SUMMARIES OF ADDRESSES OF PRESIDENTS OF SECTIONS

Instruments in Science and Industry

The presidential address by Mr. R. S. Whipple to Section A (Mathematical and Physical Sciences) is largely devoted to showing how much the progress of the sciences depends upon the development of the instruments employed. A few well-known instruments are selected as examples—the microscope, telescope, spectroscope, etc. Their development has a long history and each can be adapted to yield accurate measurements by the addition of suitable devices.

One of the earliest scientific workers, the Dutch naturalist Leeuwenhoek, during the period 1674–1723, discovered by means of a single-lens microscope the protozoa and bacteria, and made many other discoveries of supreme importance. Although many variations in the design and mechanical construction of the microscope were made during the eighteenth century and the early years of the nineteenth, yet there is no invention of fundamental importance to record until the construction of the achromatic objective. This was first successfully completed by the French optician Chevalier about 1825. Abbe carried the corrections to a far higher degree of perfection, notably by using glasses of new types which at his suggestion had been worked out by Schott, to produce, about 1886, the so-called apochromatic objective. It is difficult to see how the resolving power of the microscope is to be increased further using light from the visible region of the spectrum; the alternative is the employment of rays of shorter wave-length.

J. E. Barnard has developed a successful technique in connexion with ultra-violet microscopy and has shown that it is possible to study and photograph living bacteria, which are normally transparent to light from the visible regions of the spectrum.

The use of short-wave radiation has proved so successful in the case of the ultra-violet microscope that great interest is being shown in the development of instruments using still shorter radiations. It is possible, in a suitably designed piece of apparatus, to use a beam of cathode rays to obtain photographs of bacteria and bacilli at magnifications as high as 20,000 diameters.

Although a Dutchman, Lippershey, discovered the telescope, yet it was Galileo who first produced an instrument worthy of the name. He ground and polished his own lenses and in 1610 discovered the satellites of Jupiter. Newton pointed out that the focal length of the refracting telescope could not be reduced owing to the refrangibility of light of different colours and the impossibility of focusing for all the colours simultaneously. In 1663, James Gregory suggested the reflecting telescope, and five years later Newton constructed the first satisfactory instrument.

Herschel made many specula of high quality, culminating in one of 4 ft. diameter for his Slough telescope. Owing to the increasing demand for telescopes of higher magnification, and of increased light-gathering power, the size of the mirrors used in modern instruments is steadily increasing. An instrument is now being constructed for the Mount Palomar Observatory in which the mirror is 200 inches in diameter.

The highest accuracy obtainable is required in the divided circles of astronomical and surveying instruments. In the latest form of theodolite the circles are made of glass, the divisions being etched upon them. The advantages of the divided glass circle are so marked that the new reversible transit instrument for the Royal Observatory, Greenwich, is provided with such circles, 28 inches in diameter.

The spectroscope is proving of great service in industry both as a tool for rapidly analysing samples of materials and for detecting impurities. The value of the instrument in advanced physical work cannot be easily exaggerated.

After discussing briefly the instruments used in the measurement of time, Mr. Whipple considers the importance of modern electrical instruments and the large part that will probably be played in their future development by the thermionic valve. In concluding, he stated that he was much impressed with the steadily growing demands for higher accuracy in all measurements. As new problems arise both in science and industry the requirements become more stringent. The instrument maker constantly receives incentives to progress from the scientific worker, to whom he owes not only suggestions but also many of his new materials. If knowledge is to progress, it is essential that theory and practice advance together. Nowhere is this more true than in the development of scientific instruments.

Film Reactions as a New Approach to Biology

TOWARDS the end of the last century, the biologist considered that the biological entity was the whole living unit. In recent years the interest developed in specialized processes such as enzymatic reactions has tended to obscure approaches to the mechanism of co-ordination and integration of activities of a cell. Since an analysis of the colloidal properties of living matter reveals that a large fraction of the material and energy lies in a new phase, the interphase, it seems pertinent to inquire how far physical and chemical reactions may be modified when the reactants are confined to an interphase. This is the subject-matter of Prof. E. K. Rideal's presidential address to Section B (Chemistry). The general considerations in respect to composition and structure of the interfacial phases have long been known and have been exhaustively examined during the last twenty years. More recently, attention has been directed to the physical properties of monolayers of the macromolecules, such as the proteins and methylated celluloses and starches. These are of interest in that two-dimensional gels, prototypes of membranes, can be formed. The fact that the molecules in monolayers are orientated in respect both to the substrate and to their neighbours, and that this orientation can be affected by expansion or contraction of the monolayer, is shown to have an important bearing not only on the rates but also on the height of the potential barriers involved in the reactions. Many examples are noted in surface chemical reactions, including both enzyme activities and photochemical processes.

Since the molecules at the interfaces are orientated, in two component systems molecules of different species can be adlineated with respect to one another. Under these conditions the interaction energies comprising both the polar as well as the non-polar portions attain maximum values, and stable complexes frequently result. The formation of these complexes is brought about by the penetration of a monolayer of one species by the molecules of the penetrant. These penetrative reactions appear to be involved in various biological processes such as lysis, agglutination, or sensitization, and to play a part in the action of various drugs. Complexes formed in this way may be broken by other reactants and can likewise serve as carriers for an otherwise non-transportable reactant.

Penetrative reactions involve the penetration of a monolayer by a reactant containing but one reactive polar group. If the reactant contains two or more of such reactive groups, on injection beneath a monolayer the reactant will be adsorbed by the monolayer and form a series of interlinks. An extensive interlinking results in the formation of a non-dispersable tanned skin possessing distinct properties. Finally it is pointed out that action as opposed to injury currents can be imparted to such a system by periodic alteration of the orientation of the molecules of an interphase.

Metamorphism and Igneous Action

THE consideration of the relation between metamorphism and igneous action, which forms the subject of Prof. H. H. Read's presidential address to Section C (Geology), falls into two parts. First, a brief historical summary of the peculiarly national contributions serves to display the wide divergences in opinion on this question. The views of the Rosenbusch school of pure thermal metamorphism are contrasted with the imbibition notions of the French, and the work of Becke of Vienna, the Swiss, Sederholm of Finland and the Americans is reviewed. The classic investigations of George Barrow on zones of progressive regional metamorphism in the highlands north of Dundee and their causal relation to granitic injections are sympathetically summarized.

In the second part of the address, a discussion is presented of the origin of regional metamorphism, that is, of the transformations which have affected large portions of the earth's crust. Prof. Read objects to the customary view that regional metamorphism and dynamic metamorphism are equivalent terms, and suggests that, apart from the dominantly cataclastic effects produced in rocks by patent dislocations, metamorphism is not directly controlled by orogenic deformation. The preservation of original sedimentation textures, the coincidence of schistosity and bedding, the horizontality of schistosity over wide areas and mimetic crystallization generally are observed features which are incompatible with dynamic action.

To account for these features, the operation of a static or load metamorphism in which the transformation is considered to be due to the vertical pressure of superincumbent beds has been invoked by some. Objections to the validity of load metamorphism are, however, many. The existence of completely non-metamorphic rocks which have nevertheless been covered by an immense thickness of strata, high-grade metamorphic rocks resting on lower-grade rocks, and the narrowness of metamorphic zones are examples of these objections. Load, by itself, is not enough.

Prof. Read considers that metamorphism is not a function of depth. He suspects that the notion of the great depths of high-grade regional metamorphism flourishes because of the supposed necessity of carrying rocks down to be metamorphosed, and suggests that as an alternative we should consider bringing the metamorphosing agents up. This can take place in connexion with granitization and the formation of migmatites. Whatever be the origin of granitic magma, it has been demonstrated in dozens of localities that solid rocks have been converted into rocks of granitic character. In the production of such migmatites, replacement must be the essential process, and it is reasonable to believe that during this replacement there occurs an emigration of material into the country-rocks adjacent to the theatre of granitization. Around the migmatite core, therefore, zones of various characters depending upon the localization of different precipitation-fronts are formed.

One of the most firmly established facts of metamorphic geology is the close association of highest-grade metamorphic rocks, such as those of the sillimanite and cordierite zones, with migmatites. This association has been variously interpreted, but Prof. Read agrees with Barrow and others in seeing in it a direct causal connexion. These high-grade rocks, however, are but the final stages in the progressive series of zones which supply the common types of regionally metamorphosed rocks. It seems reasonable to suggest, therefore, that regional metamorphism as a whole is genetically related to igneous activity of some kind. Out from the central theatre of granitization there pass waves of metasomatizing solutions, changing in composition and in temperature as they become more distant from the core and promoting thereby the formation of zones of metamorphism about it. Relief is obtained in the outer and cooler zones by shearing, in the inner and hotter zones by internal reconstructions. Such a metasomatic metamorphism accounts for the superposition of high-grade on low-grade rocks, for the preservation of original textures, for the coincidence of schistosity and bedding, for the changes in chemical composition of the progressive zones and so forth.

Prof. Read's conclusion, which is offered for discussion, is that all rock transformations may be classed into two groups, those of dislocation-metamorphism associated with dislocations of the crust, and those of regional and thermal metamorphism, associated with igneous activity.

Perspectives in Evolution

THERE are some general problems regarding life and evolution which are best comprehended by analysis of long-range views of existence upon the earth. Some of these problems were restated in the light of recent knowledge by Prof. James Ritchie in his address to Section D (Zoology).

Investigation of the properties of living things has led to modification of the extreme mechanistic and vitalistic views of life and has gone far in reducing its mystery to terms of physics and chemistry. Theories of the cell as an electromagnetic unit and of life as the dynamic equilibrium between such units, or of life and the cell as originating in an etherial vortex are less convincing than the researches which show that certain activities of cells conform almost perfectly to the laws of osmotic systems, to Donnan's membrane equilibrium, and to catalytic action brought about by enzymes. None of these interpretations, however, reaches the ultimate secret of life, the quality of which is apparent in a perspective of evolutionary processes.

Living organisms have assorted and aggregated vast deposits of calcareous and siliceous ooze from the dilute solutions of the ocean, and have gathered great formations of coal and peat from the tenuous stores of carbon dioxide in the atmosphere. This is something quite different from the physical fate of gases or solutions, which normally progress towards maximum dispersal of their particles. Moreover, the evolution of life itself, from simple to more complex, is an increase in orderly arrangement apparently opposed to the thermodynamical law of increasing randomness. From this point of view the characteristic of livingness is that it appears temporarily to hold up or withstand the physical course of degradation of matter, if it does not actually reverse it, through its power of trading with the environment so that it can build up stores of high potential energy from materials of lower potential.

Another notable development which must influence evolutionary thought is the lengthening perspective of life upon the earth. Newer and consistent information about the ages of geological formations based upon the break-up of radioactive minerals in rocks emphasizes generally and in detail the stability of living organisms and the slowness with which evolution has taken place. It emphasizes still more the significance of man as an agent of change in the living world, for his active part in modifying life upon the earth is practically confined to our era and mainly to the last three hundred years. In that insignificant period he has wrought faunal changes in civilized lands which can be compared only with the great secular changes of world evolution.

Realization of the 1,200 million years through which life has been evolving leads to an attempt to view mankind and the future of man in evolutionary perspective. His past is insignificant in time; his long future is unknowable so far as science is concerned. But bearing in mind the impetus of evolution, it is reasonable to suppose that in the immediate future (geologically speaking) his progress will be continued towards perfection of social life and the widening of the social idea to include peoples and nations as well as individuals. What of his long future, in the vista of a thousand million years still to come ? The history of life upon the earth makes it seem presumptuous to suppose that with the coming of man evolution should cease or should be tied for all time to come to trifling changes in brain-power or better social organization for mankind. It suggests that man, so far the greatest of the manifestations of life upon the earth, may be no more than a stage in life's progress and a milestone upon the path of evolution towards a greater future.

Method in Geography

MR. A. STEVENS points out in his presidential address to Section E (Geography) that during the last thirty-five years, it has been customary in geographical writing to pay some sort of service to the concept of natural geographical regions as distinguished from the 'political' divisions of the earth formerly in use. Immaturity of thought is indicated by the terms in use: natural (physical) region, economic region, human-use region. It arises from the inclination to see the matter of geography as a duality and its method as synthesis or integration. Fertile scientific work, the definite emancipation from scholasticism of modern intellectual processes, has depended on confining each branch of study to a single material category, and this problem has not been solved in the case of geography. Neither synthesis nor integration is possible where the factors and conditioning circumstances are too complex and difficult fully to be enumerated, let alone evaluated, as they are in the field with which geography attempts to deal. As to method, the subject must limit itself to the analytic: further examination of the natural region concept should contribute to the definition of its matter.

The natural region must be defined with regard to neither the physical nor the human or economic severally, but to both in symbiosis, in natural synthesis. The natural geographical region is the organized or living region. Organization depends on occupation by man and the development of a system of communications the functions of which are analogous to those of both the circulatory and the nervous systems of living organisms. The functioning of such regions with special reference to space is the study proper to geography, as that proper to history is such functioning in time (or sequence). Space and time may not fundamentally be independent variables, but they may be made the basis of partial differentiation. There is the story of the evolution of communications from the porter to the aeroplane, from the smoke signal to the radio. There is also the question as to how precisely communications have managed space.

Organized regions have their ontogeneses. At a given time a region may be *saturated* and its development mature, as, some time in the past century and a half, occurred in Western Europe; or it may be undersaturated and juvenile as is the New World to-day. Until a certain degree of maturity has been attained, the region cannot be defined in detail. The conditions for saturation depend on the state of economic development.

The major natural geographical regions of Europe are the European countries. A geography of Europe not based on the characteristic European phenomenon of the nation-State is absurd. Spatially these regions are quite out of proportion to modern possibilities of communication, the means of organization and cohesion.

Rates and Taxes

PROF. H. O. MEREDITH'S address to Section F (Economics) entitled "Rates and Taxes" is a plea for more serious consideration of the distribution of the tax burden through society in view of probable increase in the ratio of public to private expenditure.

It is alleged that while the policy of *laissez-faire*, as understood by the Victorians, has been abandoned, we have failed to develop a financial practice comparable in logical coherence with that of Gladstone. In consequence, our finance is more and more passive and less and less capable of advance in good time on constructive lines. "Instead of grasping our nettles, we wait until we are stung". Defect of intelligible principles is illustrated by the case of income tax abatements in respect of children, and the policy of derating; and the question is ultimately posed of whether any of our existing sources of revenue are really satisfactory with the exception of income tax and sur-tax and the duties levied on property passing at death. The case against indirect taxes upon commodities and the local rates is argued at considerable length, attention being directed particularly to the sinister influences which have in the past promoted indirect as opposed to direct taxation. The arguments in favour of these sources of revenue are also examined and the conclusion is reached that little, if any, force is attached to any of them here and now, whatever may be or have been the case in other countries or at other times. Special attention is directed to the disputable character of the widely held opinion that virtuous conduct may found a valid claim to exemption from taxation and vicious conduct establish a case for pecuniary penalty.

Finally it is claimed that these methods of raising revenue must inevitably, under modern conditions, distribute the burden of taxation partly in an indiscriminate and partly in a clearly noxious way. In its concluding section the address propounds the theses that taxation ought to be felt and that every citizen in a community ought to pay and know that he is paying at least some minimum contribution to the expenses of the State.

The Future of Flying

THE presidential address to Section G (Engineering) provides each year an opportunity for a survey of some aspect of engineering science which happens to be of especial importance at the time it is given. The subject chosen by Mr. Wimperis is "The Future of Flying". Of its importance at the present time there can be no doubt. Aviation is surveyed by the public with a tempered pride; pride it is true in man's achievement, but apprehension as to the use which is being made of it.

The aspiration towards winged flight was expressed with wisdom when, more than two thousand years ago, the Psalmist avowed his longing for "wings like a dove". Mankind possesses the power of flight—a marvellous scientific and technical triumph; but brilliant as was the work of the pioneers, the crown of achievement cannot be regarded as won until mankind sees that the wings gained are indeed the wings of a dove, not those of a bird of prey. Every new invention has its warlike use as well as its peaceful purpose, and each has challenged men's wits to ensure that good, rather than harm, shall result from the new discovery. To bend the newest invention of all, the conquest of the air, to the service of mankind is now his great task. In it, success is essential lest we presently find that it is the air that has conquered mankind rather than mankind the air.

That the cleaning up of the aerodynamic structure would carry aircraft performance much further than had hitherto been realized was first pointed out, little more than ten years ago, by Prof. B. M. Jones of Cambridge. This required that all excrescences should be removed, and of these some of the worst were then the interplane struts and wires. When that had been achieved it was realized that much of the equipment hitherto carried externally, especially in military types, must be put inside, and with that attained, after a severe struggle, there arrived the modern streamlined aeroplane with its undercarriage, and even its tail wheel retractable into the body of the structure.

As a consequence the speeds of military aircraft are now in excess of 400 m.p.h. and will rise to 500 and possibly even 600 m.p.h. But civil aircraft rarely go faster than 250 m.p.h., and it is doubtful whether it is economically advantageous to have even so high a speed as that. This at once makes a great difference between the two types. Moreover, the comfort and space needed for civil transport tend to produce a design of body which does not in the least resemble military requirements, and in so far as the civil types, in their really large sizes, come more and more to take the flying boat form, so are they the less like military types.

In Mr. Wimperis's view there will be no reason, once the international situation has cleared, why there should not be an agreed limitation, in respect of numbers or tonnage, of bombing aircraft—leaving the interceptor fighters entirely aside. It would be but cautious to agree on a limit to the speed of civil types; but as this would merely confirm what economic requirements would themselves require, it need be no hardship to anyone; excessively high speeds for civil types do not pay, are much more dangerous to passengers, are much more noisy to everyone, and need extravagant air ports.

Scope and Limitations of Physical Anthropology

ANTHROPOLOGY spreads its domain over unusually wide fields of scientific inquiry, and it is becoming increasingly impossible for the representatives of the different branches of the subject to maintain intelligent contact with each other and to judge of the validity of the evidence which is presented in branches other than their own. In his presidential address to Section H (Anthropology), Prof. W. E. Le Gros Clark discusses the present position of physical anthropology and its future prospects.

Intensive studies in comparative anatomy have established broadly the relation of man to the lower primates; but evidence of this nature is necessarily limited since it is often impossible to assess the relative taxonomic value of different anatomical or physiological characters. The extension of our knowledge of the zoological status of man must now await the accumulation of palæontological data. The existing palæontological evidence of the origin of man is briefly reviewed, and stress is laid on the difficulties of interpretation when only fragmentary fossil remains are available for study. Physical anthropologists in the past have been somewhat too confident in the general inferences which they have drawn from such scanty evidence, and erroneous conclusions have frequently been based on an inadequate appreciation of the great range of variability in fossil and recent man. It is much more difficult than is generally supposed to draw even simple conclusions, such as those regarding sex and race, from the study of the skeleton alone.

The validity of taxonomic characters in the study of racial differentiation demands a careful study, and it is necessary that anthropologists should make more detailed inquiries into the genetic basis of the characters which they commonly use. There is evidence that even the shape of the skull is susceptible to nutritional and other environmental influences. Craniometrical evidence is further complicated by the possibility of parallel mutations, a phenomenon which is well known to occur with other physical traits. Consequently, craniometrical resemblances do not necessarily indicate correspondingly close genetic affinities. It is necessary to endorse the criticism of Prof. R. A. Fisher that, for the study of racial problems, physical anthropologists might more profitably direct their attention to living populations rather than rely on skeletal material, which too often is unsatisfactory and inadequate.

Apart from palæontology, it may be doubted whether physical anthropology as a historical science is likely to advance our knowledge of racial origins and racial differentiation very much beyond its present state with the techniques now commonly used. On the other hand, there are many profitable lines of inquiry which are waiting to be explored in other fields of physical anthropology. Many biological sciences have passed or are passing through what may be termed the 'museum stage' of their development, a stage involving the collection of material in the laboratory, its detailed examination and classification, and the interpretation of the facts which it presents in the form of general hypotheses. To complete its natural metamorphosis, physical anthropology should also now be emerging from the museum stage and developing along experimental lines or along the lines of active observation in the field.

The study of the bodily changes which man has undergone in the past gives a clue to the nature and extent of the changes which may be anticipated in the future. But what is far more important for the same purpose is the study of man as he is to-day. Sociological problems are becoming more and more forced on our attention which demand for their solution a conscious control of processes which have hitherto been left to chance. The improvement of health and physique and their relation to nutritional and climatic factors, the relative importance of hereditary factors in determining the distribution of physical characters, the results of the hybridization of different racial types, the effects on physical type of the redistribution of the populations of the world, the relation of changes in the reproductive rate to human variability and the composition of regional populations, all these are practical problems which can be approached systematically and scientifically only if we have adequate data regarding the physical nature of man in the conditions under which he now lives.

There is little doubt that the physical anthropologist of the future must be essentially a field-worker if he is going to develop his subject along progressive lines. Since, also, physical anthropology is one of the biological sciences, he must be a man of sound general biological training if he is to acquire a real insight into the problems which are set for him.

The science of physical anthropology has already contributed much to the study of the past history of the human species. By the study of modern populations it has a still more important function to fulfil, namely, the accumulation of data on the basis of which it will be possible in some measure to control the destiny of mankind.

The Assessment of Physical Fitness

In the House of Commons on Thursday, July 20, 1939, the Prime Minister said, "I am presenting a very serious argument. What is going to be the result of this increased expectation of life, coupled with the diminution in the birth-rate, which is going on at the same time ? In 1931 the number of persons of 65 years and over was, in proportion to the number of people between 15 and 65—the earning age—as 11 to 100. In 1955 that will have risen to 16 to 100 and in 1975 to 20 to 100. It may be said that that is a long way off and we shall not know anything about it, but surely we ought, if we have a proper sense of responsibility, to consider what is going to be the effect on the next generation of anything that we may be doing to-day. The implication of the figures have given is this : That as time goes on there will be an increasing proportion of the population who will be eligible for pensions and to whom pensions will have to be paid, and there will be a decreasing proportion of the population who will be earning wages and therefore able to make contributions to pay them."

In 1930, after the Contributory Pensions Act was passed, the cost to the Exchequer was £46,000,000. The estimates for the current year showed a charge of £69,000,000, and in the course of the next forty years the estimated annual cost will rise to £115,000,000 at the present rates of payment.

To blacken the picture still further, the only grade of the population that has a high birth-rate is the lowest in the social, economic and biological scale. It is therefore of importance to have some means of carrying out an audit of the physical fitness of the population so as to ensure a rational means of raising the general level of fitness.

Methods of assessing fitness are classified as somatometric, physiological and psychological. In his presidential address to Section I (Physiology), Prof. D. Burns reviewed the various indexes of fitness in general use and dealt with their validity. He restricted his discussion to the testing of subjects apparently healthy from the clinical point of view.

Somatometric assessment *per se* is of very little use as fitness is functional, depending not so much on the structure of the body as on the way it works, and on the speed and accuracy of the various correlations involved in action; and on the determination of the subject to do his best. Tests of cardio-vascular efficiency combined with some form of 'stunt' test may be considered reliable indexes of fitness.

Measurement in Psychology

In his presidential address to Section J (Psychology), Mr. R. J. Bartlett deals with measurement in psychology. In using the measurements of physics to evaluate the objective products of mental activity, psychology finds as an essential feature of its data a scatter which makes statistical treatment of that data necessary. No progress could have been made without accepting what Dr. Darwin, last year, in his presidential address to Section A, called "the fuzziness inherent in absolutely all facts of the world".

Intensity is a characteristic of sensory experience which has occasioned controversy that still leaves divided the committee of Sections A and J set up in 1932 "to consider and report upon the possibility of Quantitative Estimates of Sensory Events". Apparently much of the difficulty arises from confusion of two sources of 'error'. Sensitivity, in its true sense is a 'scatter error', would seem to be slightly superior to the demands of the Weber ratio, $\Delta I/I$, and is not subject to decrease with extreme stimuli. The rapid increase in the Weber ratio, as ordinarily determined, is due to a 'constant error', dependent on a memory factor and causing regression towards accustomed values.

After a review of experimental investigations of reaction times, bodily and mental work, and the physiological concomitants of emotional-conational experience, in which the methods and measurements used are those of physics and physiology, measurements peculiar to psychology are considered. In 1924 a Board of Education report on "Psychological Tests of Educable Capacity" concluded that intelligence tests were of value. The original 54 'manifold and heterogeneous' tests of Binet, compiled in 1905 for the diagnosis of mental deficiency, have become, in the 1937 revision of Terman and Merrill, two sets of 129 tests each, covering mental ages from 2 years to 22 years 10 months and measuring intelligence quotients up to 170 for children and 152 for adults.

Spearman's great contribution to work on intelligence was the introduction of methods of correlation to establish the value of tests. From his work he educed the two factor theory and tetrad criterion—a mathematical method of general application.

Work of the Industrial Health Research Board, the National Institute of Industrial Psychology and other research has given tests for abilities and skills of value in industry and for particular disabilities that unfit for certain occupations. These, as tests for vocational guidance and selection, are being used with increasing frequency.

There follows the measurement of personal attitudes and interests, as in the case of Thurstone and Chave's 'attitude to the Church scale', which enables a person's attitude to be assessed in a scale ranging from enthusiastic support to bitter antagonism. Similar methods have given social maturity scales and enabled a start to be made with the measurement of temperament and character characteristics.

Steady progress made, from measurement of sensory discrimination, through measurement of intelligence and measurement of abilities and skills, to measurement of attitudes and interests and measurement of temperament and character traits, justifies psychologists in expecting yet greater achievements and in not being unduly disturbed by the criticisms of those who continue to hold, with Malebranche, Leibniz and Kant, that psychological data contain nothing 'that can properly be called measurement'.

Interpretation of Plant Structure

Prof. D. Thoday, in his presidential address to Section K (Botany), traces the change of outlook in plant anatomy from the adaptational and the phyletic to the causal and developmental.

Using xerophytes as example, he shows how difficult it is to assess the functional effects of structural features with exactitude. Xerophytes co-existing in the same habitat vary greatly in the efficiency of their structural provision for controlling the loss of water and are not as a class characterized by low rates of transpiration. Contrary to teleological expectation, stomatal frequency is higher in plants growing in exposed places; it is affected by the degree of expansion of leaves, under different conditions, after the stomata have been initiated. Correlations between vascular tissue in leaf and stem, too, require a causal rather than a functional interpretation and point to the influence of one part upon another during development. The discovery of hormones in plants, especially of auxins, which among other effects stimulate cambial activity, justify such an interpretation of structural correlations.

Phyletic studies have had only limited success in the tracing of phylogenies, but have revealed numerous instances of parallel evolution. These direct attention to the nature of major changes, which do not present the haphazard appearance of those which cytology has revealed. It is suggested that, from the lowest chemical plane upwards, the important factors were inherent probability of particular changes, and *selection of harmonious changes*, in dynamic systems. The study of development from a causal point of view may therefore throw light on the nature of the major changes in evolution. The material for comparative morphology consists, not of three-dimensional, but of four-dimensional patterns.

Prof. Thoday then approaches seedling structure from a causal point of view. He suggests that the shoot and root apices, as organizing centres, determine between them the vascular structure of the hypocotyl, the variations observed reflecting different degrees of dominance and extent of influence of one or the other, in different species and at different phases of development. The number of strands of procambium reflects the early influence of the cotyledons, sometimes also of the plumule. Exarch protoxylem, with flanking strands of phloem, reflect the influence of the root, and represent the smallest symmetrical arc-segment of the repetitive root-pattern. Subsequent centrifugal development of xylem shows the increasing influence of the shoot. Adventitious roots, especially polyarch roots of Monocotyledons, and the successful culture of excised root-tips, show that the root apex is self-determining as regards its structural pattern. In dicotyledons, however, no secondary growth is initiated apart from the shoot.

Williams's experiments with rhizophores of Selaginella show that hormones may throw light on morphological problems. While, however, hormones may be agents in the correlation of development, they do not account for the processes that are correlated. By reference to the development of the adhesive disk and haustorium of *Viscum album*, Prof. Thoday emphasizes that differentiation consists in the active response of living cells to various influences, which in this example are largely external, but in ordinary plant organs are mostly internal. Inheritance of structure is thus inheritance of behaviour patterns, the subtlety of which transcends our present conceptions of chemical or structural change in chromosomes.

Education for Industry

In his presidential address to Section L (Education) Dr. A. P. M. Fleming directs attention to the vital part which the manufacturing industries play in the economic life of the nation, and points out that the well-being of these industries depends on the personnel engaged in them, so that the education and training of this personnel is a matter of great national concern.

The function of industry is to transform raw materials into useful commodities, and in both the social and economic sense it is the manufacturer's responsibility to the State to effect this conversion with the minimum of waste of time, effort and materials.

Industry is never static and particularly is influenced by the continual accession of new scientific knowledge. Hence there must be similar mobility as regards the outlook on industrial education.

The education of industrial personnel is considered in relation to two main groups of employees —manual and non-manual workers—and embraces entrants from all educational levels from the elementary school to the university.

In progressive manufacturing concerns it is becoming increasingly the practice—and this applies to all grades of personnel—to seek entrants who have received an appropriate education in fundamentals and to provide the required specialized training during the early years of employment. This practice applies equally to skilled artisans, foremen, supervisors, draughtsmen, designers, salesmen, research workers and those who eventually attain the highest executive positions.

The industrial education of the future must envisage the continual addition of new scientific knowledge, which is the basis of all industrial progress and particularly the development of entirely new industries.

The increasing mechanization of industrial processes and the tendency to reduce hours of labour should enable technical instruction to be given in the daytime and thus eliminate part-time evening technical study, leaving leisure for cultural pursuits and opportunities for increasing physical fitness.

At present the facilities for imparting practical instruction within industry are by no means fully utilized, and there is need in this respect for greater co-operation between industrial concerns. The practical training of industrial personnel is a national service to be conducted irrespective of any narrow commercial considerations.

The raising of the school-leaving age will have the effect of rendering practical training more intensive and will bring into prominence the question of the length of time really required for the effective practical training of every type of industrial personnel. Greater co-operation is needed between industry and education in the matter of providing adequate teaching staffs, notably in connexion with the technical institutions and universities. Post-advanced courses will, to an increasing extent, bridge the gap between the adoption by industry of newly developed scientific processes and the availability of knowledge of such processes in text-books used for the more conventional teaching courses. The extension of scholarships and fellowships to industrial students is desirable, especially those of such character as lead from general education to actual employment in a job after university education has been completed.

Though the importance of education and training of an industrial character is stressed, it is appreciated that all education must be liberal, and even to meet the urgent needs of industry no technical specialization should be permitted which excludes the possibility of time being devoted to broadening the mind in both the mental and the social sense.

Science and Agriculture

SIR THOMAS MIDDLETON, who takes as the subject of his address to Section M (Agriculture) "The Farmer's Position and the Scientific Worker's Programme", refers to the well-known motto of the Royal Agricultural Society of England, "Practice with Science", and contrasts the fortunes of the farmer and the scientific worker a century after the motto was adopted. The progress made by science would cause astonishment to those who chose the motto ; the condition of agriculture would disappoint their hopes. Agriculture's achievements were then judged by the capacity of the country to maintain its people, and the soils of Great Britain supported about seventeen millions. To-day, although no doubt the quality of our farm produce has improved. our soils support some fourteen millions only. Moreover, as is generally known, the difficulties of farmers are so great that even in a year when Parliament has been greatly pressed for time and the Exchequer for money, much time has been given to the discussion of agricultural matters and some money has been spared for assisting the farmer. Aid has been called for since, in the post-War years, rising costs, low wholesale prices and uncertain markets have depleted the farmer's resources to an extent that makes the requisite treatment of the soil impracticable.

References are made to the incomes of arable farmers in north-east Scotland and eastern England which show that, when a moderate interest is paid on capital, the farmer's earnings in recent years have approximated to the wages earned by cowmen and shepherds. In the United States in the early thirties the farmer's earnings did not equal those of his hired men, and similar conditions were faced by farmers in other countries, such as Canada, Holland and Denmark. Poverty among peasants and agricultural labourers has been widespread. A Committee of the International Labour Office has recently shown that in twenty-three countries studied by it an improvement in the condition of land workers was urgently called for.

The reasons for the meagre reward of those engaged in the production of man's primary need are discussed ; some are due to the producer's fellow-countrymen, others to the farmer himself. The nature of the farmer's calling is such that he finds it impossible to equate supply to demand. Thus, as a competitor in the food market, he occupies a weak place and is compelled to accept as remuneration for his work what is left over after others in the food industries have secured a margin which satisfies them.

In the second part of his address Sir Thomas Middleton alludes to the increase in the financial resources of scientific workers in agriculture and claims that this increase is justified because of the value of the work to the nation. The fact that markets may be over-supplied, though unfortunate for the farmer, benefits the public.

In the United States, where surplus commodities created great difficulties for the administration, there was no limitation of scientific work because of surfeited markets ; on the contrary, all available scientific assistance was enlisted in an endeavour to recover from the recent depression. A similar lead has been given by our own forefathers. When, in 1839, Britain had passed through difficulties as great as those recently encountered in the United States, the agricultural leaders of the day took "Practice with Science" for their motto. Since science is incomparably better qualified to help and farmers are far more ready to seek its aid than before, we have now, in facing an uncertain future, reason to do so with the courage, as with the motto, of our ancestors of 1839.

After a brief reference to investigations in progress at some of our agricultural institutions, the subject of food supply in war is discussed. The coming of the aeroplane calls for changes in English farming which would enable food production to be increased rapidly should war break out. Attention is directed to the ease with which production was increased in Scotland in 1917 and 1918 as compared with the very great effort required in England, and it is argued that many English farmers, who now keep their land permanently under grass, should adopt the Scottish system of the temporary ley. The principal change desirable in English methods is thus the change for which Sir George Stapledon argued so strongly in his address to Section M at last year's meeting of the Association. It is a change which, superficially, would appear to be easy. In fact it presents many difficulties which call for careful study, and study from different points of view. Scientific workers in framing their programmes should ask themselves how best they may contribute to a solution of this problem and thereby enable agriculturists to increase food production rapidly should the need arise.

Although all our usual foods would demand attention, the chief effort in war would be to secure an increase of energy-supplying food. At the present time about 70 per cent of our energy supply is imported. Experience in 1914–18 suggests that, farmed as Britain now is, it would be difficult in war to provide more than 35 per cent of our requirements. This was the percentage which the United Kingdom raised at home in the years 1909–13. In 1918, favoured by the season, the figure was raised to 42 per cent, but since that year the area under grass in Great Britain has increased by nearly four million acres, and land under grass is unlikely to provide even one-fifth of the human food produced by cultivated land under cereals and potatoes.

The duration of wars cannot be predicted, nor can we forecast the effect on sea-borne supplies; we should not rely on storage and shipping to supply as much as 65 per cent of the food we should need in a prolonged war. The food production campaign of the future may be required to aim at a six months' supply. Britain now has about 17 million acres under permanent grass; if on four to five million acres of the most suitable land temporary were to replace permanent grass, so as to increase the area of arable land to about 16½ million acres (the area of fifty years ago) and the fertility of this arable land was maintained at a satisfactory level, the production of 50 per cent of our food in war should not prove to be beyond the combined efforts of our farmers and scientific workers.

Local Scientific Societies and the Community

Prof. H. L. Hawkins, in his presidential address to the Conference of Delegates of Corresponding Societies, emphasizes the opportunities for team-work that these societies afford. While the society should not become too parochial in its interests, nor lapse into a picnic-club, its local and social aspects are both essential to its success. Interest, not erudition, should be the criterion of membership.

Much useful work in natural history depends on observation, so that topics accessible to the majority of members will give most satisfaction. A society in a coastal town can study marine conditions that would be outside the scope of one located in a midland city.

Every local society should control the mania for collecting. Great advances in this respect can be recorded; rarities are rarely exterminated to-day in the name of science. But some people still need reminding that it is criminal to celebrate a meeting with a long-sought friend by dragging home his corpse.

Collecting specimens, living or inanimate, dissociates them from their environment. Specimens become curiosities of little value without particulars of the circumstances of their occurrence. For inanimate objects the collector can, if trained to observe, record all the features of their environment that are likely to be significant; but where living things are concerned, an individual cannot deal with all the factors that may have influenced their occurrence. The arrival of a migratory bird may be controlled by the appearance of a particular insect, and this may depend on the growth of some plant the development of which may have been affected by the weather of the previous season. Here is the opportunity for team-work.

Local scientific societies have a splendid opportunity for compiling statistics of transient phenomena. Every recurrent seasonal event invites, and should receive, accurate observation and a permanent record. Each society should encourage its members to keep statistics on all such topics. Large-scale maps for plotting localities, and a card-index for the records, and perhaps a retired business-man to keep order, would soon provide a mine of information packed with unsuspected wealth.

This suggestion may be thought to be concerned more with the relation of a scientific society to science than with its reaction on the community.

Such a view is not only narrow, but also out of date. Prophecy is based on knowledge of past history. The statistics suggested above are the raw material of prophecy. If such truly natural history of a few decades were available, many of the problems that confront every farmer, and so every consumer, would meet at least partial solution.

In these critical times, statistics of the natural resources of the country are being eagerly compiled. There could be no better compilers than local residents trained to observe facts and to tabulate them methodically. Many of the problems involve elaborate technical study; but their fundamental aspects are within the capacity of any reliable observer. All who love their country can find here valuable and congenial work for which the need is urgent.

The number of people in any district likely to join, and work with, a scientific society is small. But the study of natural or human history should develop a philosophical outlook that can supply a tonic for the world, and mitigate the attacks of the flesh and the devil. The mere existence of a body of people that declares its interest in matters bigger than political squabbles, preferring wider vistas than those of the daily headline, should ensure a nucleus of stability in the quicksands of suspicion and opportunism where civilization is floundering.

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