The British Association—Leicester Meeting, 1933.

The Presidential Address—Some Chemical Aspects of Life.

SIR FREDERICK HOPKINS' thoughtful address relates to the chemical processes that determine the mechanism of life.

'Though speculations concerning the origin of life have given intellectual pleasure to many, all that we know about it is that we know nothing.' We do, however, know a few fundamental facts concerning that process. One such is the arrest of the steady increase of entropy displayed by all the rest of the Universe. That the living organism checks the degradation of energy in Nature is primarily a biological concept. Related to it and of equal importance is the concept of organisation.

'It is almost impossible to avoid thinking and talking of life in this abstract way, but we perceive it, of course, only as manifested in organised material systems, and it is in them we must seek the mechanisms which arrest the fall of energy. Evolution has established division of labour here. From far back the wonderfully efficient functioning of structures containing chlorophyll has, as everyone knows, provided the trap which arrests and transforms radiant energy fated otherwise to degrade—and so provides power for nearly the whole living world. It is impossible to believe, however, that such a complex mechanism was associated with life's earliest stages. Existing organisms illustrate what was perhaps an earlier method. The so-called autotrophic bacteria obtain energy for growth by the catalysed oxidation of materials belonging wholly to the inorganic world; such as sulphur, iron or ammonia, and even free hydrogen. These organisms dispense with solar energy, but they have lost in the evolutionary race because their method lacks economy. Other existing organisms, certain purple bacteria, seem to have taken a step towards greater economy, without reaching that of the green cell. They dispense with free oxygen and yet obtain energy from the inorganic world. They control a process in which carbon dioxide is reduced and hydrogen sulphide simultaneously oxidised. The molecules of the former are activated by solar energy which their pigmentary equipment enables these organisms to arrest.'

'Are we to believe that life still exists in association with systems that are much more simply organised than any bacterial cell? The very minute filter-passing viruses which, owing to their causal relations with disease, are now the subject of intense study, awaken deep curiosity with respect to this question. We cannot yet claim to know whether or not they are living organisms. In some sense they grow and multiply, but, so far as we yet know with certainty, only when inhabitants of living cells. If they are nevertheless living, this would suggest that they have no independent power of obtaining energy and so cannot represent the earliest forms in which life appeared. At present, however, judgment on their biological significance must be suspended. The fullest understanding of all the methods by which energy may be acquired for life's processes is much to be desired.'

The past one hundred years have witnessed considerable amount of controversy between the extreme physico-chemical and the vitalistic concept of life. We are yet far from knowing the ultimate truth but it would form a useful basis for discussion if we recognise that 'at a different and recognisable level of its dynamic organisation, an organism can be logically described in physico-chemical terms alone.'

Researches conducted during the present century have brought about marked changes in our outlook in various directions. To take an instance one may cite the respiration of the muscle and the attendant transformations. To-day we know that the previous 'conception of continuous building up and break-down of the muscle substance, as a whole, has but a small element of truth. The colloidal muscle structure is, so to speak, an apparatus relatively stable even as a whole when metabolism is normal, and in essential parts very stable.' The related chemical processes and energy transformations have also been studied with remarkable thoroughness. They show, among other things, that the conditions are, to a large extent, similar to those occurring in the yeast cell, thus providing a striking illustration of the unity of life.

The living cell would be a static system were it not for the fact that it is equipped with a variety of enzymes which assist in bringing about the required transformations. Each enzyme is specific in its action. The combined activities of the different enzymes present in a cell determine its ultimate physiological behaviour and thus distinguish it from other forms of life.

When the multitude of chemical events in a living cell are well co-ordinated, then the latter displays its sensitiveness to molecules of the special nature which enter from without. A striking instance of this is provided by the response of the heart to the impulse of the vagus nerve. When the heart receives vagus impulses, the substance, acetyl choline, is liberated within that organ. It is acetyl choline that ultimately produces the characteristic effect as may be demonstrated by direct injection of graded doses of that chemical.

Similar and, perhaps, even more profound are the effects of the chemicals which are formed in specialised organs of the animal body and which maintain harmonious growth and control the rate of metabolism. Some of these chemicals such as adrenalin, thyroxin, secretin and insulin are already well known. More recently, considerable light has been thrown on the nature and mode of action of œstrin, the harmone which, in a most remarkable manner, co-ordinates the phenomena of sex.

In the group of substances which control and co-ordinate events in the animal body by virtue of specific molecular structure we must also include the vitamins. As distinct from the harmones which are formed in the animal body, the vitamins have to be supplied in the diet. The distinction between the two is not, however, so great as it may appear because some animals can synthesise the requisite vitamins, in which case the latter become harmones.

The recent output of scientific work in the field of vitamins is prodigious, nearly one thousand papers on the subject appearing in a single year. 'Some aspects of its development have been interesting enough. The familiar circumstance that attention was drawn to the existence of one vitamin (B1 so called) because populations in the East took to eating milled rice instead of the whole grain; the gradual growth of evidence links the physiological activities of another vitamin (D) with the influence of solar radiation on the body, and has shown that they are thus related, because rays of definite wave-length convert an inactive precursor into the active vitamin, alike when acting on foodstuffs or on the surface of the living body; the fact again that the recent isolation of vitamin C, and the accumulation of evidence for its nature started from the observation that the cortex of the adrenal gland displayed strongly reducing properties; or yet again the proof that a yellow pigment widely distributed among plants, while not the vitamin itself, can be converted within the body into vitamin A; these and other aspects of vitamin studies will stand out as interesting chapters in the story of scientific investigation.'

In recent years increasing evidence has also been obtained to show that many micro-organisms and higher plants require the supply of vitamin-like substances for the promotion of growth. The 'auxines', as they are called, are essentially of the nature of harmones.

Our knowledge of the molecular structure of vitamins and harmones is growing fast: the relation between the individuals and the manner of their action on animal tissue is also fast coming to light. As an instance of this, one may cite the following observations that relate to some well-known substances.—"The vitamin, which in current usage is labelled A, is essential for the general growth of an animal. Recent research has provided much information as to its chemical nature. Its molecule is built up of units which possess what is known to chemists as the isoprene structure. These are condensed in a long carbon chain which is attached to a ring structure of a specific kind. Such a constitution relates it to other biological compounds, in particular to certain vegetable pigments, one of which a carotene, so called, is the substance which I have mentioned as being convertible into the vitamin. For the display of an influence upon growth, however, the exact details of the vitamin's proper structure must be established. Now turning to vitamin D, of which the activity is more specialised, controlling as it does, the growth of bone in particular, we have learnt that the unit elements in its structure are again isoprene radicals: but instead of forming a long chain as in vitamin A, they are united into a system of condensed rings. Similar rings form the basal component of the molecules of sterols, substances which are normal constituents of nearly every living cell. It is one of these, inactive itself, which ultra-violet radiation converts into vitamin D. We know that, as stated, each of these vitamins stimulates growth in tissue cells. Next consider another case of growth stimulation, different because pathological in nature. As you are doubtless aware, it is well known that long contact with tar induces a cancerous growth of the skin. Very important researches have recently shown that particular constituents in the tar are alone concerned in producing this effect. It is being further demonstrated that the power to produce cancer is associated with a special type of molecular structure in these constituents. This structure, like that of the sterols, is one of the condensed rings, the essential difference being that (in chemical language) the sterol rings are hydrogenated, whereas those in the cancer-producing molecules are not. Hydrogenation indeed destroys the activity of the latter. Recall, however, the ovarian harmone œstrin. Now the molecular structure of œstrin has the essential ring structure of a sterol, but one of the constituent rings is not hydrogenated. In a sense therefore the chemical nature of œstrin links vitamin D with that of cancer-producing substances. Further, it is found that substances with pronounced cancer-producing powers may produce effects in the body like those of œstrin. It is difficult when faced with such relations not to wonder whether the metabolism of sterols which, when normal, can produce a substance stimulating physiological growth, may, in very special circumstances, be so perverted as to produce within living cells a substance stimulating pathological growth." Some of the links still require experimental support, but even the observations, so far made, are sufficiently conclusive to show that there is close relation between chemical structure and biological activity.

The relative importance of the physical sciences and biology in the study of the phenomena of life has been much debated, but it would suffice to say that, whatever be their limitations, the former are bound to profoundly affect biological conceptions. At the same time, it should be emphasised that pure biology, in all its concepts, has an important bearing on human welfare though, unfortunately, it has not lately been realised so well as it should be. This is partly due to the neglect of biology in our educational system and partly to the fact that physical sciences have, lately, had more brilliant exponents to the intelligent lay public than biology.

In recent years, much thought has been given to the possible misuse of the gifts of science to mankind. 'The command of nature has been put into man's hand before he knows how to command himself.' It should, at the same time, be admitted that the fault is with mankind and not with science. "War apart, the gifts of science and invention have done little to increase opportunities for the display of the more serious of man's irrational impulses. The worst they do perhaps is to give to clever and predatory souls that keep within the law, the whole world for their depredations, instead of a parish or a country as of yore."

There are two other great questions before mankind which require careful consideration. One is the paradox of poverty in the midst of plenty and the other, replacement of human labour by machinery. Applied science should take no blame for the former, but indeed claim credit unfairly lost. As for the latter, there would now appear to be greater fear arising from 'Money *versus* Man' rather than from 'Machinery *versus* Man'!

Considering the present march of events, there is great need to plan for the future. 'In such planning the trained scientific mind must play its part. Its vision of the future may be very limited, but in respect of material progress and its probable consequences Science has at least better data for prophecy than other forms of knowledge.' 'Though statesmen may have wisdom adequate for the immediate and urgent problems with which it is their fate to deal, there should yet be a reservoir of synthesized and clarified knowledge on which they can draw. The technique which brings Governments in contact with scientific knowledge in particular, though greatly improved of late, is still imperfect. In any case the politician is perforce concerned with the present rather than the future.' 'When civilization is in danger and society in transition might there not be a House recruited from the best intellects in the country with functions similar (*mutatis mutandis*) to those of Bacon's fancy? A House devoid of politics, concerned rather with synthesising existing knowledge, with a sustained appraisement of the progress of knowledge, and continuous concern with its bearing upon social readjustments. It is not to be pictured as composed of scientific authorities alone. It would be rather an intellectual exchange where thought would go ahead of immediate problems!'

'If the political aspirations of the nations should grow sane, and the artificial economic problems of the world be solved, the combined and assured gifts of health, plenty, and leisure may prove to be the final justification of applied science. In a community advantaged by these each individual will be free to develop his own innate powers, and, becoming more of an individual, will be less moved by those herd instincts which are always the major danger to the world.'

Section A.—Mathematical and Physical Sciences.

THE Presidential Address to Section A of the Leicester Meeting of the British Association was delivered by Sir Gilbert T. Walker on Seasonal Weather and its prediction. After pointing out the importance of weather forecasts, he stressed the danger to the prestige of the science which might arise from over-confident forecasts based on insufficient data. He also deprecated the practice of ascribing periodicity to weather conditions on insecure evidence and trying to predict weather on the basis of such assumed periodicity. Passing next to his main theme, the lecturer explained what was meant by the correlation coefficient between two varying factors. The method of weather determination was then explained. Taking the variation over a period of years of the pressure, temperature and rainfall of a number of typical places whose variations show a positive or nagative correlation coefficient approaching unity a mean graph or set of numbers is computed and taken to be characteristic of the region. Then the correlation coefficients between this mean variation and the variation of the weather conditions at any particular place are calculated. Wherever there is a large correlation coefficient between the variations say in winter and those in summer, there is opened up the possibility of predicting summer conditions from the winter oscillation. Sir Gilbert illustrated this process by means of a number of graphs showing the North Pacific Oscillation and its relation to the pressure, temperature and rainfall in the surrounding regions, and also the Southern Oscillation from December to February and the same from June to August with the correlation between them. The lecturer also pointed out the necessity of a careful discrimination in drawing conclusions from statistics and illustrated his remarks by means of a very effective example, in which a comparison of illiteracy at marriage with unemployment led to a high negative correlation coefficient, but the fallacy lay in not taking into account the trend of the total amount of trade at the same time. Sir Gilbert then quoted instances from actual practice where the above methods had led to important results as in the monsoon forecasts in India and weather predictions in Southern Rhodesia. He then described the methods used for seasonal forecasting in Sweden and Russia and referred to the researches carried out by Dr. Franz Baur at Frankfurt a.M. In conclusion, the lecturer again stressed the necessity for stringent tests of any suggested periodicity in weather and for caution in prediction and expressed the hope that the subject may draw more investigators to its study on account of its interest and importance.

Section B.—Chemistry.

IN his Presidential Address to Section B (Chemistry) of the British Association, Prof. R. Robinson has made a fascinating and extremely valuable survey of his brilliant researches on the anthocyanin pigments of plants, which in the course of a decade have revolutionised our knowledge of the subject. A prefatory account of some natural colouring matters and their synthetic analogues indicates the value of investigations on plant pigments from the point of view both of academic interest and of technical possibilities.

The pioneering work of Willstatter established the main features of the structure of the anthocyanins as saccharides, occasionally acylated, of the anthocyanidins. They exhibit amphoteric character, forming salts with both acids and bases. The constitution of the three fundamental anthocyanidins, pelargonidin, cyanidin and delphinidin, has been proved beyond doubt by degradation and many syntheses. Although one method of synthesis, the reduction of quercetin to cyanidin, offers a ready and attractive hypothesis of the biogenesis of the anthocyanin pigments, the experimental support for such a view will not bear scrutiny.

Peonidin, petunidin, malvidin and hirsutidin have been shown to be methyl ethers of two of the three fundamental types and all have been synthesised.

The greater number of the anthocyanins can be classified as (*a*) 3-monoglucosides and 3-monogalactosides, (*b*) 3-rhamnoglucosides and other 3-pentoseglycosides, (*c*) 3-biosides, (*d*) 3 : 5-diglucosides, and (*e*) acylated anthocyanins. Several of the types, notably pelargonin, cyanin, peonin, malvin and hirsutin, have been synthesised by ingenious modifications of the general schemes of pyrylium salt synthesis devised by Robinson in collaboration with Pratt and others.

(Mrs.) Robinson and Robinson have studied the behaviour of the anthocyanins as indicators and the causes of the variations of flower colour. The main factors affecting flower colours are: (1) the nature and concentration of the anthocyanins and other coloured substances present; (2) the state of aggregation of the anthocyanin in solution, the *p*H of the cell-sap and the presence of protective colloids being some of the subsidiary factors affecting this; and (3) the presence or absence of co-pigments and, problematically, the effect of traces of iron and other complex forming metals.

The culmination of the work so far is the evolution of qualitative tests, dependent for example on oxidation, on colour variation in solutions of graded *p*H, and on distribution between immiscible solvents, which enable us to recognise the nature of an anthocyanin with speed and certainty.

Section C.—Geology.

IN his Presidential Address to the Geology Section of the recent (Leicester 1933) Meeting of the British Association for the Advancement of Science, Prof. W. G. Fearnsides deals with an intensive study of the structures in the coal fields of the Midland Province in England. In accordance with his strong conviction that structural geology is a science of measurement and that the real geology of an area is not fully known until it can be represented by a model true to scale, Prof. Fearnsides has chosen the Midland coalfield province, with a view to prepare such a model, if possible, based on known details of the geology of this area compiled from the records of nearly a thousand working mines within this province. From a detailed account of the stratigraphy and mode of accumulation of the local rocks and of the crustal movements which allowed their accumulation in the Midland carboniferous geosyncline Prof. Fearnsides has proved that the Midland Province is a structural unit of deposition and slowly developed as a coal measure geosynclinal basin which was averted before Permian time; and in general, it is now a synclinorium with a central lop-sided crumpled dome. The synclinals within the synclinorium "deepened intermittently, but progressively, as the geosynclinal filled; and though as a whole the province may occupy an early downfold in the foreland of the Hercynian Alpine chain, its leading fold lines are re-emphasised and rejuvenated structures which in origin are older."

Section D.—Zoology.

DR. GRAY gives an indication of the scope of his address by formulating three questions which, though historical, have to be asked now and then in reviewing the progress of the different branches of Zoology. What is our conception of the essential nature of the living organism? Do we believe that the activity of living matter and its potentiality for change can be expressed adequately in terms of physical units? Do we incline to the belief that living animals have been evolved from inanimate matter? These questions in one form or another have perplexed the mind of philosophers of antiquity who sought refuge in revealed religion and within recent times several theories have been propounded in answer to them. Of these theories, the mechanistic and vitalistic concepts of life have held the ground with varying fortunes.

According to the Mechanical Theory of Life, the biological phenomena are only complicated constellations of physical and chemical processes. It is true that the results that have been obtained by the application of physical and chemical methods as instruments of biological investigations, have greatly helped the understanding of the physical and chemical attributes of living matter and the elucidation of certain aspects of single physiological process, but obviously they can offer no adequate explanation of the equally fundamental facts such as adaptation, regulation, activity, autonomy, compensation and pathology which give to the organisms a unique position in contrast to the inorganic world. The mechanical theory of life as Dr. Gray has pointed out, received a fresh impetus by the synthesis of certain organic compounds and by the parallelism instituted between the processes of organic and terrestrial evolution, as though they involved the operation of similar forces. Among the Biologists there are notable advocates of the mechanical theory of life and "it is a curious but pertinent fact that the most far-reaching mechanistic views have been and are being put forward by biologists, the more cautious views or the vitalistic views are held by physicists and chemists." It is conceivable that at some remote time in the geological history of the World inanimate matter may have possibly been transmuted into living substance just as it is perfectly conceivable that "it is also possible for a stone to leap spontaneously from the surface of the earth." "These things are possible but are they probable?" Biological researches do not provide any evidence to support the spontaneous origin of living substance and attempts on the part of biologists to postulate the spontaneous origin of intermediate stage between the living and the inanimate world cannot be comprehended under the category of "laws" which relate to the body of verifiable natural events. If we can entertain a concept of "co-ordinated series of self-regulating and self-propagating chemical reactions" in the production of living from inanimate matter, then what is it that hinders a not dissimilar concept being entertained of a lump of iron, wood, rubber and glass acquiring a co-ordinated series of self-regulating reactions to be spontaneously converted into a motor car, running through a crowded traffic without encountering accidents by generating a series of self-propagating reactions, including stoppages at kerb fountains for re-fuelling and re-oiling? What makes the mechanical view of life unacceptable to most scientists is the fact that it is unsuitable for the very purpose for which it was introduced, *viz.*, the physico-chemical analysis of vital processes, and so far as is known there is no evidence "which suggests that within the physical world, a dynamic machine has spontaneously come into existence." It is true that matter in a living organism in certain aspects of its behaviour may be interpreted in terms of physical and chemical units, but its characteristics in its wholeness are fundamentally different from those of inanimate objects. The modern theories of development and the researches of experimental embryology tend to confirm the view that "the cell has an individuality of its own—which is free from the limitations of statistical laws."

The main attributes of living organisms are more vividly recognised by studies in embryology than those of general biology, *viz.*, Life is a system-property and an organism functions in its wholeness. Mechanism provides us with no understanding of these fundamental characteristics of the organisation of organic processes among one another, of organic wholeness, of the problem of the origin of organic Teleology or of the historical character of organisms. Since the fundamental attribute of living organisms is their complicated organisation and their wholeness, the experimental investigations of the single part and single process based on the methods of physico-chemical analysis, cannot provide a complete and satisfactory explanation of the vital phenomena. This mode of investigation gives little information concerning co-ordination of parts and processes in the living organisms in their wholeness which cannot be compared with the reactions observed in test tubes.

The physiologist and the experimental embryologist have added considerably to our knowledge of the physical and chemical behaviour of parts of living substance or organisms, but our knowledge of the organs and organisms is something more in that they arise from a system unlike their own and possess potentiality of evolving into newer and more complicated forms. The investigations of the physical and chemical properties of parts of the living organisms may give us an explanation of the attributes and behaviour of the mechanical framework of such parts under induced conditions but that explanation must be hopelessly inadequate to give us a complete picture of "the intrinsic potentialities of living matter revealing as it does a co-ordination of events" for which there is no parallel in inanimate nature. In the first type of study we are free to use the instruments provided by the physical sciences, but in regard to the latter, organismic biology must build on her own foundations and not tend to merge in physics or chemistry.

Section E.—Geography.

IT is immaterial whether Geography is a synthetic new recruit to the ranks of science or is the mother of all sciences; its cultural value in any scheme of education is always profound and the presidential address of Lord Meston is a skilful and elaborate exposition of this theme. The intrinsic usefulness of the study of Geography from a broader standpoint becomes all the greater when it establishes contact with the other branches of knowledge closely related to it and in fact we are fast arriving at a stage when knowledge cannot be treated in isolated segments, but should be presented in its wholeness. Perhaps instead of subjects, topics will have to be adopted for study and the children are to be enabled through easy and gradual stages, to grasp the many aspects from which each topic can be viewed and understood and that all approaches to the study of a topic result in unfolding one and indivisible truth. If at the present moment, the subject-method is in the widest practice in the class rooms, it is because the teachers do not have that intimate and comprehensive acquaintance with different branches of science so as to enable them to deal with the general scientific topics from their different viewpoints and harmonise knowledge into an integral unity.

The greatest mistake that the old text-books of Geography made was to describe the solid earth as an immutable structure, the hills as everlasting, the races of mankind as static social groups and the soils, climate, commerce, and international relations treated more or less from a stereotyped standpoint. If Geography is a function of a number of sciences, it must keep pace with the progress of the latter and its content must include the fresh data contributed by Physics, Chemistry, Geology, Biology, Sociology, Economics, Archæology, Anthropology, Explorations, Politics and History. Pre-historic geography is not a mere study of the movements of land and sea, the distribution of ice on earth's surface and the occurrence of strange fauna and flora, but represents precisely the point of time when the study of geography acquires a vastly human interest. It was about the close of the Tertiary period, that the movement of man, from whatever place he might have taken his origin, began and the direction of his march was determined by land connections, the climatic conditions, the abundance of food and the absence of enemies. Everything about this pre-historic man, his dress, his implements, his crude craftsmanship, his food and his rugged appearance, his habitation and his hunting trophies have far more interest to us than the startling disclosures of a modern political intrigue or the romance of modern social life. How he incessantly battled with the forces of nature and used his intelligence in laying the foundation of modern industries and culture must at all times exercise a strange fascination upon reflective minds and possess an irresistible attraction for the imagination of the young.

Geography is the study of the changes not only of those occurring in the crust of the earth and the borders of the ocean, but primarily of the transformations taking place in everything belonging to man and his environmental relations. The study of the globe in its physical aspects, the height of mountain ranges, the length of rivers, the size of lakes and the depths of seas must be barren and the interest and cultural value of Geography must be derived from the age and area of plants and animals and the biological lessons which they reveal, the produce of the land and sea and the uses to which the modern industries put them, the means of intercommunication which have built up political institutions, the distribution of the different races of mankind and their isolation determining their level of social development and how from cruder and simpler types of family system, the enormously complex international life has arisen. These must be the legitimate province of historical, political or human geography and the influence of its study must always exercise a profound influence on the growth of human mind and its outlook. With the expansion and growth of political institutions the geographical frontiers have shifted and within recent years, the map of Europe has been altered out of recognition. These shiftings of frontiers are an expression of the drama of the struggle for life ceaselessly enacted in nature and repeated by man and the cause in both cases is identical. Over-population, shortage of food, desire of colonisation, and armed position are the causes which lead to expansion or restriction of political areas, and when the inhibition becomes too strong, the restlessness of the nations manifests itself in ethnographical or racial movements, eschewing foreign admixtures. All this is biological phenomenon and intensely geographical in interest in its historical aspects.

Pre-historic geography is mystic and romantic; physical geography dealing with climate, the sea and the changes on the land's surface and its productivity, is a study of the grim forces of nature; historical or political geography is the story of the evolution of social and economic institutions and human geography provides the absorbing background for all these divisions, by making man the centre towards which every other aspect of geography converges. The study of man is one of actions and reactions; it investigates the conditions which lead to over-population and distribution and the influence on them of the geographical features of the country inhabited by him and his capacity to adapt himself to the changing environment, his struggles and his survival value. In these struggles, with the powers of nature, his character and personality unfold themselves, and how the physical features of a country have moulded the national characteristics and its historical destiny is part of the evolutionary aspects of geography which must excite imagination and cultivate understanding. The study of physical features of countries such as India and Greece must offer scope for the investigation into the rôle while geography plays in developing religious and moral ideas of the people. The profusion with which nature supplied the wants of man without demanding labour for procuring them, supplied him with opulence and leisure leading to contemplation of the stupendous natural phenomena by which he is surrounded and out of such meditations which could not search the fundamental causes all theistic forms of religion and the primitive forms of nature worship rose. Geographical conditions of Arabia and Palestine must certainly have influenced the development of Judaism and Islam, whose stern simplicity and unitarianism are the products of the desert solitude and the temper of mind it fostered.

Geography, as Lord Meston conceives it, helps us to understand where the defect in the eternal struggle with nature has been final and where victory can be snatched and how harmony with nature can be established. The conflict is not all with the blind forces of nature, but it has to be waged between ethnic groups for racial domination and the results to which such conflicts lead are well known. Viewed from such broad standpoints the materials of geography form the subject-matter of other more specialised branches of knowledge and the cultural value of their study must be as wise and deep as human civilisation itself.

Section F.—Economic Science and Statistics.

PROFESSOR J. H. JONES, the President of the Section, in his address spoke on the value of the gold standard. The address is of immense value especially in view of the present state of affairs in the world. He spoke about the working of the gold standard before the war, then about the effect of the war upon the financial machinery and then gave an account of the post-war history of the gold standard. "If we ignore other metallic systems, the real issue lies between the gold standard rigorously interpreted and the maintenance of national currencies which are not linked together by being linked to gold or any other common measure." Abandoning of the gold standard achieved considerable popularity for a time; later experience is that currency disturbances lead only to increased difficulties. Gold standard is useful to countries to pursue a currency policy, to maintain a stable price level. A national system of currency is applicable only to a country which wishes to isolate itself from the rest of the world. It is inconsistent with a policy of internationalism in other branches of economic activity. The gold standard stands for internationalism in economic affairs. It is a condition for the free development of trade between countries. Post-war changes in the value of gold have been due not to the gold standard but to the failure of a number of countries to operate that standard. Restoration of the gold standard is necessary to the progress of the world. But it is not suggested that an immediate return to the gold standard is desirable, before certain preliminary conditions are restored, such as the price averages of different countries expressed in their respective currencies have reached those heights which may be considered satisfactory. But it may happen that political considerations will drive countries to take to gold standard before the necessary preliminaries have been properly considered. There is also the question of unequal distribution of gold. It is said that a return to gold standard is impossible so long as the world's supply of gold is concentrated in two countries. But this is not really an insuperable difficulty, for if we could restore these conditions which are essential for the maintenance of the gold standard it is not unlikely that a redistribution of gold according to apparent need would be accepted. It is, however, true that "the gold standard is a form of discipline which may itself help to restore some of those conditions that enable it to be operated with success."

Section G.—Engineering.

IN his Presidential Address at the Engineering Section, Mr. Richard W. Allen dwelt on the outstanding developments in Mechanical Engineering during the past few years. The improvements in time-saving and labour-saving devices have been so rapid that it often seems doubtful whether mankind can adapt itself to the rapidly changing conditions. The last fifty years saw the three most important contributions to mechanical science, namely, the steam turbine, the Diesel engine and the centrifugal pump. Electrical generation and transmission have also so rapidly increased that Lord Kelvin's statement, made as recently as 1895, that power stations of 100,000 H.P. under one roof would be possible in the future, has been more than justified because at the present day there are single units developing more than this power.

In the field of the steam turbine the great pioneering labours of Sir Charles Parsons laid the main foundations for the turbine design of to-day. From the uneconomical non-condensing turbine, the condensing type was conceived, thus increasing the efficiency to a very great extent. The geared turbine made it possible to be adopted to ship propulsion, to driving electric generators and to operating various kinds of mills, where its greater economy of space and steam consumption gave it advantages over the steam engine. The thermal efficiency has also increased so rapidly that at present, a figure of 34 per cent is possible.

The development of the oil engine has not been less phenomenal. Although it is only 41 years since Rudolf Diesel took out his patent, the advantages of the Diesel engine for land and marine service have been fully recognised. Considerable developments in the method of fuel injection, in speed, and in power per unit weight have been achieved. The low initial cost, the limited space required for its installation, the ease of starting from cold and the low costs of operation and maintenance have all contributed to the great industrial exploitation of the Diesel engine.

The centrifugal pump is also largely a development of the last fifty years, although its principle was known long before. Osborne Reynold's patent in 1875, of the multistage turbine, centrifugal pump and the use of guide vanes, established a very wide field of application for this type of pump, even for the handling of materials like coal, sands, gravel and the like, besides liquids. The axial flow type is a recent development in this field. The tin industry of the Federated Malay States and the large floating and growing docks of to-day have largely been made possible only by the aid of this pump.

Similar phenomenal development in naval and military services, radio-communication, aviation and transport have taken place. The whole outlook has entirely changed due to the substitution of science and the scientific method for the "rule of thumb" procedure of the so-called "practical man" of the previous generations. The lay-out of plant, the housing of machinery, the transport question, the introduction of the planning department, the testing department and the works laboratory, are all due to the adoption of the scientific method of outlook. In achieving this end, all engineers owe a debt to the National Physical Laboratory, the British Standards Institution and to the technical press of the country.

The training of the future engineer, the craftsman and the apprentice are then dealt with at length.

Section H.—Anthropology.

TRADITION is the unwritten code handed down from generation to generation, influencing profoundly every department of human thought and activity. We have traditional methods of agriculture, craftsmanship, eating, dealing with property, marriage, rituals, and social relations and etiquette, superstitious faiths, games and sports and even narratives of semi-religious events and studies. The long-continued observance of certain rules and practices for regulating human affairs and institutions soon acquire the force of law and in primitive social groups, the younger members must become versed in the traditions of the society before they are permitted to the privileges of "citizenship" of the group. In the case of unregulated minds, tradition, whether rational or otherwise, exercises absolute sway and its influence on every aspect of human life in semi-savage societies amounts to religious sanction. Lord Raglan's address is devoted to the consideration of traditional narrative in its various forms such as "Myth, legend, epic poem, ballad, saga and fairy tale" and the contribution of each of these to history. The historical and fictitious aspects of traditional narrative must be an interesting field of anthropological investigation.

The essence of tradition is its oral transmission from age to age and its contents relate to the heroic exploits of mythical persons, the mystic practices of rituals and the observances of certain social rules or procedure in the practical affairs of life. It flourishes in illiterate and semi-civilised communities and lingers even in the highly cultivated societies. The contribution of traditional narrative to history cannot be trustworthy because the illiterate people are notoriously indifferent to facts and the genuine sources of history are well authenticated documents of events and careers of great men. Perhaps the reason why historical facts are capable of being transmitted with accuracy from generation to generation is that the events are contemporaneously recorded and they affect the fate and fortunes of countries and the recollections of these events must be far too vivid to undergo distortions from which traditional narratives are apt to suffer. For this reason historical facts rarely enter into tradition.

Do the illiterate people invent fables and fairy tales which are obviously intended to please and profit the community? Traditional narratives, according to Lord Raglan, are rules for the performance of rites or ritual dramas. The prosperity of the community depends upon the correct observance of these rules, which form the basis of traditional narrative and it is almost impossible for figments of imagination entering into such narratives because the rites or ritual dramas are enacted in the presence of all the members of the community. Primitive man is incapable of embellishing or distorting tradition and beyond being a repository of legends, sagas and poems, he is devoid of all faculties of imagination. The large number and variety of traditional narratives prevalent among peoples have been built up by the ritual practices and ritual drama.

Family and local traditions do not form part of historical facts and to a large extent may arise from confusion of tribal names or from gratification of parochial pride. The family tradition of Sir Hereward Wake which Lord Raglan quotes is an instance of such a confusion of names. It arises from a desire to connect pedigrees with an ancient name, however mythical, for the purpose of securing sufficient antiquity. Local traditions are false history started by the local Antiquaries and the traditional accounts of Henry V of England made famous in the historical plays of Shakespeare are opposed to historical facts of the early life of this sagacious monarch. Similarly, folk tales and songs and anectodes have no foundation in history. Lord Raglan's theory is that the traditional narrative is always an account of a ritual drama and this view is based on the fact that in tribes and localities where traditional narratives abound, ritual dramas are numerous and elaborate. The principal ritual drama is the "creation rite", the installation of the king or the old king ceremonially killed by his successor. In all primitive social organisations, the ritual was practically universal, but the myth associated with the ceremonies and festivals partook of local character. If the myths and legends have their origin in the world of ritual drama, then the place of history in it becomes meaningless. In the process of evolution the ritual dramas undergo transformations and among the numerous instances of such transformations, the cycle of Robinhood which forms the most important body of English and Scottish traditional narrative is a classic instance. May celebration was called "Robin Hood's Festival". He was a mythical hero whom the people were fond of personating in semi-dramatic performances and dances usual at that season. Lord Raglan concludes that all traditional narratives are accounts of ritual drama and gives a summary of their principal features. A narrative is generally dramatic, but history is seldom so. The action of the narrative is based on songs and rhymes and the language of the characters though coming from different countries is the same. Again in costume, conversation, conventional settings and in other important particulars, traditional narratives may be cast in quasi-historical language but cannot be true history. If in the early historical works, there are traces of traditional narratives as in the case of Herodotus and Thucydides, such references as for instance the historical character of the *Illiad*, are due to the methods of treatment which must be unscientific. The foundations of social anthropology have been encumbered "not merely by the ruins of ancient superstitions, but also by the jerry-buildings of pseudo-history and pseudo-psychology" with the consequence that the subject is not accorded a place among the sciences. "It will never occupy what should be its proper place until a vast quantity of pre-scientific and pseudo-scientific rubbish has been cleared from its path" and Lord Raglan's brilliant address ought to assist the clearance.

Section I.—Physiology.

PROFESSOR E. D. ADRIAN discussed the "Activity of the Nerve Cells".

The problem before us is whether it would be reasonable to discuss the working of the Nervous System with reference to its constituent cells. The Nervous System is responsible for the behaviour of the organism as a whole or, to use the classical phrase of Sherington, "its action is an integrative one". In the human we have not merely a Nervous System but also a mind. But we can discuss the activity of the nerve cells purely on the physiological plane. The Nervous System is composed of cells containing living protoplasm (which in itself offers any number of bewildering problems) but their more important function is to make the organism respond rapidly and effectively to changes in its environment and to achieve this they have developed a specialised structure and a complex arrangement in the body.

In the study of the development of the Nervous System emphasis was laid before on how the pattern of the Nervous cell is laid but now the approach is from why they are arranged in such a manner. In tissue culture and other variety of experiments it is possible to rearrange the geography of the Nervous System showing its plasticity—the forces moulding the system coming partly from the central mass of the nerve cells and partly from cells outside. The forces may be electrical or chemical, the nerve cells cling to structures already laid down, *e.g.*, the main arteries and the lymphs.

The Nervous System is made up of neuron cells with threadlike extensions. The activity is essentially rhythmic, probably a rapid breakdown and repair of the cells. The evidence comes from the analysis of minute electrical changes of cell activity sets as electrical Eddies. An external stimulus acting on a sense organ upsets delicate equilibrium of its surface the disturbance acting along the fibre while active process analogous to the spread of a flame along a fuse. The change is momentary excitement being followed by a rest and recovery. The impulses in a fibre may be as high as 300 or as low as 10. The sole function of the nerve fibre is to carry message without distortion. But these specialised reactions are not peculiar to the Nervous System and it may be observed that the ground plan of the mechanism is the same in the nerve cell or muscle cell.

The elaboration of our impulse is another problem, Sherington having worked on the Spinal Reflexes and Pawlow on the Brain. An important line of attack is by measuring electrical changes in the central grey-matter. It is found that there are large electrical oscillations in the cerebral cortex varying from moment to moment and difficult to experimental control. In the more measurable fibres of Optic retina it is found that there are waves in regular rhythm. It seems probable that both chemical and electrical changes may be concerned in spread of activity from one neuron to another. Our Nervous System is built up of cells with specialised structure and reactions—but the reactions are of a type to be found in many other cells. There are electrical gradients at an active point and it is a long step from the mechanical precision an impulse discharge to irregularities of the record from the cerebral cortex.

In considering the Nervous System as a whole clinical neurology has slightly emphasised exact localisation though this does not afford the whole explanation of cortical activity. Localisation as is now known is a matter of various than of single neurons. This is shown by an examination of habit formation and by remarkable way in which Nervous System adopts itself to injury. When the Central Nervous System is injured there is a greater evidence of localised function but that localised function is not a hard and fast rule. In reactions where there is no evidence of localisation, Lashby finds the important factor to be the total—mass of cortex.

How do the individual neurons combine to form a system capable of exactitude? This is as yet not possible for Physiology to explain but at distant date the solution may be found—not foreign to the conceptions of Physiology. The organisation of neurons into the Nervous System is yet a physiological problem and if a solution has to be found outside Physiology it will be interesting to know as to what light it throws on the relation of the Nervous System to the mind.

Section J.—Psychology.

IN delivering the Presidential Address of the British Association for the Advancement of Science at Leicester on the 8th of September 1933, Professor F. Aveling stressed the importance of mind over sensory experiences and made an emphatic plea for the status of psychology as an empirical science. All the sciences of Nature begin in sensory experience, abandoning the experience of conceptual construction and return to experience to verify their constructive work. Empirical science is defined as the science which is supported by the evidence of the senses or which is built up out of the elements of experience. Physical sciences which begin and end in sensory phenomena are examples of the first and psychology an example of the second; but the ordinary use of the term 'empirical' limits experience to that of a sensory nature. This limitation is an arbitrary one and is due to a philosophical prejudice. There is no doubt that there is more in experience than in sensory elements. Empirical sciences which begin with sensory material, work from this towards its explanation on conceptual lines: and those sciences like Mathematics, which begin with abstract quantitative concepts work from these concepts and their relations towards a statement of the implications which are contained in them. Both these kinds of sciences are selective of their material and leave out of account much experience, which as such is as good as any other. "These neglected experiences are necessary to explain the constructions of the empirical sciences of Nature, for we need no longer concern ourselves with the deductive sciences .... It is psychology concerned with the totality of experience, objective and subjective alike, of which we are or may be conscious, and making no abstraction from the fact that it is experience, which provides an account of the empirical origin of principles of systematization and explanatory concepts alike which are found in the other sciences." On the other hand psychology is the most empirical of all sciences "in the sense that it deals directly with experience as such, makes no partial selection, but embraces all experiences alike indifferently and at their face value."

Section K.—Botany.

IN this exhaustive account of the types of Entrance mechanism of the traps of *Utricularia* (including *Polypompholyx*) the minute structure and behaviour of the valve and its contactual parts specially the threshold of seventy species of Bladderworts belonging to two major ecological groups are described. The trap is a snap-action mechanism—so swift is it that the whole action falls within the limit of 1/16 second. During this brief moment the side walls of the trap spring out, the door opens fully and closes half relaxed, when a column of water with small luckless animals rushes into the trap. The resetting of the trap takes place from 15 minutes to 2 hours or more during which period the water diffuses out of the trap and as a result of which the outer water presses equally on the walls and the door alike. The door is shifted out of its position, the water pressing thereon pushes the door in. Thus the trap is actuated. The water-tightness is maintained by a Velum which arises from the Epithelium of threshold. The structure of the door in all the species studied as correlated with the function of its various regions, remains uniform. Two general types of traps are noticed, *i.e.*, those that have broad threshold and those with narrow threshold. The characteristic glandular trichomes and their distribution in the trap has been observed. The details of several types are appended such as *U. cornuta*, *U. capensis*, *U. Cœrulea*, *U. monanthos*, *Polypompholyx*, *U. globulariæfolia*, *U. orbiculata*, *U. vulgaris*, *U. reniformis* and *U. purpurea*. In all these, living forms from the old as well as the new world have been studied.

Section L.—Education.

THE Presidential Address of Mr. Holland to the Educational Section is a brilliant review of the principal educational developments rendered possible by the passing of several Education Acts commencing from Forster's Act of 1870 to Fisher's Act of 1918. These Acts deal with the elementary and secondary educational systems, their administrative control, the governing bodies and the distribution of grants, and on the whole the energy and zeal displayed by the County Councils and the County Borough Councils which were charged with responsibility for all forms of Education in their areas, deserve ample recognition by state for the excellent use they have made of the opportunities. The development of a sound national system of Education in a democratic country with conflicting public and private interests must be comparatively more difficult than its organisation in states with a unitary national purpose. In Russia which is dominated by a single idea, the whole aim of education is to train the young man to become a worker for consolidating a socialistic state. Under the Nazi administration Germany is giving up her liberal notions of free individual development. The child is part of corporative state and has no existence apart from it. The idea of education is service and subservience to the state. In Italy the teacher and pupil own allegiance to Fascism and education has no ideal higher than the glorification and advancement of Fascist movement and all other considerations are subordinated to the exigencies of the State. Concentration on a single aim such as the central European countries have placed before themselves will undoubtedly simplify and speed up the educational reform, but in countries where the demands of the public are neither simple nor uniform, the task of building up a homogeneous system is fraught with complexities and difficulties. We cannot organise a department of national Education which will reconcile the conflicting demands of the parents, of the Society, of the industrial organisations and of the State and these demands change frequently in proportion to the changes in the economic and political system of the people. In adjusting the system of education to the requirements of these very often conflicting interests, it should not lose sight of the important task of providing an atmosphere for the free and ample development of the personality and character of the child. In a free country untrammelled by any political or socialistic incubus, the primary duty of the state is to offer extensive opportunities for the children and young persons to benefit to the fullest bent of their natural aptitudes, from any system of education by which they are capable of profiting. It is this assertion of the individual rights which is at once the strong and weak point of the British system of Education and it is this feature which baffles the efforts of would-be reformers of Education in England who wish to reconstruct a system on the socialistic basis of the state.

The secondary education in almost every country has reached a stage of development when further reforms are possible only by reorientation of the entire outlook and purpose of this grade of instruction. With the awakening of mass consciousness to the benefits of education and the increasing opportunities it offers for the betterment of the social and economic position of the communities, the secondary schools have ceased to be exclusive institutions of a class. They have turned numbers of young men of practical ability toward professional and clerical occupations, a diversion causing no small amount of uneasiness to industrial and commercial concerns. Any system of secondary education which does not set out to discover their natural talents to boys and girls, but creates a thirst for soft sinecure posts in State Services, is wasteful and the country loses the benefits which might otherwise accrue, by the employment of the creative faculties of the young people. Boys and girls who now prefer the labours of the desk might possibly be diverted to industrial occupation through the new type of service schools which are rapidly coming into existence; the success of these schools must depend upon the public support accorded to them in a measure so unreservedly extended to the secondary schools.

The relation of education to industrial and commercial organizations is discussed in great detail in the address and the reasons why secondary education has become a part time and post employment one are set forth. The success of all endeavours in educating the employees must ultimately depend upon a co-ordinated plan in which the responsibility is equally shared by the employers and the local authorities. Technical education in other European countries has tended to divide society into horizontal sections offering no stimulus for personal advancement and individual self-expression and technical schools with such ideals will never succeed in discovering the exceptional man upon whose energy and genius, all industrial expansion must depend. In the concluding portion of the address the problem of unemployment of young men and women whose numbers are increasing is dealt with. Fundamentally it is a problem for the solution of which the state must assume responsibility and we do not agree with Mr. Holland who points out that it is a subject for the local education authorities to tackle. The suggestion that the young people should be advised to remain at school till proper situations are found for them is no solution and the maintenance of pupils in the school beyond the necessary period must be viewed by parents with alarm and by the Government not as a helpful suggestion, for in both cases the money spent on educating the young men after the completion of the courses must be wasteful expenditure. Mr. Holland makes other suggestions such as the age of compulsory insurance being lowered to fourteen years, and credit being given against the unemployment fund for attendance beyond that age, and grants being obtained by local education authorities, from the Board by submitting area schemes of Fisher's Act of 1918. Admittedly all these are only palliatives and are not real solutions and social consciousness should be thoroughly roused to the demoralising effect of enforced idleness of a large section of able-bodied citizens on the efficiency and productive-power of the nation, before the major part of the question may be deemed as having been solved.

Section M.—Agriculture.

DR. ALEXANDER LAUDER'S address is a review of the contributions of chemistry to agriculture since the year 1880 when Sir Henry Gilbert addressed the Association on a similar subject.

The past fifty years have witnessed several discoveries of fundamental importance, among which particular mention should be made of the fixation of atmospheric nitrogen, the rôle of vitamins in animal nutrition, the theory of base-exchange in soils and the principles of bacteriology. Some of these have found application in practical agriculture while the others have greatly improved our knowledge of soils, fertilisers, crops and animal nutrition. Our organisation for demonstration and advice are also more efficient, so that it is now possible for us to assist the farmers more effectively than at any earlier period.

The soil has been studied from both academic and practical points of view. Extended surveys have been conducted and vast areas have been carefully mapped. Several new methods for determining the availability of plant nutrients have been devised and although none of them has proved fully satisfactory, yet the estimates obtained by them are more reliable than those by any of the earlier methods.

In the field of fertilisers, synthetic production of ammonium salts and nitrates, the discovery of the fertilising value of basic slag and improved methods of manufacturing superphosphate, deserve special mention. Attention should also be drawn to the new synthetic concentrates containing varying proportions of nitrogen, potassium and phosphorus.

Biochemical researches have, in no small measure, contributed to the advancement of our knowledge of plant and animal nutrition. The application of X-Rays to the study of plant tissues, the discovery of the chemical nature and mechanism of function of chlorophyll, increasing knowledge of the rôle of enzymes and investigations on the nature, behaviour and more recently, concentration and synthesis of vitamins are only a few of the outstanding contributions of the period.

In recent years, the opening of a number of research stations, establishment of bureaux of information for disseminating fresh knowledge, development of improved methods of packing, transhipment and marketing different products have also proved to be of great service to both farmers and dealers in agricultural produce.

Much more yet remains to be done. Particular mention should be made of the need for improved systems of cropping, so that crops of high nutritive value may displace those of inferior quality. Lands of poor yielding capacity should be improved so as to maintain more cattle, sheep and poultry than at present. The possibilities of further reclamation of land should also be investigated.

Dr. Lauder's address is a useful compilation but it is unfortunately lacking in freshness of outlook. Discussion of a few of the most outstanding problems in agricultural chemistry together with some suggestions regarding new lines of attack would have greatly enhanced the intrinsic value of the address.