishes the intensity of the struggle for existence for the other groups.

An important point bearing upon the evolution of forms is that certain characters, whether their direction was predetermined at the outset, or whether they were induced and selected by circumstances at an early stage, once started, continue to develop in the same direction to a limit that they become a source of weakness and may ultimately be the cause of extermination of the organism that possessed them.

Palæontology affords no evidence at all as to the ultimate origin of various groups or of the manner in which life arose, though we have abundant proof of relationship and descent during the course of geological time. And this at least has been definitely established that the life-history of an individual represents, in an abbreviated form, the life-history of its species, that of the species the history of the genus to which it belongs; the generic history in turn represents the family history in a shorter span.

We now come to the application of palæontological principles to the evolution of man and the human race. One important point must be borne in mind, namely, the brevity of the geological history of man on the globe owing to which very little structural change has come about.

The principal characters that distinguish the human species from others are its upright posture, its capacity for intelligent speech and other mental powers. By the exercise of his intelligence, man is able to overcome difficulties and compensate himself for his structural shortcomings. He can, to a certain extent, overcome the influence of environment, which is an important factor in the evolution of other groups, but bereft of his intelligence, in other respects, he is no better fitted to stand the vicissitudes of environment than an animal.

Now specialisation in one particular direction is a sure sign of decadence and ultimate extermination, and thus high cerebral specialisation points to a rapid and spectacular rise and an equally sudden fall of the human race. But we may look at this from another view-point, that this type of specialisation, on account of its wide scope, its control over environment and over natural destructive forces, is not really specialisation but extreme generalisation and, therefore the human race may yet have a long history before it.

It may therefore be said that paradoxically man "has become supremely generalised by the exercise of a highly specialised faculty."

Palæontological evidence is more reliable than facts of history recorded by men because it is neither influenced by personal outlook, nor tainted with prejudice and deliberately falsified, as human documents sometimes are. A revolution that might have been the salvation of a country according to some may be regarded as a perversion of human capacities by others.

Finally the causes that lead to the decadence of the dominant races and empires are varied. The most important of these are complexity and over-specialisation in one particular direction and internal discord, which results, when the component parts, having struggled together to attain a position of dominance, begin to struggle among themselves, instead of working in harmony. There is then a remarkable correspondence between the behaviour of races and empires and the evolutionary trends of animal groups. Those who deny the truth of the statement surely misread the lines :—

Ill fares the land, to hastening ills a prey,
Where wealth accumulates and men decay.

M. R. SAHNI

Zoology.

President : J. S. HUXLEY, M.A., D.Sc.

NATURAL SELECTION AND EVOLUTIONARY PROGRESS.

MODERN research in Biology has emphasised above all things the necessaity of synthetic frame of mind to explain evolutionary phenomena. That selection alone or mutation alone cannot produce evolutionary change is the most important outcome of post-War biological thinking and it is becoming increasingly clear that the two processes are neither alternative nor competitive but perfectly complementary. The findings of geneticists have tended to show that the effect of a given gene does not rest within itself but is the outcome of the co-operative action of a number of associated genes, so that we now are concerned with a gene complex. Therefore mutations when they are dominant or recessive, become so through the action of other genes in the gene complex. But the fact remains that most mutations so far investigated are deleterious, and the question will be asked, if mutation is the directive source of change, should it not be advantageous also? That very slight gene differences producing extremely small effects exist has been shown by recent analysis and it is more than likely that these may be the initial factors of evolutionary change. Again, a certain mutation that is harmful in a certain environment may be useful in another as has been shown in the vestigeal winged mutant of *Drosophila* and a few other cases. So that in a Mendelian world, the basis of evolutionary change is a co-operative effort between mutation and natural selection.

It is becoming increasingly clear too that the processes of evolution are very complex involving a number of smaller processes. The origin of species can now no longer be thought the whole of evolution. It is only one of the processes. It is now clear that the origin of new species from pre-existing ones must take place in several different ways. A gradual transformation may bring about the result along two divergent lines. A sudden separation may also occur. Hybridisation is another powerful tool in the hand of Nature resulting in a great complexity of characters which help in species formation. In all these cases physiological as well as geographical isolation is involved. And from the standpoint of natural selection, species will then fall into two contrasted categories. Specific characters which are different from others initially and abruptly could not have been produced by natural selection but in species where character modification is gradual, natural selection must have played an important part in species formation.

The origin of adaptations is another process of evolution. While it is true that one-character, single-step adaptations do exist, generally "most adaptations clearly involve many separate characters" which could not have arisen by mutation alone but which must have been brought about by "some agency which can gradually accumulate and combine a number of contributory changes: and natural selection is the only such agency that we know."

Recently much work has been done to evaluate the importance of the rate of action of genes. "A large number (possibly the majority) of genes exert their effects through the intermediation of a process operating at a definite rate. The speeds of processes with such rate factors control are not absolute, but relative—relative to the speeds of other processes of development and of development in general." The bearing of this on the interpretation of the diverse phenomena of development is considerable and probably the rate of every developmental process is gene-controlled, providing us a clue to the clearer understanding of the evolutionary aspect of recapitulation, neoteny, fœtalisation, clandestine evolution and apparently useless characters.

But natural selection alone has repeatedly produced results as unfavourable as they were unexpected. It is no longer true that natural selection must always be for the good of the species and this is especially so if it is intraspecific and if it is taken to an extreme. The result is often the production of unbalanced organisms whose existence becomes intensely precarious. The result of natural selection is not always progressive improvement; indeed, it is only rarely so. And by no means is it the best mechanism for achieving evolutionary progress.

The process of evolution has been so far one of progress though it has been limited to a few stocks and though it has often resulted in specialisation. In Nature, there is a very thin line between progress and specialisation and while one may lead to further improvement, the other often results in extinction. But what is the general trend of evolution of the future? Man's peculiar way of living and the dawn of conceptual thought in him have made him less susceptible to nature's laws. So that future progress of man must largely rest with man himself. He must formulate for himself a purpose and this purpose must guide the destiny of every individual and the whole race. Many efforts have been made to define this purpose. But what a task?

Geography.

President : BRIGADIER H. S. L. WINTERBOTHEM, C.B., C.M.G., D.S.O.

MAPPING OF THE COLONIAL EMPIRE.

"MAPS are potted information about environment and about man. They are indispensable to us, and at the moment, we are, as regards their production, in the trough and not on the crest."

This is the central theme of Brigadier Winterbothem's presidential address to the section of Geography. Undoubtedly, the first step towards man's comprehension of the physical world around him is its mapping. A chart or a map is not merely a record of the terrain around a given locality, but is also a background against which many details might be depicted.

An outstanding feature of the science of mapping at the present moment is the paucity of maps which give all the information which we have learnt to expect of them. The importance of good maps to administrators can hardly be overrated. It is said that the very backward state of mapping in the United States is due to the fact that the country is rich enough to survive the handicap of indifferent map-making. This warning note must serve as an eye-opener to all, and nations must seriously question themselves whether they are rich enough to survive a similar handicap. In 1922 in England the order of the day was frugality and building " a land for heroes". Ambitious building programmes were planned, while the survey vote was cut down to the barest minimum. This policy is somewhat akin to the wisdom of an elderly gentleman who, when he has out-grown his old suit of clothes, orders a new one with strict injunctions to the tailor to use a yard less cloth.

Maps are useful not only for what they show, but for what they may be made to show. It is of interest to see in this connection what the British National Survey has done to evolve the modern map.

At first the Geological Survey started an Ordnance Geological Survey and the first 10-mile map was prepared for the River Commissioners, and others were produced at a joint call of archæologists, geologists and soldiers. Population maps helped to delimit inter-state boundaries. Archæological and historical maps emerged as by-products of the mapping of the relevant sites usually as a function of the Ordnance Survey. The position in respect of map-making is not so bad in Great Britain as it is in some of her dependencies. In the areas administered by the Colonial Office, the first step towards seriously attempting the problem of map-making was the establishment of the Depot of Military Knowledge as a branch of the Quarter-Master General's Department. But this department which began with fair promise passed imperceptibly into a state of suspended animation after the defeat of Napolean, and was not revived till the Crimean War. In 1855 the idea, that a department of Geography should be attached permanently to the Foreign Office, originated by a certain Major Jervis, took effect and a " Topographical and Statistical " department was founded. For some time, this department and the Ordnance Survey (essentially a domestic survey) were coalesced under a single director, but financial stress cut them asunder; the topographical department concerning itself with the especial task of overseas and colonial map-making. The first map produced by this section was that of Africa, compiled from a miscellaneous horde of data that had accumulated by random collection. Another large and important series produced under the same auspices, was that of Asia Minor which was still the best map extant of that region at the beginning of the War. Since the War the Geographical Section has produced two very important series of maps, *viz.*, the ¼-M of Asia and the ½-M of Africa which are remarkable alike for accuracy and painstaking execution.

To-day the most important factor in map-making is reliable ground survey. Surveying, in general, consists of two branches, *viz.*, property survey and topographical survey. Property survey is the concern of private practitioners, who carry them out for their clients; while topographical survey is conducted for the State by soldiers. In Africa the property surveyor was the first to be active and his activities date back to the early Dutch settlements at the Cape. British colonial development owes a lasting debt to the pioneer Royal Engineers who made possible the construction of roads and railways and cathedrals and government houses not to speak of the towns themselves.

A step forward towards the fusion of the property and topographical surveys was taken when the astronomer entered the field. It was due to Sir David Gill that the triangulation of the Union of South Africa was initiated and completed, and it was his ambition to see that it was carried through till it joined the Egyptian triangulation completing an arc roughly along the 30° E. meridian of Greenwich.

The War period saw the complete cessation of all mapping and revision in Great Britain. But in Africa this was by no means the case. A good deal of East Africa was learnt, and improvement and compilation of the more generalised maps were seen through on account of dire necessity. Since the War, however, there has been little progress compared to what was achieved during the previous period. Land surveying did record some improvement and triangulation was steadily carried on by Mudge in England and Everest in India. The next important step in the advance of colonial survey was to build up a department which is both economical to run and is graded into specialised branches. This was of the utmost importance to Africa as both money and labour were being expended uneconomically. As a result of the recommendations of General Hills, Sir Gordon Guggisberg began to introduce a progressively increasing native element into the survey department of Nigeria and the Gold Coast. Gradually this practice which had its precedent in India is gaining ground in the other British Colonies.

An important addition to the surveyors equipment in modern times is the advent of aerial surveying which has made considerable contributions to his bill of fare. As a method this is without rival as it is invaluable to the surveyor while surveying inaccessible ground.

Despite the rapid advances which surveying in all its phases has registered, topographical mapping in the colonies is showing signs of decay and compared to the pre-War record the post-War achievements present a melancholy contrast. For instance, there is a certain British West Indian Island which is " insisting on remaining unmapped " and thereby saddling the fruit industry with an extra annual expenditure of a thousand pounds. Again in many of the boundary demarcation expeditions local officials are being increasingly employed instead of imperial parties and so we have failed to secure proper boundary mappings.

The most serious problem for the future in colonial mapping, is the overhauling of the machinery as a whole. It must not be concluded, however, that the Geographical Section is idle to-day. It has inaugurated periodical conferences of empire surveyors, and has started the *Empire Survey Review* which can be ranked as the best of its kind in the world; and the surveyors themselves have co-ordinated the various aspects of their work. But it is " the trust in the higher beings which has failed". The fault mainly rests with the fact that public opinion in England is slow to grasp the real situation in Africa and the position is worsened as there are few good maps on which the public can work. Past experience has taught that social, economic or industrial development cannot be divorced from land surveying and it is the urgent necessity of the day for geographers to forward this matter, in the interest of colonial development.

Engineering.

President: PROF. WILLIAM CRAMP, D.Sc., M.I.E.E.

THE ENGINEER AND THE NATION.

"THE object of the British Association is to make known, as widely as possible not only the aims and achievements of every science, but also the bearing of each advance upon world conditions. The very fact that engineering was the seventh section to be formed shows that there never was any intention to restrict the activities of the Association to 'pure' as distinct from 'applied' science. Our President was strictly in order when he suggested, last January, that Sectional Presidents should not hesitate to deal with current difficulties and misconceptions in their particular fields of work, and with the reactions of that work upon the community. These are matters that concern the engineer very closely, since his activity is linked with the national life and often consists in the application of knowledge previously secured by the physicist, chemist and metallurgist. He himself is not thereby debarred from fundamental researches. On the contrary, he is frequently led to investigate in detail problems half solved by the physicist, or to discover phenomena which the chemist has missed. No better example could be quoted than the arc-rectifier which from its humble beginning in the investigations of Cooper-Hewitt to its present position as the most important converter in heavy electrical engineering is entirely the work of engineers."

PURE SCIENCE AND ENGINEERING.

" But though engineering has for so many years been regarded as a branch of science by the British Association, there are great and fundamental differences between those engaged in pure science and the engineers. The former may, if they so choose, indulge in a life of ardent detached curiosity, devoting themselves to the observation of behaviour and to the construction of a framework of principles neatly fitting the collected observations. To such men, the known is just a key to the unknown, and the unknown is the one thing worth knowing. This is called the pursuit of truth as distinct from the pursuit of learning."

The function of the engineer is to supply the co-ordinated knowledge of the pure scientist and the experience of the ages to the satisfaction of human desire, and to the increase of the amenities of life. He is the link between human experience and scientific knowledge, and, as such, he cannot perpetually live in a rarefied atmosphere of detachment. He must be in daily contact with humanity and learn to understand human psychology as well as human needs. As a result, he is less specialised, more balanced, more adaptable and understanding than his colleague in pure science. His judgment in human affairs is more developed; he is a better 'mixer'. A nation of pure investigators would be calm and peaceful, but cold as Scotland Yard. A nation of engineers might be quite a pleasant community.

ENGINEERING AND CIVILISATION.

In its purest form, engineering is the greatest instrument of civilisation that the world has ever seen, in the sense that it continually tends to promote a closer contact, a greater intimacy, and therefore a more profound understanding between individuals and nations. Three-fourths of the work of the engineer is devoted to the development of communication. Roads, canals, bridges, railways, harbours, ships, motorcars, aeroplanes, telegraphs, telephones, television, all these and many more are humanity's hypens. Their natural effect is to foster friendliness and dissolve differences. Left undisturbed by the politician, the scaremonger, and the patriot, the engineer would demolish the Tower of Babel and render war impossible. Build a channel tunnel; then Calais and Dover become neighbours and Anglo-French understanding ensues in all senses. Place transmitters in the trenches with receivers and televisors at home; then war becomes unthinkable. The very first thing that a government does on going to war is to seize and control every means of communication and every engineering device that might otherwise serve to unite the combatants. For the promotion of peace and understanding, engineering easily outclasses every religion; and for battle, murder, and sudden death it has no equal.

STATUS OF THE ENGINEER.

At all times, in peace or in war, the engineer must be intimately concerned with human relationships. This fact gives him proportionately greater opportunities both for the development and for the loss of character: his chances of salvation and of damnation are alike increased. For character does not mature in cloisters and exposure is necessary to prove immunity. To what extent do his fellow subjects recognise this national importance and this difficult dual rôle; and to what extent does the engineer abuse his unique position or allow himself to be made the tool of less scrupulous men?

The engineer now has the liability without the status. The doctor or barrister has fairly acquired the status; but the organisation to which he belongs tends, as I think unwisely, to shield him from the healthy breeze of liability.

REMUNERATION OF THE ENGINEER.

The contrast between the remuneration of the engineer and that of the other professions is very striking. The doctor or the barrister at equal ages gets very much more than an engineer. Consequently, the output of original work from the medical schools is small compared with other branches of pure and applied science.

CHARGES AGAINST THE ENGINEER.

The first is that he is equally willing to lend himself to works of utility and to works of death and destruction. Remember, however, his dual rôle. Pure science has nothing to do with ethics, she recognises no moral obligations whatsoever. The same explosive that releases coal underground can also kill men in battle. The telephone is useful alike in the home and in the front line trenches. The same bacteria may be beneficial in one case, harmful in another. The same principles that bring the stars within our ken also control the range-finder. There is no scientific apparatus that cannot be misapplied; and to every advantage there is a corresponding drawback. The ear that relishes music is the more sensitive to discordant noise. Not until beauty is seen to be beautiful can ugliness be defined. To the extent that the engineer is a scientist, the use to which his discoveries shall be put does not concern him. But, it will be urged, the engineer on the human and commercial side designs to make armaments for profit. And if he does, he should be credited with at least as much honesty of purpose as the politician who declares war and orders the guns.

The engineer is charged with the creation of the problem of unemployment by his inventions, such as, the internal combustion engine and various labour-saving devices. But to rid the world of machines needs a change of attitude towards occupation, a love of monotonous work for its own sake, a real desire for real work and not merely for the reward thereof. These, however, seem difficult.

Another charge against the engineer is that they are not fertile or enterprising, nor introduce new industries in distressed areas. But the law of patents right is such that it does not afford real protection to the inventor. To defend a patent or to attack an alleged infringement involves incredible legal expense, and large firms knowing this, will unblushingly copy the invention relying on the inability of the patentee to finance an attack.

Anthropology.

President: MISS D. A. E. GARROD.

THE UPPER PALAEOLITHIC IN THE LIGHT OF RECENT DISCOVERY.

PREHISTORIC studies have received a new impetus during the last 12 years by the multiplication of researches outside Europe. Excavations outside Europe have shown the possibility of a revision of the existing knowledge about the palæolithic cultures. Three important cultural elements of primary importance in the Old Stone Age are manifested in the so-called hand axe industries, flake industries and blade industries. The first two run side by side as far back as can be seen, but the origins of the third may have to be sought much further back. Any attempt to present in an intelligible form the vision of man's earliest history is hampered by a vocabulary which is out of date. The terms Lower, Middle and Upper Palæolithic are used at the same time in a chronological and a typological sense. Miss Garrod however believes that the time has come when the labels Lower, Middle and Upper Palæolithic should be used exclusively in a chronological sense without any typographical connotation to cover approximately the periods from the beginning of the Pleistocene to the end of the Riss Glacial, from the end of the Riss to the middle of the Würm, from the middle of the Würm to the close of the Pleistocene respectively. For purposes of typological classification the three main groups of hand axe, flake and blade cultures are essential and it will be necessary to multiply names derived from type stations to denote the many varieties found within these groups.

The blade cultures of the Upper Palæolithic must have passed through the early stages of their development somewhere outside Europe during Middle or even Lower Palæolithic times though as Miss Garrod admits there exists only the faintest clue as to how and when that development took place. She discusses the type stations in Europe, Asia and Africa and shows clearly the diversity of the strains grouped so far together under the name Aurignacian and also how the blade industries developed their main characteristics at a surprisingly early date.

Perigord, a classic centre for prehistoric studies, indicates a close relationship between the Lower and Upper stages of the Aurignacian. Laugerie Haute finds resemble the industry of Ros del Ser in the Correze and the Upper Chatelperron level. Discoveries of remarkable parietal engravings in pure Aurignacian style in the caves of La Hoz and Las Casares in the province of Guadulaja and the excavations of Senor Pircot Garcia in the cave of Parpallo show that the commonly accepted view that Spain was a Capsian province needs to be modified. The Franco-Cantabric cultures appear to be intrusive in the southern part of the Peninsula and a parallel development from a more or less typical early Aurignacian to a rather finely characterised late industry is probable. Capsian influences appear in the final stages which agree with the late dating of the Capsian as proposed by Vaufrey. Recent study of the Italian blade industries by Vaufrey has shown that they present a single facies corresponding in time with the whole period of the Aurignacian, Solutrean and Magdalenian in France. In the south Russian plain, a probable succession of blade industries has been worked out though this is not yet confirmed at all points by stratigraphical evidence. Typologically the sites discovered fall into two divisions, the first characterised by an industry of Willendorf type and the second by a rather generalised Upper Aurignacian. In Southern Siberia has been found a most remarkable series of objects in bone and ivory and female statuettes carved in bone belonging probably to the Gagarine family. The mixture of Mousterian and Aurignacian forms in the lithic industry is a fact which suggests possible connection with the Far East as the discovery of a similar industry in the lœss along the course, of the Shuitungkou River in Northern China indicates.

The discovery of a highly developed Aurignacian of Willendorf type in the Palæolithic of Southern Kurdistan suggests a connection with the Kostenski I, the earliset known blade industry of South Russia. Excavations in Palestine have established a sequence of blade cultures. Egypt was cut off from the main lines of development in Upper Palæolithic times since blade industries proper are unknown before the appearance of the microlithic cultures. In Africa which still awaits systematic excavation, investigations point to the possibility of true blade cultures arriving late, their place taken up by Aterian with strong Mousterian traditions. The Microlithic facies appeared in Africa perhaps much earlier than in Europe, though it is difficult to maintain this in view of the paucity of evidence. There is no proof, however, that the Kenya Aurignacian is older than the Eurasiatic blade industries and Miss Garrod points out that the late survival of a culture of Mousterian tradition as in Little Africa and Egypt, in the cases of the Kenya Stillbay is certain.

The blade cultures have a wide distribution and it is unlikely that the key to the progress is to be found in Southern France. The French sequence appears to be the result of successive immigrations superimposed perhaps on a certain amount of local variations and development in place. The first blade industry to reach Western

Europe is that of the Chatelperron stage. The Lower Kenya Aurignacian appears to be more or less of Chatelperron type and may be contemporary with this stage in France. A similar, though not identical industry, occurs at the base of the Upper Palæolithic sequence in Palestine. Thus at the beginning of the Upper Palæolithic three areas with similar industries are found. Two of these, Palestine and East Africa, may have been in touch with each other through Arabia and across the Bab-el Mandeb while the third remains apparently isolated.

The Chatelperronian may have developed from the contact of the Acheulean and Levalloisian cultures but it is more probable that Chatelperron had an independent existence, and having developed in some centre still unknown it is an intrusive element in the Acheulean. The original home of Chatelperron industry cannot be Palestine or East Africa but an Asiatic centre seems inevitable. East Africa may possibly be the centre of origin of the Capsian which would thus enter Little Africa by way of the Sahara. The Capsian would thus derive many of its features direct from the Chatelperronian. As for the peculiar industry which closes the Upper Palæolithic sequence in Palestine it is quite definitely Aurignacian rather than Capsian.

The Aurignacian and Chatelperronian appear to have developed independently from an early date. The Gravette-Font-Robert industry has a very wide distribution in Central and Eastern Europe and its remarkable development in this region points rather to a Euro-Asiatic origin. The Capsian and the Gravette-Font-Robert industry are perhaps derived from the Chatelperronian. Though the Gravettian industry appears to be of eastern origin yet Central Europe cannot be regarded as the centre of dispersion as there is clear evidence that the Gravettian is there preceded by the Aurignacian proper. Nor is it likely that the centre of dispersion can lie very much further to the east. In Palestine the true Gravettian is absent and in Southern Kurdistan it probably represents a relatively late migration from Russia. In Palestine the Chatelperronian level shows signs of evolution towards the Gravettian type and it is possible that an industry of this character had already penetrated into Northeast Europe before the westward moving Aurignacian invasion had reached the Mediterranean coast. Thus the Chatelperronian has emerged in the Lower Palæolithic and sent out two branches, one into East Africa to give rise to the Capsian, the other into Northeast Europe to develop into the Gravettian. The Aurignacian pushes westward in the meanwhile and separates these into two great provinces. From Aurignacian and Gravettian centres migrations poured into Central and Eastern Europe and interpenetrations took place along the fringes of the original provinces.

DIRENDRA NATH MAJUMDAR.

Physiology.

President: PROF. R. J. S. McDOWALL, M.D., D.SC., F.R.C.P.

THE CONTROL OF THE CIRCULATION OF THE BLOOD.

IN his Presidential Address, Prof. R. J. S. McDowall has given an account of the various mechanisms which work together to provide adequate blood supply to any part of the body whatever its activity or whatever the posture of the body. He has dealt with the effects of physical exercise since most of the mechanisms elaborated in his address are brought into operation thereby. Thus when a tissue, *e.g.*, muscle, increases its activity it needs more blood per minute to ensure a proper supply of oxygen and food. This is brought about by variations not only in the activity of the heart but also by a redistribution of blood. The heart can, within limits, increase its output and alter its rate. The heart is under the control of the sympathetic and vagus nerves or rather under the control of two sets of reflexes. In the case of the sympathetic, the source of afferent impulse is not accurately known, but in the case of inhibitory impulses, the source of afferent impulses is known to be situated "in the left side of the heart, arch of the aorta and the carotid sinuses" and the normal method of stimulation has been shewn to be the change of blood pressure in these parts of the circulation at each beat of the heart.

During the exercise there is an increase in the sympathetic accelerator and reduction in vagus impulses. The range of acceleration is determined by the degree of activity of cardio-inhibitory centre. In athletes mild exercise results in an increased cardiac output with a slight increase in rate. Animals and human beings taking large amounts of exercise have slow hearts and the cause for the slow heart is not known. The increase in cardiac output is the result of dilatation of the vessels in active muscles, and the constriction of vessels in less active tissues. The dilatation is due to chemical and nervous influences. The cause for the chemical dilatation has been much debated. Carbon dioxide and lactic acid, changes in H-ion concentration, adenylic acid, histamine and histamine-like substances are credited with a vasodilator function. The nervous dilatation is probably sympathetic.

In describing the "capacity effects" Prof. McDowall states that with the possible exception of the voluntary muscles, the heart muscle and the brain, all the other tissues of the body provide the blood necessary for the active muscles. He refers also to the constriction of the spleen and intestine in animals, and to the constriction of vessels of the skin under emotional stress or anticipated activity. The sympathetic constriction of the vessels is due perhaps to a sensory stimulation from the outside world.

The maintenance of vascular reserve is rendered possible by the existence of the tonic dilator control of the vessels. The primary function of the control of vessels is to maintain the arterial pressure at a constant level. The reflex control may have a more important function, and in exercise or emotion increase both rate of the heart and output per beat. It may be stated that the vagus controls the range of activity of the heart and the depressor reflexes determine the quantity of blood available for the heart. The vaso-constrictor action of the sympathetic and the effect of adrenaline and the value of the other mechanisms are already referred to. Adrenaline in physiological doses constricts the vessels of the skin and splanchnic region but dilates those of the muscles which latter is perhaps due to its environment. Further adrenaline influences the depressor reflexes markedly, as it has been found that after the effects of injection of adrenaline have passed off, vagus stimulation, effective before injection, has no action on the heart; similarly in injection of adrenaline the effects of blocking of impulses from the carotid sinus are either reduced or completely abolished.

A study of the effect of exercise and of emotion on man affords confirmative evidence of the function of the vasodilator reflexes mentioned earlier in the address. A rise in systolic blood pressure of man taking exercise on a stationary cycle, with subsequent fall below normal on the cessation of exercise, has been observed. The fall in pressure is due in part at least to a diminution of the peripheral resistance in the muscle. It has also been observed there is no change in blood pressure as a result of psychical effect of intended exercise and that of exercise and the rise in arterial pressure is therefore due to psychical effect. Since it is known from the work of Mosso, Barcroft, Florey and Florey that generalised vaso-constriction is an accompaniment of psychical effect "we must assume that the increased output of the heart is in part if not wholly the result of vaso-constriction which calls into use the reserves of blood and thus circulation is maintained in spite of the greatly increased capacity of the active muscles". It should be observed that the problem of the control of circulation of the blood is bristling with difficulties, especially since the activity of the vagus and depressor mechanisms is variable in different animals under varying experimental conditions.

A. S. R.

Psychology.

President : DR. A. W. WOLTERS.

THE PATTERNS OF EXPERIENCE.

THE Presidential Address is devoted to recording of certain reflections stimulated by contributions to the Psychology section of the previous year's session, and to a short active vindication of some of the views of the colleagues of the President. A comparatively young discipline like Psychology which has not yet acquired any great content of established fact is bound to be confronted with controversies and civil wars which need not be deplored. Controversy is the vital breath of science. A too ready loyalty to "a school" is symptomatic of a fettered mentality. Omniscience or infallibility cannot be claimed for this or that group of workers and researchers however distinguished. Opposing theories have in them elements of truth. A balanced and judicious eclecticism is thus not only reasonable but inevitable. Eclecticism *qua* cheap collection of elements from different schools or groups is valueless unless the dynamic orientation is administered to it of a personal view-point. Two papers read last year are taken as texts.

Prof. Rubin's paper on the "Ways of Seeing" makes an important contribution to the psychology of perception maintaining the thesis that perceptual cognition or awareness is shot through with suggestions of movement and direction which are not reducible to the geometry of the object. The mind contributes structural principles to its own experience. This had been emphasised before by others, but, the value of Rubin's contribution lay in experimental elaboration and demonstration of the theme. Rubin pointed out that pictures in European Art have a definite left-to-right character on which their meaning and æsthetic appeal largely depend. An exciting confirmation of Rubin's theory was afforded in the shape of a drawing of Rembrandt which proved to be an exception to Rubin's general thesis. Rembrandt's error explained by Mr. Betts as due to absorption in technique of sketch, really confirms Rubin's conclusion. This is something like *exceptio probat regulam.*

There are then, pre-established manners of seeing, and it must follow that other modalities of sense also reveal pre-established manners. The patterns of perceptual experience are dependent upon the mind, in some instances upon congenital endowment and in others upon acquired factors. Rubin suggested that the left-to-right direction of European pictures was derived from reading left-to-right script. Mr. Peake suggested that Rubin's theory may be tested in reference to cave-drawings. This is yet to be done. So far as the evidence now available goes, right-handedness is among the determinants of perceptual direction. It appears that perception can be shaped by factors extrinsic to the material experienced. The mind influenced by them is creating, is actively patterning its experience, so that in some sense and to some degree, (the limits being experimentally ascertainable) the mind makes the world it knows. If, on a view like this, no knowledge is possible of reality, as some would contend, the other contention is equally forceful that if the percipient mind merely registered the objective world there could be no psychology of perception worth the name. The researches of Katz and Thouless demonstrate that the mind sometimes deals with its material autocratically. Here Gestalt-psychology cannot be treated incidentally but admiration for the ingenious research stimulated by it cannot be witheld. To speak a little dogmatically the mind informs its sensory material making the percept consistent with certain subjective principles. The patterns of experience are latent in some sense, in the subject's mind as he confronts the world.

Perceiving is a response of the organism. It means that the distinction between cognition and conation is not ultimate. *Conation must* be fundamental because every organism must remain alive and to that end it needs to shape, and control its environment. Behaviour exhibits ordered sequence on the basis of which laws are formulated. A man's business activities show a constant pattern. Patterns are the constancies without which social life would be impossible. Instincts are examples of behaviour-patterns. These patterns are observable in virtue of which the epithet 'instinctive' is used. The character of the organism is among the causes that produce the patterns. Human behaviour patterns resemble those of animals. A pattern is latent in the organism. It exists formally. There are also patterns in acquired activities. Skill is said to produce the patterns. Skill in itself cannot be scientifically inspected but the resultant activity can. Skill is responsible for characteristic behaviour-patterns which control environment and which lead a subject from success to success as it were. Skill is conditioned by racial and individual experience. Perception is a preparatory reaction and Rubin's 'ways of seeing' belong to the vast family of skills. It was argued in a paper read at a London Meeting (1931) that concepts are not mental entities but as outline preparations for response. Conceptual thinking is schematic preparation for response. Prof. Bartlett uses the term 'schema' for active organisation of past reactions with which new experiences are redintegrated. Characteristically redintegrated effect of experience determines responses of the subject at all moments. Racial and individual experience results in schematic preparation for future activity thereby determining the pattern of the experiencing and the pattern experienced, and these preparations or schemata are modifications of the psychological organism.

This view is illustrated in reference to social psychology and social patterns. Reference is made to Prof. T. North Whitehead's paper in which report is made of a study of a group of five girls at the same task. They had developed a social pattern on the basis of conversation, and when their seating arrangement was deliberately altered output was adversely affected. Other details of the experiment are given which demonstrate-that the developments of social patterns is due to the psychological character of individuals. A group or society exists only in virtue of the conative tendencies developed by individuals. It requires to live socially, considerable skill. Social skills are schematic preparations for adaptive responses. Society exists immanently in the minds of its members. A group pattern is the product of the behaviour schemata of the constituent members. Social patterns are exemplified in institutions and current ideas—the English Common Law for instance. There is no need 'to turn round upon the schemata' so long as particular patterns contribute to efficient life.

Ideals and institutions express the developing patterns of society. An Ideal is just a scheme of behaviour rendered sufficiently inspectable to receive a name. The activities of the organism striving to hold its own in the universe would form the subject-matter of Psychology. The material presented to it in experience should be organised into patterns if it is to control its environment. It develops skills. These skills are called schemata. The system of a person's schemata embodies all his experience upto the present and determines the direction of his future behaviour. The patterns are formed by them though not independently of objective conditions. "Ways of seeing" and "ways of living" would then be species of a common psychological genus. Thus in conclusion experience in the fullest sense of the term is formed in a complex of patterns interlacing and revealing a heirarchy of increasing generality. Or Psychology is a study of all the detailed embroideries upon behaviour patterns the formula of which runs—He was born, strove to master his world for his own safety; he mated, fought for his offspring and died. There is really no opposition between Individual Psychology and Social Psychology.

R. NAGA RAJA SARMA.

Botany.

President : J. RAMSBOLTOM, O.B.E.

THE USES OF FUNGI.

(1) *Edible Fungi.*—The common edible mushrooms are probably the best known of all the fungi and they are cultivated on a large scale in Europe and America. Formerly it was believed that they occurred spontaneously on horse dung. Nowadays the spawn is produced commercially by scientific methods by inoculation with either the spores of the fungus or the flesh of the stipe. The annual production of mushrooms in America now exceeds 17,000,000 lb.

The Japanese and the Chinese are great consumers of fungi. Several species of *Cortinellus* are cultivated widely in Japan for the purpose. About £100,000 worth of the material is exported annually from Japan. "Kah-peh-soon", which is much valued as food by the Chinese in Formosa is the hypertrophied portion of the shoot of *Zizania aquatica* infected with *Ustilago esculenta.* Species of edible *Volvaria* are also cultivated in the tropics. The highly esteemed truffles and morels of Europe and America are fungi belonging to the family *Tuberaceæ.*

(2) *Poisonous Fungi.*—It is also well known that some of the common fungi are poisonous. The French criminal, Girard, who was executed in 1918, used *Amanita phalloides* for poisoning his victims. In the religious rites of certain Siberian tribes *Amanita* is used for its intoxicating effects. It is reported that the Watusi tribes of Victoria Nyanza, for acts of vengeance, used to remove the lungs of persons who had recently died of pneumomycosis, dried and powdered them and administered this powder in banana beer. The fungus always survives the treatment.

(3) *Articles of Toilet.*—Hottentot ladies use the spores of *Podaxis carcinomalis,* as a face powder. The black spores of *Ustilago esculenta* are used in Japan for blackening the eye-brows. Spores of *Tolyposporium* were found mixed with rice flour as face powder in the "vanity case" of "An European Mummy" from a Roman cemetery near Budapest.

(4) *Ornamentation of Wood Work.*—The famous green wood of Tunbridge ware is only oak or birch containing the mycelium of *Chlorosplenium æruginosum* which imparts the green colour to wood. The black lines of some decorative wood are due to infection by *Armillaria mellea* or *Ustilina vulgaris.* The colour of the much valued "brown oak" is due to infection with *Fistulina hepatica.*

(5) *Fodder for the Cattle.*—On the Chiloe Island and in Eastern Patagonia the wood of various trees is converted into palatable fodder by the action of *Mucor racemosus* in conjunction with bacteria. Inoculation with *Aspergillus fumigatus* raises the assimilable protein content of straw.

(6) *Medicinal.*—The ergot of rye (*Claviceps purpurea*) is mentioned in the British Pharmacopœa. The medicinal properties of Agarics like *Polyporus officinalis* have been recorded by classical writers. Yeast is still used for various ailments and is incorporated in many patent medicines. *Cordyceps sinensis* which parasitises the caterpillar is widely used as medicine by the natives of China and Tibet.

(7) *Horticultural.*—The part played by the mycorrhiza of fungi in the cultivation of orchids is

now well known to horticulturists. The difficulty in germinating the minute orchid seeds had baffled the horticulturists for a very long time. Noel Bernard however astounded the botanical world by extracting a fungus from the roots of *Neottia* (the bird nest orchid) and by sowing the seed with it obtained abundant germination. This method is now used commercially. Like the orchids many of the forest trees have fungal mycorrhiza in their roots which help the passage of food into the tree roots. Sylviculturists are now investigating the problem of artificially infecting seedlings with appropriate fungi.

(8) *Food and Drinks.*—The use of fungi in bringing about desirable changes in food and drink has been known from very early times. At present this is done under controlled conditions and fungi are becoming increasingly important in the industrial application of fermentation activities. "The chemical conversions performed by these organisms rather resemble witchcraft than chemistry." In bread-making the use of leaven which contains the yeast is very well known. Nowadays pure culture strains of compressed yeast are used in bread-making.

Yeasts bring about the fermentation of fruit juices in the manufacture of cider and wines. *Botrytis cinerea* is used for infecting grapes to produce the Sauterne wines with higher alcohol contents. Beer brewing is now a well-known art. Almost every nation has its ancient fermented drink like the Kvass of Russia and a few others.

Certain bacteria are also used in conjunction with yeast for bringing about fermentation in beverages like the Mexican Tibi. Chinese curd, To-fu, is made from soybean milk fermented with mould. Food products and beverages amounting to a value of £40,000,000 are manufactured annually in Japan alone by the fermentation activities of fungi. The Chinese "Red rice" is produced by infection with *Monascus purpureus.* The part played by species of *Penicillium* in the ripening and flavouring of cheese is only too well known.

(9) *Fuel.*—In order to economise the use of coal, the supply of which is not likely to last very long, power alcohol obtained from plant materials by fermentation with yeast may have to be substituted.

(10) *Industrial.*—The production of dextro and lævo tartaric acid by Pasteur by the action of *Penicillium glaucum* is probably the first step in the use of fungi to industry. Van Tieghan isolated gallic acid from tannin by fermentation with *Aspergillus niger.* During the War, glycerine for nitroglycerine, was manufactured first by the Germans and then by the Americans by the fermentation of sugar with yeast. Commercial diastase is manufactured from *Aspergillus flavus-Oryzæ.* Oxalic and citric acids are produced as a result of fermentation by many fungi. An American firm is stated to maintain nine acres of mycelium of *Aspergillus niger* to supply calcium citrate for the American cheese industry. Gluconic acid is another fermentation product of *A. niger* and several species of *Penicillium.* Anthroquinone pigments which are so important in dyeing are produced by certain species of *Helminthosporium.* The antispetic, penicillin, is produced from *Penicillium notatum* and *Fusarium* sp. produce large quantities of alcohol from glucose. Ergosterol has been synthesised by the action of yeasts and moulds. Marmite is an extract prepared by autolysis from fresh brewers' yeast. The Russians after the War utilised yeast for the production of fat. The manufacture of acetone with *Mucor Roxii* is one of the romances of modern microbiology.

The above are only just a few of the products obtained with the help of fungi. A vast field for useful researches is thus opened out where the taxonomist, chemist and physiologist can work profitably together for the good of humanity.

K. C. M.

Educational Science.

President : SIR RICHARD LIVINGSTONE, M.A., HON.D.LITT., HON.LL.D.

THE FUTURE OF EDUCATION.

"To cease education at 14 is as unnatural as to die at 14. The one is physical, the other is intellectual death."

THIS is the main thesis of the address which expounds the need for a strong and efficient system of continuation and adult schools for the diffusion of the essential elements of culture in order to equip the democracy in the intelligent participation of public problems and in the maintenance of a reasonably high standard of useful and enlightened life. So far as education is concerned the primary duty of the State is to provide for every individual opportunities to make a livelihood and to function as a citizen and to become the " beauty of the world". In endeavouring to achieve these three-fold objects, education is obviously limited by its material, and encounters difficulties in the accomplishment of its goal of the making of human beings. If this is the supreme aim of education, then it follows that all men and women, irrespective of the class to which they belong, must have a cultural training without prejudice to the technical courses which the majority may find it profitable to pursue. Men differ in degree but not in kind, and if the electorate is incapable of appreciating the great historical movements or the wealth and variety of the human spirit, then its stability becomes precarious, and its political and spiritual life, impoverished. Perhaps humanistic studies might preserve the democracy from such a disaster.

Education in its different branches,—University, Secondary, Technical and Elementary,—has solved some of the problems with which it was confronted, but we have not been able yet to define to our own mind what we wish education to do for us, and to ask whether it is doing it and, if not, why not. The examination papers reveal the great gaps in our national system of education and the task of improvement and elaboration necessary for the more efficient use of its tools for obtaining a deeper insight into its purpose and significance. There is a fairly satisfactory provision for the minority who attend secondary school and university, but we have shown the rest either a glimpse of the vast treasures of knowledge or disinherited them from the purest and highest intellectual pleasures. The question of the working-man and his leisure affects the future of civilisation. Will he enrich it ? or will he devote his leisure to the films and the dog races ? Fifty years ago the employment of leisure was no problem for any but the rich who mostly wasted it, but to-day it is becoming a common place of education. The task of the future is for us to ask ourselves how the intellectual and spiritual life of the nation will fare, when the greater part of its people leave school at the age of 14 and are thrown straight into the deeper waters of life. In this matter the attitude of the State has been as complacent and unthinking, if not as disastrous and cruel, as that of the earlier generation who acquisced in social inequalities which seem incredible to us. The task of the future is clear, *viz.*, to deal with this great educational problem of the boys and girls who leave school at 14.

One of the fundamental principles of education is that its fruitfulness depends on experience of life, though this may not apply to the physical sciences with the same force as it does to the humanistic subjects. It is necessary to know life itself, to have seen something of human nature, before either achievement or understanding in these fields is possible, and it is obvious that a fourteen or fifteen-year-old is not sufficiently adult to grasp the value and significance of history, economics, sociology, politics and philosophy. What does a pupil of the age of 14, 15, 16, 17 get from the study of history, for instance which in secondary schools is a favourite subject for specialisation? They are well taught and interested in the subject and they can reproduce the best books. " They have the appearance of wisdom but not its reality " as Plato said of these who absorb information from books without digesting it.

The practical conclusion is that an education which ends at the age of 14 is no education at all. Money spent on secondary education is not wasted if it prepares the pupil to go on to something else. The fact is that a vast majority go to nothing else, after putting their feet on the first step of the ladder of knowledge. But the defects of the present system will not be remedied by raising the school age to 15 or even to 16. The pupil will be still unripe for the studies without which an intelligent democracy cannot be created. Raising the school-leaving age may help some of our difficulties. Its value is perhaps moral and economic rather than intellectual. No body who has seen the results of compulsory education to the age of 16 in the U.S.A. will be under the delusion that it produces an educated nation. If, however, the raising of the school-leaving age is preparatory to an education continued into the adult years, well and good; if not it will leave the problem still unsolved.

The solution of this problem will not be found in the secondary education about which this age is over-credulous. The hard fight for its development has caused us to exaggerate what it can do. Secondary education is only one part of the great picture; and we need to stand back a little and see the canvas as a whole. Economic reasons suggest that the earlier years of life should be given to secondary education which is addressed to pupils whose intellectual faculty, except that of memory and imagination, is not fully developed, and who cannot have a full perception of the purpose and value of education. In every point except the economic one adult education has the advantage over secondary education. It is given to students who desire it, and who have the mental development to receive it; whereas secondary education is given to pupils whose faculties are not fully developed, and who have not seen enough of life to value and interpret it. It should be realised that the education of the masses can never be achieved through secondary education. The ideal plan might be for everyone to leave school at 15, and pass into a system where a part of the week is allotted to school, part to earning the living in some practical occupation. Unless we establish a compulsory part-time continuation system which will carry the pupils on to 18, the education of the earlier years of the youth of the nation will still be largely wasted. If the first step to retain those who leave school before the age of 18, under some educational control is secured, it will be easy to take them to the threshold of adult education, where the solution of the problem of educating the democracy must be found. The experience of Denmark is encouraging. The Danish Folk High School is attended by 30 per cent. of the small farmer and working-class population, voluntarily and at their own expense, for five months, and the education is humanistic in the sense that it is neither technical nor utilitarian. The main point is to urge the indispensability of adult education, to review what it has already done in order to harmonise, develop and complete it.

Agriculture.

President: PROF. J. HENDRICK.

SOIL SCIENCE IN THE TWENTIETH CENTURY.

THIS is perhaps the first time that a Presidential Address deals specifically with soil science as a fundamental subject, though some of its aspects have received attention in the past as from the nature of things such reference was unavoidable when dealing with the various different problems of crop production which have formed the subject of those addresses. It was only in the last century that the vast store of practical knowledge built up solely through experience and handed down by tradition began to be succeeded by a knowledge of the science, advance in chemistry and geology being chiefly responsible. In Great Britain the provision for agricultural research was for a long time meagre, Rothamstead, Cirencester and Edinborough being about the only centres of study and research. A forward move was possible only with the Development Commission of 1910, but the easier and more obvious problems of manuring and field experiments claimed first attention and soil studies were stagnant; such as were taken up were mainly from the point of view of its fertility and usefulness as a medium for crop production and not in any of its fundamental aspects. British views on soils remained rather narrow and insular, the soils of S. E. England being regarded as the types, notwithstanding the variety of location and climate even in this small island which have given rise to a corresponding variety of soil types. In contrast with Great Britain the countries of America and Russia embrace vast areas extending through wide ranges of latitude and climate, with great variations in geological conditions and with soils derived from many kinds of rock formations. Arid and alkaline soils were also a special group. Soil studies there were more comprehensive accordingly but British thought could be influenced only by the studies of American workers, the barrier of language rendering Russian work inaccessible and therefore unknown in Britain for a long time. No better picture of the gradual growth of recognition in Great Britain of the Russian school and its work can be found than the bibliography appended to the different editions of Sir John Russels' book *Soil Conditions and Plant Growth* which devotes adequate attention to the work of this school only in its latest or sixth edition of the year 1932. It was through the agency of the International Society of Soil Science which was founded in Rome in 1924 that publicity was afforded to this new knowledge of soil science, although this itself grew out of international conferences on Agrogeology held before and after the Great War at Budapest, Stockholm, Prague and Rome, which last led to the formation of the International Society and later to an International Congress at Washington in the year 1927. It was at this congress which was attended by a large contingent of British, American and Russian workers that the new views of the Russian school were fully explained, demonstrated and discussed, making it to many a new education in soil science. Other agencies for publicity have not been wanting and the journals *Soil Research*, *Soil Science* and the *Proceedings of the International Society* are doing much to make known widely these new movements.

The historical background having thus been described, these new views of the Russian school of soil science may now be discussed. In the first place, the Russian school treats the soil as an independent natural body worthy of study for its own sake and not merely as a medium for plant growth or as subsidiary to chemistry, geology or other sciences, according it a new and separate status under the name of Pedology. Secondly, the Russians regard climate the most important among pedogenic factors and hold that its nature is not determined by its geological origin. They have shown that very different soils may be formed from the same rock in different climates and on the other hand similar soils may be produced from different rocks under similar climatic conditions; that, for example, the granitic soil produced in the cold humid climate of Scotland would have been different if produced in the hot humid climate of Africa and would be still more different if produced in a hot arid climate in Asia. The climatic zones indeed form the basis of classification, so much so that one can detect a tendency to go too far in excluding geological origin as an important factor. A third feature of the new science is the study of the "soil profile" and of the "horizons" which go to make it up. The virgin soil unchanged by human agency is what is required for this purpose, which is a condition impossible to satisfy with soils in many of the most important parts of the world and which would therefore necessitate some modification in the methods. The profiles are also sought to be classified as mature and immature; but the soil-forming processes greatly vary in their duration, some requiring periods of geological time while others can take place in a few centuries or even in a few years. The granitic soils of Scotland are examples of the former and factors which produce changes in the organic matter content of soils come under the latter category. Much further study is therefore needed before these can be properly accounted for and a satisfactory system of soil classification established.

The importance of soil moisture and rainfall as climatic factors in soil formation is recognised especially as they may be influenced by the humidity, temperature, topography and the amount and distribution of the rainfall itself. The closely relevant study of soil drainage and of the changes taking place in the composition of the soil and the soil water during the process has not received the attention that it deserves in this connection. This is owing probably to the difficulty of constructing drain gauges which will deal with soil in its natural *in situ* condition and not with soil moved and filled into the cisterns. The latter are only of limited use in their application to actual field conditions. Reference may however be made to those in Rothamstead and those constructed by the author at Craibstone near Aberdeen which are of the type dealing with the undisturbed soil.

A notable advance in soil science is our knowledge of soil colloids and base exchange. K. K. Gedroiz the Russian worker, van Bemmelen, Dr. Hissink and G. Wiegner are noted names in this field and it is from their work that we know now that base exchange is a colloid phenomenon and that both mineral and organic colloids possess this property and that it is not the former alone which was concerned in the process as was supposed at one time. This advance has also enabled us to estimate the degree and intensity of soil acidity and alkalinity as well as to understand the exact rôle of lime in its capacity as an exchangeable base. The structure of clay, the nature of its base exchange capacity and the differences found therein have received considerable elucidation by the X-ray method which has revealed the presence of a lattice structure and of several different minerals showing at least two different types of lattice structure. X-ray methods are also clearing up the nature of humus and are furnishing evidence of its possessing a complex molecular structure.

Soil science is making steady progress in these and along other lines of research and in the British Isles soil problems are now being studied from many angles in the various research stations, colleges and universities. The British attitude towards soil science however is still somewhat utilitarian, in that it declines to dissociate soil study from its practical application, with the complete detachment of the Russians; one is primarily interested in the soil on account of its plant-growing capacity. Increased production of the products of the soil is a blessing and not a curse and a strong plea may be put in for the harnessing of science for increasing production, despite the cry of overproduction. As long as there is want and underfeeding in this world there cannot be overproduction.

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