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Man and Machine.

IN his presidential address to the British Association two years ago, H.R.H. the Prince of Wales gave a comprehensive and illuminating account of the various ways in which the aid of science was being invoked and encouraged to assist in the solution of the industrial and social problems confronting the nation. Not less important are the problems which the advance and application of science are creating in every sphere of national activity. Of fundamental importance is the effect which science is producing in craftsmanship ; and it is peculiarly fitting that this should have been made the theme of the address in Glasgow of this year's president, Sir William Bragg, a consummate artist in a craft of his own creation, of which he is the greatest exponent. The address itself is printed in full in our Supplement (p. 353).

Craftsmanship is the quintessence of happy toil. In its highest form it is the greatest contribution which the individual can make to the happiness of the community. It is at once a wonder, a joy, and an inspiration to others. The elements of which fine craftsmanship is compounded are, as defined by Sir William Bragg, knowledge of materials, imagination, technical skill, perseverance, love of the work itself, sympathy with the use that is to be made of it, and with the user. Thus defined, craftsmanship is identical with citizenship at its best, an identity so aptly emphasised in the address : "The craftsmanship of a nation is its very life . . . the state of a nation's craftsmanship is an index of its national health." It should be the high purpose of a community to conserve its craftsmanship by encouraging the progressive modification of traditional crafts and the creation of new ones, and strive by all means at its command for the preservation against the onslaught of mass production, of beauty in its utilities. The contentment of the user is probably less important than the satisfaction of the maker.

There is a tendency on the part of some people to attribute all the ugliness of present-day life to the advance of science and invention, to regard every fresh application of the genius of man with misgiving as adding to the complexity—and perplexity—of existence. The progressive elimination of starvation, famine, pestilence, the satisfaction of the growing needs of rapidly increasing numbers of people, coupled with their increased leisure and ministration to that leisure, the enlargement of man's intellectual horizon, all of which have been made possible by the new crafts called into being by science, are discounted by these regretful obscurantists. It is well for them to be reminded that science can rediscover for mankind most of the beauties of the past, can enable the skill of bygone craftsmen to be regained and even surpassed, at the same time providing man with new outlets for the exercise of his imagination, instinct for adventure, love of beauty, and technical skill.

We are at present, and have been for a century, passing through a transitional stage, the difficulties of transition heightened by the inability or unwillingness of society to adjust its social, political, and economic institutions, and its outlook generally, to meet without catastrophic shock the successive impacts of science on life. We are still far from achieving understanding of the environment which science has created.

Our outlook on craftsmanship is still essentially conservative. We still incline to regard it in its application to time-honoured occupations, forgetful of the fact that, in most of these, modern methods of production no longer provide scope for the exercise of much creative imagination on the part of the workers engaged in them, that the real craftsman in mass production is the individual who creates the machine, and not the operator, that in few of the old crafts has the individual craftsman survived, or if he has survived, his survival is an anachronism. Sentimental regrets for the passing of the single-handed craftsman in the production of utilities are vain. Modern craftsmanship in industry is the outcome of association, in which many minds and "many hands working in an alliance which is often unconscious, are employed in bringing a product to its finished form." It is true that the machine-made product may not always attain the same perfection as the product of the skilled individual craftsman, but the remedy is to be found in a more perfect machine—mastery over new means of production rather than dependence on the old. As Sir William Bragg says: "Let us try in all possible ways to mend its hardships, but in all honesty let us recognise that we live on modern craftsmanship in its modern form."

To us as a nation of craftsmen there are disadvantages attached to the perfection of the machine. Usually, the more perfect it is, the less intelligence is needed for its operation. The transference of a skilled machine to another country is a simpler matter than the transference of skilled craftsmen, and may lead to the partial transference of an industry to other countries where labour is cheaper, markets just as accessible, and the raw materials of manufacture nearer at hand. The cotton industry is a case in point. Again, the invention of a machine for mass production may result in large numbers of skilled workers being suddenly cut off from their customary means of livelihood, with consequent loss of individual skill. For the first, it is no remedy to reduce the standard of living of the operatives, say, of Lancashire, to that of Indian or Chinese operatives. There should be no room among an educated community for productive processes calling for little intelligence in their working.

The remedy for the first, as for the second, situation is to be found in the full utilisation of the skill of the displaced operatives on new processes, new machines, and in entirely new industries. It is true this postulates a new orientation of outlook in industry for employers and employed, but the nation should profit by it: the old static conceptions of industry and industrial relationships have stood too long in the way of their rationalisation.

The eloquent tribute which Sir William Bragg paid to the qualities characterising our craftsmen, not the least important of which are pride in their work and their adaptability to changing conditions, was well deserved. The obstacle to industrial progress is to be found not among them but in out-worn policy, the incapacity of those who shape it to do more than frame panic measures for the protection of threatened industries, instead of concentrating upon those which, by putting the greatest strain upon our resources of knowledge, ingenuity, and skill, quicken the national intelligence, and thereby enable us to stand pre-eminent by virtue of our capacity to assimilate and apply scientific knowledge, new ideas, new processes, and to devise new machines. "The most active of our modern industries are those which are founded on recent scientific research." The only hope for older industries to gain their former position in the world is for their leaders to encourage and to look to scientific research for salvation and to comply with its precepts, even if this involves the ruthless scrapping of antiquated plant and the adoption of entirely new methods of production.

Not less important than the change from single-handed to associative craftsmanship which science has effected, and the consequent changes which this has involved in industrial organisation, is the introduction of a new factor in industry, namely, university-trained scientific research workers. The social and political significance of this introduction of scientific workers into industry is apt to be disregarded, so that it is particularly pleasing to find that Sir William Bragg's address deals with the influence which they can be expected to exert, not merely by bringing scientific knowledge and infusing a scientific spirit into craftsmanship, but also, what is of even greater importance, by bridging that dangerous gulf which has been ever widening between so-called capital and labour. "They can speak with the employer as men also trained in university and college, exchanging thought with ease and accuracy, and at the same time they are fellow-workers with those in the shops, and can bring back there some of the interest and enthusiasm which springs from the understanding of purposes and methods." By bringing the interest and outlook of scientific inquiry into touch with both employer and employed, they may prove to be the flux that will make them run together.

It is not a polite exaggeration to assert that the country should be grateful to Sir William Bragg, not only for choosing for his presidential address a subject which exercises so many minds to-day, but also for the way in which he has raised it above the level of the factious controversy, and for the hope which it inspires. The feat is the more remarkable because he shirks none of the issues involved. Fortunately, the attitude of the press towards the British Association meeting ensures the dissemination of his views among millions of our countrymen.

Scientific Calvinism.

William Bateson, F.R.S., Naturalist: his Essays and Addresses; together with a Short Account of his Life. By Beatrice Bateson. Pp. ix + 473 + 4 plates. (Cambridge: At the University Press, 1928.) 21*s*. net.

THE book before us falls into three parts. The memoir is followed by twenty-two essays, which for various reasons are not to be included in Bateson's collected scientific papers. Some of these, such as the lecture to the Royal Horticultural Society, which contains the first English account of Mendelism, are mainly of interest from the historical point of view, as illustrating the growth of the science of genetics, and of Bateson's own ideas. Others, in particular his Herbert Spencer lecture on "Biological Fact and the Structure of Society," contain his views on social problems.

The memoir shows us a man who must have impressed his contemporaries even had he never made any serious contributions to knowledge. He formed definite opinions on a number of subjects, from the Sistine Madonna and compulsory Greek to nationalism and natural selection. But the processes by which he arrived at them make it clear that he was one of those radically abnormal phenomena, men who think for themselves. Hence, the life and letters are worth reading, not only by those who knew Bateson himself, or wish to follow the history of genetics, but also by all who desire to study the workings of a certain type of scientific mind. Even in his scientific writings, and still more markedly in his correspondence, Bateson was never afraid of 'thinking aloud.' Some of his ideas have not found any application, some perhaps never will, but others may yet be developed. In particular, no biologist who is interested in the problem of periodic structure, whether it be the segmentation of an arthropod or the striping of a zebra, can afford to neglect his point of view on this subject.

Bateson was of course in advance of his time with regard both to teaching and research. His applications for the chairs of zoology at Oxford and Cambridge (neither successful) contain programmes of study which are to some extent being adopted at the present time. He had the utmost difficulty in obtaining any facilities for research in genetics, and was only able to carry on at a critical period by means of private benefactions. Even NATURE on more than one occasion refused him publication! If we are to measure his success by the impression which he made on his compatriots, Bateson was a failure. In spite of the fact that the British Empire produces more animal and vegetable products than any other state, it boasts of exactly two professors of genetics at the present day, and the geneticists of the U.S.A. and U.S.S.R. are undertaking programmes of research beyond the resources of any British institution, programmes in which Bateson's personal influence can often be traced.

The first two of the addresses show how Bateson came to take up Mendelism. In 1899 he was speaking to the Royal Horticultural Society from his own experience on the effects of crossing various types of plants and poultry. He pointed out the universal occurrence of discontinuous variation as the result of such crossing, and described a case of what is now called dominance. In 1900 he was to read another paper to the same Society on "Problems of Heredity as a Subject for Horticultural Investigation." In the train to London he first read Mendel's paper on inheritance in peas. So completely did it fit in with his own experience and deductions that he incorporated an account of it into his lecture, which is reproduced in the present volume.

In a number of other papers, including the famous 1914 presidential addresses to the British Association in Australia, and an unpublished lecture on "Gamete and Zygote," we can follow the development of his genetical ideas. But to the reviewer at least, the most interesting essays in the book are those in which he allowed himself to apply his biological ideas to human problems. For he had little sympathy for any but a scientific approach. "Religion, politics and law he mistrusted and disliked; to him they seemed systems of cumbersome intrigue menacing human progress and content." He regarded democracy as based on a fallacy, and socialism as probably impracticable, but he hoped for the coming of a world state and considered the present social order to be both evil and unstable. So very few of us are likely to find support in his writings for our own political views.

The foundation of Bateson's social philosophy was the innate inequality of man. A Scottish soldier, who heard one of his lectures during the War, said, "Sir, what ye're telling us is nothing but Scientific Calvinism," and he had considered the possibility of publishing some of these essays under that title. But he did not, like Calvin and many eugenists to-day, regard a large section of the human race as damnable. He could not sympathise with Galton's condemnation of 'Bohemian' habits ingrained in the nature of certain men. He was inclined to believe that susceptibility to tuberculosis and insanity might be associated with genius, and, therefore, hesitated as to whether such conditions should be discouraged, though he had of course no doubt that the feeble-minded should be segregated. On the whole, he welcomed human diversity in the spirit of the fancier or the dramatist, and he based his social philosophy on its recognition.

When politicians have learnt the elements of biology, which, as Bateson realised, is likely to occur elsewhere before it takes place in Britain, they will attempt to put into practice some of the ideas adumbrated in "Biological Fact and the Structure of Society." They are beginning to realise the evils of an increasing population, and of a criminal law based on the theory that crime calls for punishment rather than treatment. But many of them still hold to the view that equality of opportunity and universal education will lead to equality in other respects, rather than to an intenser social stratification. Bateson's ideal State was stratified, but stratified on grounds of innate differences rather than of ancestry or wealth. Similarly, he deprecated a general code of morals for so polymorphic a species as man, and looked to science for salvation from such codes. "Science knows nothing of sin save by its evil consequence. . . . As science strengthens our hold on nature, more and more will men be able to annul the evil consequences of sin. Little by little the law will lapse into oblivion, and the sins which it created will be sins no more."

In order that the rulers of the country should be at least aware of the scientific view, he was deeply interested in any reforms in the educational system which might achieve that end. He was not very sanguine as to its possibility, and he defended the classics to the last. But he regarded biology and geography as the proper approaches to physics and chemistry, and the reading of ancient authors with a translation as the proper approach to grammar. Hence the present type of scientific teaching current in schools was as little to his liking as that of classics. The reviewer at least can sympathise with his plea that much school laboratory work too often consists of slavishly verifying what has already been verified repeatedly, and that a few lessons in the use of indexes and books of reference would be far more valuable.

Characteristically enough, the book ends with a list of controversies in which Bateson was engaged. His views on most topics were controversial, and for that reason no one can read his essays without being stimulated, for it would, we think, be impossible to find anyone who agreed with him on all points. Nor would he, with his love of human diversity, have expected such agreement. He was often pessimistic of the immediate future, and some of his opinions are perhaps unlikely to stand the test of time, but the premises from which they were deduced are those with which the majority of scientific men would agree, though few could express them so well.

"The one reasonable aim of man is that life shall be made as happy as it can be made, with as much as possible of joy, and as little as possible of pain. There is only one way of attaining that aim: the pursuit of natural knowledge. We are all citizens of one little planet. We are, as it were, a ship's company marooned on an unknown and mysterious island. There is no time to quarrel about our origins. We have food to find and shelter to prepare. Of what that island may provide for our comfort we know still very little. Let us in peace explore the place. It is full of wonderful things, and for aught we know we may yet find the elixir of life."

J. B. S. H.

The Scientific Study of Populations.

(1) *The Human Habitat.* By Ellsworth Huntington. (Library of Modern Sciences.) Pp. xii + 293 + 27 plates. (London: Chapman and Hall, Ltd., 1928.) 15*s.* net.

(2) *The Builders of America.* By Ellsworth Huntington and Leon F. Whitney. Pp. xv + 368 + 4 plates. (London: Chapman and Hall, Ltd., 1928.) 16*s.* net.

(3) *Human Migration and the Future: a Study of the Causes, Effects, and Control of Emigration.* By Prof. J. W. Gregory. Pp. 218 + 4 plates. (London: Seeley, Service and Co., Ltd., 1928.) 12*s.* 6*d.* net.

DR. HUNTINGTON and Prof. Gregory have no little in common. They are both men of science, one a geographer and the other a geologist. They have travelled widely; they are profoundly interested in broad human problems, and are not afraid to go outside the narrow range of technical studies, and upon the basis of their knowledge and experience to discuss social and political questions of the day. In so doing they have sometimes exposed themselves to criticism, but we may be grateful to them, since in general it is more to be desired that men of science should attempt to draw wide lessons from the results of their research than that those without scientific training should do so.

(1) In "The Human Habitat," Dr. Huntington returns to a favourite theme—the influence of climate upon the course of civilisation. He is, as always, interesting and stimulating. He adds little to the scientific foundation, but he works out his views in new and ingenious ways. The cautious reader, while ready to admit that there is no doubt something, and possibly much, in the theory, will probably remark upon the slender amount of evidence at present available in support of the two fundamental notions. These are that all races exhibit maximum activity in a certain climate characterised by frequent variations of temperature and humidity within fairly narrow limits, and that the zone exhibiting this climate has shifted. The latter conception is necessary to explain the fact that the earlier civilisations arose in latitudes where the more progressive peoples no longer dwell.

Dr. Huntington shows some signs of yielding to the temptation to leave the troublesome task of testing these foundations by further research, and to devote himself to the pleasant pastime of speculating about the course of civilisation on the assumption that they are true. This tendency to push speculation beyond limits that are profitable is evident when he brings in biological selection as an adjunct to the theory. He speaks of famines in China, and assumes that the sequence of events is as follows. The inhabitants of the stricken district leave it. Later, the poorest and least efficient return. Not all the competent return, because many of them will have found occupations in towns. Therefore the inhabitants of the district are less well endowed biologically after than before the famine.

There seems to be no evidence whatever that this does in fact happen. It would appear to be quite as reasonable to suppose that the more competent and fearless would tend to return, and that the population would be better rather than worse as a result. What is required is more support for the fundamental conceptions and well-attested evidence as to what does take place, whether in regard to mental and physical activities in different latitudes or in regard to the working of selection in various circumstances.

(2) It would seem that Mr. Whitney had prepared a draft of a popular book on eugenics when he had the good fortune to persuade Dr. Huntington to collaborate, with the result that they produced a work that no one interested in the subject can neglect. The book does not begin in a promising fashion. Certain assumptions commonly made by writers on eugenics which can be severely criticised are uncritically accepted. Later, however, the results of original studies of the American "Who's Who" and of the records of college students are given, which are of no little interest. Unfortunately, the data are not presented in full, and the methods employed in their treatment are not adequately explained. Therefore it is impossible to arrive at any definite opinion as to the importance to attribute to them.

Nevertheless, many of the results which the authors claim to have reached are very suggestive. Thus they state that, among the men who have reached a standing admitting them to "Who's Who," those with the best education leave most descendants, whereas among the women the position is the contrary. The result for men is unexpected. They find a considerably higher fertility among ministers of denominations where a system of family endowment has long been in vogue than among ministers of other denominations. Still more interesting is the evidence that within any group of those following a profession or calling, it is the most valuable who have the largest families.

They believe this to be well substantiated, and to be a favourable aspect of the differential birth-rate. The differential birth-rate may work adversely as between social classes, but favourably within social classes. It is a pity that the evidence for these and other interesting results is not given more fully.

(3) Prof. Gregory has followed up his study of racial problems by a survey of migration. His work is distinguished by scientific detachment, which does not, however, prevent him from seeing the human aspect of the problem. He may be said to have a world outlook. He does not emphasise either emigration or immigration at the expense of the other. It would be possible to debate his views on many of the issues raised. His attitude in regard to the relation between over-population and unemployment in Great Britain might be severely criticised. His estimate of two and a quarter million surplus population seems quite arbitrary. But the value of the book does not lie in its contributions to specific issues. It is valuable because it is a serious attempt to take into account the geographical, biological, and economic considerations which are relevant to a problem which may well prove to be the next test of the world's capacity for statesmanship.

There is no country which is not interested in this matter from one aspect or another. Already the encouragement given by some countries to movement, and the restrictions placed by other countries upon movement, whether inwards or outwards, are potential causes of serious international friction. The future alone can tell whether the nations of the world can rise above narrow and selfish considerations and show some regard for the general welfare. They will only do so if their leaders learn to adopt Prof. Gregory's attitude, whether or not they adopt his conclusions.

A. M. C.-S.

The Milky Way.

A Photographic Atlas of Selected Regions of the Milky Way. By Prof. Edward Emerson Barnard. Edited by Edwin B. Frost and Mary R. Calvert. Part 1: *Photographs and Descriptions.* Pp. vi + 134 + 53 plates. Part 2: *Charts and Tables.* Pp. iv + 52 + 50 tables + 50 charts. (Washington, D.C.: Carnegie Institution, 1927.)

THIS beautiful atlas contains fifty photographs of Milky Way regions taken by Prof. E. E. Barnard with the Bruce telescope of the Yerkes Observatory about twenty years ago. A grant for its publication was made by the Carnegie Institution of Washington so long ago as 1907, and the delay in its appearance is due to Barnard being for some years after that date engaged on the reproduction of his earlier photographs of the Milky Way and of Comets, which form Vol. 11 of the *Publications of the Lick Observatory*; and to the fact that with such a devoted and assiduous observer the making of observations always had prior claim to the publication of results. That such was so is indeed fortunate for astronomy, as there have been very few observers so skilful as he, and what little has been lost owing to lateness in publication is a small price to pay for the continuation of his observational work. Thus the great observer died five years before the publication of this atlas, and it appears ably edited by Prof. Edwin B. Frost and Miss R. Calvert, the latter of whom assisted Prof. Barnard with it during his lifetime. Most of the details of the form of publication had been settled, and the descriptions of the fields written, by Barnard himself.

Many of the regions are the same as those which Barnard had already photographed at the Lick Observatory, and appear in the volume referred to above. A comparison at once shows the superiority both of the Bruce telescope over the Willard lens and of the direct method of reproduction employed in the atlas under review over the collotype in the Lick volume. The Bruce telescope has two photographic lenses of the doublet type of 10 in. and 6½ in. aperture. It belongs to, and is normally stationed at, the Yerkes Observatory, but forty of the fifty photographs reproduced in the "Atlas" were made during the spring and summer months of 1905, when Barnard transported the telescope to Mount Wilson to take advantage of the clearer atmosphere and lower latitude. It is not stated which lens was employed for the photographs reproduced, but presumably it was in most cases the 10-inch. The definition is excellent over a field of seven or eight degrees in diameter.

Over the ever difficult question of how best to reproduce the delicate detail of celestial photographs, Barnard spent considerable time. He was not satisfied with the uniformity of the collotype process, and finally decided on direct photographic prints from negative copies of the originals, in the hope that with sufficient precautions in the photographic processes the prints would be reasonably permanent. The result is a volume of photographs which for beauty and faithfulness in the delineation of detail far surpasses anything of its kind that has yet been produced.

The "Atlas" contains photographs of 'selected' regions of the Milky Way, and the great majority of these are naturally clustered round galactic longitude 330°, the portion of the galaxy most rich in interest, in the constellations of Ophiuchus, Scorpius, and Sagittarius. Opposite each photograph is a detailed description of the field; and in the companion volume there is for each field a chart in which are shown the B.D. stars and principal nebulæ, clusters and dark markings, and an accompanying table giving the positions of these objects and other details. It is a little unfortunate that the positions are referred to such an obsolete epoch as 1875. The division, however, into two volumes, enabling photograph, description, chart, and table to be consulted simultaneously, is an immense convenience. It is futile to attempt to describe the photographs; suffice it to say that the dark markings in all their gradation of intensity and intricacy of outline are most faithfully reproduced. The lack of uniformity in the blackness in these photographs of many of the dark markings at once suggests their true cause; that they are obscuring clouds and not holes, as was at first thought. To Barnard we owe most of our knowledge of these markings, and it is therefore appropriate that there should be included in this volume a "Catalogue of 349 Dark Objects in the Sky." The first part of this list was published by Barnard several years ago, and the greater part of the remaining objects were selected by him personally.

There remains to be mentioned the introduction. This appears in the first person as from the pen of Barnard himself, it having been compiled from notes that he put down for this purpose over a period of ten or more years, and from extracts from his published papers. It contains a description of the Bruce telescope, some general remarks on the Milky Way, in particular on its naked-eye aspect, and notes on the preparation of the "Atlas." It ends with a useful bibliography of Barnard's papers on cognate subjects.

Everyone connected with the production of this "Atlas" is to be congratulated. It is a delight to behold and to handle, and forms a fitting memorial to the great observer who planned it. A glance at the striking portrait forming the frontispiece will suggest why anything less noble would have been inadequate.

H. K.-S.

Our Bookshelf.

Evolution and the Spirit of Man: being an Indication of some Paths leading to the Reconquest of the 'Eternal Values' through the Present Knowledge of Nature. By Dr. J. Parton Milum. Pp. 228. (London: The Epworth Press, 1928.) 7*s*. 6*d*. net.

THE subject of this work is "the significance of the evolutionary world view for man himself," and the writer's endeavour is "to re-read the facts of scientific research in the spheres of biology, geology, anthropology, and psychology." The task seems an ambitious one, but it has to be done over and over again unless we are to be submerged by a continually increasing flood of uncorrelated facts. Men of science are often impatient of such attempts, partly because they themselves are interested in particular problems of research, partly because the limitations of their own outlook are apt to be emphasised in these attempts at a synoptic view. Nevertheless, we can imagine a student of any of the natural sciences reading this book with both interest and enthusiasm. It displays not only a remarkable acquaintance with recent research and theory, but also vigorous powers of comprehension, and genuine fertility of speculative resource. The book, in a word, is original and will repay careful study.

It is probable that many readers will find that the anthropological sections interest them most. Dr. Milum regards man as a mutation, and has no belief in any intermediate species such as the brute-man, dear to Freudian psychologists and popular encyclopædists. He is disposed to think that the rigours of the Great Ice Age effected the provocative crisis of the origin of our species. He does not consider that since the Stone Age there has been much in the way of increase of natural intellectual capacity; accumulation of knowledge is not the same thing. He takes the line adopted by the Rivers–Elliot Smith–Perry school, that modern savages are degenerates, not, in the true sense, primitive men; and with regard to civilisation, he regards it as a cultural tradition (not primarily racial) developed by creative individuals, inspired by ideas, and overwhelmed from time to time by barbarians from without or within. There is an especially interesting section upon the relations of the pastoral age of culture to the development of religion, particularly of Christianity. Religious teachers, as well as students of science, would do well to read this excellent book. J. C. H.

The Naron: a Bushman Tribe of the Central Kalahari. By D. F. Bleek. (University of Cape Town: Publications of the School of African Life and Language.) Pp. ix + 67. (Cambridge: At the University Press, 1928.) 6*s*. net.

THE School of African Life and Language of the University of Cape Town is to be congratulated on having attained the dignity of a series of publications, even if, owing to scarcity of funds, it has been possible to attempt nothing elaborate in form. That, however, is a matter of little moment if the standard of quality continues to be as high as that attained by the first issue. This is a study of the Naron, by Miss D. F. Bleek, the lecturer on Bushman languages in the University.

The Naron are a Bushman tribe of Sandfontein, whose language is closely allied to that of the Nama, and clearly differentiated from those of the tribes whom Miss Bleek calls the Northern and Southern groups, their languages being related but only distantly. The investigation was undertaken at the request of the Government of the South-West Protectorate — an encouraging sign — and the material was gathered on two separate visits. It was fortunate that Miss Bleek was able to pay a second visit, for it was only as her acquaintance with the people grew that they became really confidential — an essential condition of success. It is clear from the analysis of their religious beliefs that nothing but an intimate acquaintance, such as Miss Bleek attained, could avail to disentangle the elements of their religion. They show unmistakable evidence of Hottentot, and possibly of Bantu, influence. Miss Bleek herself thinks that their oldest religion is a worship of the moon. There can be little doubt that this is correct.

A Theory of the Solar System. By Percy John Harwood. Part 1. Pp. iii + 94. 10*s*. Part 2. Pp. ii + 64. 5*s*. (Brighton: The Author, Endersby, Ainsworth Avenue, Ovingdean, 1928.)

THIS work is of the type that in some libraries is politely classified as 'paradoxical science.' Among the author's special contributions to the theory of the solar system is the hypothesis that magnetic fields, of the sun, planets, and comets, play a large part in determining the motions of these heavenly bodies; for example, he concludes that "a magnetic cause rather than gravity underlies precessional movement and change of axial inclination" of the earth (p. 66). Again, "The spheroidal forms of sun and planets may be largely due to the magnetic 'globe' that helps to hold them together. Maybe the oblateness of the forms of Saturn and Jupiter is not due entirely to their rapid rotations, but also to the oblate form of a magnetic field on which their highly vaporized and ionized constituents are hung" (p. 19). Another example of the style may be quoted: "With the idea of the sun as an organic unity in view, so that no strong character in his nature is separate in itself but derives its sustenance from the contributions of service extended to it by other members in its body, as they likewise depend on it, the sun as magnet may for the time being be left, to consider what other agencies are operating in this Great Builder of energetic forms" (p. 21). The work, like most of its class, is the product of earnest and industrious labour on a large mass of undigested scientific reading, on which imagination has been allowed to play, unbridled by any attempt at quantitative estimation. The second volume is of a semi-metaphysical character.

Die Vegetation der Schweiz. Von Prof. Dr. H. Brockmann-Jerosch. Zweite Lieferung. (Pflanzengeographische Kommission der Schweizerischen Naturforschenden Gesellschaft, Beiträge zur geobotanischen Landesaufnahme, Heft 12.) Pp. 161-288. (Bern: Hans Huber, 1927.) 9 Schw. francs.

THIS is the second section of a work to be completed in four parts. It continues the detailed consideration of the environmental factors affecting vegetation in Switzerland. The details concerning rainfall are completed, and a full account is given of snowfall, snow-covering, dew and hoar-frost, hail, and lightning as they influence the structure and development of plant-life. The factor of temperature is introduced, but the account is incomplete in this part. A compound graph illustrates the alterations in the snow-lines at various stations in the Jura and the Alps throughout the year. An instructive and well-printed coloured map indicates the distribution of the chief kinds of vegetation and types of human exploitation of plant-life in the country. A full discussion of the value of this work must be left until it is complete.

Nova Francia: a Description of Acadia, 1606. By Marc Lescarbot. Translated by P. Erondelle, 1609. (The Broadway Travellers, edited by Sir E. Denison Ross and Eileen Power.) Pp. xxxi + 346. (London: George Routledge and Sons, Ltd., 1928.) 12*s*. 6*d*. net.

LESCARBOT'S "Histoire de la Nouvelle France," published in 1609, was based on a year's personal visit and long business relations, for Lescarbot was a lawyer with one of Sieur de Mont's chief lieutenants at Port Royal. An abridged form of the English translation, which did not include the whole work, appeared in "Purchas His Pilgrimes," 1625. The translation was reprinted in 1745 in the Harleian collection, and again two years later. Since then it has not been reissued until the appearance of this volume. The descriptions of the Indians and of early French life in Canada are full and vivid, and give one of the best pictures existing of Acadia in the seventeenth century. The volume is a useful addition to the excellent series of old travel-books in which it appears.

Tidal Research: the Adaptation of Sir Isaac Newton's Tidal Laws to the Prediction of the Height of High Tides; being an Examination of the Cause of the High Tides at Milford Haven, and their Application to the Heights of the related High Tides at Southampton (1st H.W.), Liverpool, London Bridge (Old Swan Pier), and Southampton (2nd H.W.); the patient collection of Physical Facts by which other Facts are Revealed. By Comdr. John A. Rupert-Jones. Pp. 20. (Southampton: The Author, 57 Westwood Road, 1928.) 5*s*.

THE author claims to deduce the height of high water at Milford Haven by considering the *actual* distance of the moon from that port, to which end a table is provided giving this distance. A comparison is made between the calculated and observed heights.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Constitution of Zinc.

THAT zinc was a complex element was demonstrated by Dempster using the method of analysis associated with his name. From the curves published in 1922, he came to the conclusion that the element contained three strong isotopes, 64, 66, 68, in descending order of abundance, and one faint one, 70. A kink in the curves at 67 suggested that this mass number was also probably present. Many attempts were made to check these conclusions by means of the mass-spectrograph, but in no case could the mass lines of zinc be obtained either by the discharge in zinc methyl or by accelerated anode rays.

Following my recent success with germanium, and using the same setting of the discharge tube, I have now obtained satisfactory results from zinc methyl which are in striking agreement with the conclusions of Dempster and disclose two additional components. The mass-spectra indicate that zinc consists of seven isotopes 64 (*a*), 65 (*e*), 66 (*b*), 67 (*d*), 68 (*c*), 69 (*g*), 70 (*f*). The letters in brackets indicate the order of intensity. Three of these mass-numbers, 65, 69, 70, are isobaric with those of copper, gallium, and germanium respectively.

F. W. ASTON.
Cavendish Laboratory,
Cambridge, Aug. 22.

Corpuscular Theory.

G. L. LE SAGE, of Geneva, devoted the best part of his life to a theory of the mechanism of gravity. It appeared in the Transactions of the Berlin Academy in 1782. The fullest account of his theory was published by Pierre Prevost, as editor, in 1818 ("Deux traités de physique méchanique"). The general idea of the theory is that ultramundane corpuscles are flying through space in all directions with great velocity; that they collide with the atoms of mundane matter; and that in consequence they issue from the sun or a planet with less velocity than that with which they entered it. Thus the atoms of the moon are bombarded by corpuscles from all directions equally, except that those coming from the earth have a smaller velocity and, in consequence, the moon is driven towards the earth by the force called gravitation.

This is almost the only mechanical theory that contains the elements essential to a true theory. One other theory of gravitation also fulfilling that condition is founded upon Prof. Frederick Guthrie's experiment on the attraction of a balloon by a vibrating tuning-fork. This experiment was extended by Bjerknes, theoretically and experimentally, to the reactions of vibrating drums in a tank of liquid; and was discussed further by Lorentz.

On Dec. 18, 1871, Lord Kelvin (then Prof. Sir W. Thomson) communicated to the Royal Society of Edinburgh a paper "On the Ultramundane Corpuscles of Le Sage." The theory advanced by Le Sage is there described in great detail. The abstract of this paper occupies about 13 pp. of the *Proceedings* of the Society. The object of the paper was to remove some objections that might be raised to the theory of Le Sage. Lord Kelvin suggested also that the energy of translation lost by corpuscles in collision with atoms might be converted into vibrations, or vibrations and rotations. In this way the excessive rise of temperature in a planet penetrated by corpuscles might be reduced. Clerk Maxwell criticised this. Much later, however, Sir J. J. Thomson expressed the opinion that the kinetic energy might be converted, not into heat but "into the energy of a still more penetrating form of radiation which might escape from the gravitating body without heating it." He added: "It is a very interesting result that the machinery which Le Sage introduced for the purpose of his theory has a very close analogy with things for which now we have direct experimental evidence."

I was present at the reading of Kelvin's paper in 1871. I regret that his abstract gives no account of the nature of corpuscles and atoms which he then described. Atoms were vortex rings, and corpuscles were vortices like a serpent, in which the inside is ejected at its mouth, passes outside, and enters at its tail.

Some years later Aitken exhibited his remarkable experiments on the rigidity of endless chains in rapid motion along the tangent to the curve of the chain (*Phil. Mag.*, 1876 (?)). It then appeared that the vortex filaments in Kelvin's corpuscle would behave in the same way; and that these corpuscles might form the basis of a corpuscular theory of light.

On Aug. 15, 1878, at the Dublin meeting of the British Association, I read a paper on the "Mutual Action of Vortex Atoms and Ultramundane Corpuscles" (*q.v.*), wherein I explained the radiation, propagation and absorption of light. Each corpuscle when passing a vibrating atom would have kinks or saw-teeth impressed on its surface along its whole length. Aitken's results led me to infer that these saw-teeth would remain fixed in position, and would not travel along the vortex-filament. While travelling through space the toothed corpuscle may encounter an atom of the same frequency of vibration as the original radiator. In that case the saw-teeth must set the atom into vibration. Thus is radiation and absorption explained.

That paper may perhaps now, fifty years later, be useful as a suggestion to present-day workers. That paper to the British Association concluded with these words: "The question naturally arises, Can this action be the keystone to a new theory of light? Can the phenomena of reflection, refraction, interference, diffraction, and polarisation be explained by this kind of action? In answer to these questions it can at present only be said that the germs of a complete theory of light do exist in this speculation."

I did not publish anything more on the subject. To-day, however, I will say what was meant by the last sentence. *Plane Polarisation* occurs when the corpuscles have saw-teeth only on opposite sides, and not all round them. Refraction is more difficult to explain. *Interference* and *Diffraction* follow, exactly as in the wave-theory, if corpuscles flying in all directions rob other corpuscles of their saw-teeth and carry them on. The saw-teeth form wave-fronts as in the wave-theory; and these can only be propagated in a direction perpendicular to the wave-front. Diffraction and interference can then be calculated by mathematical formulæ, which are precisely the same as we use in explaining the same phenomena by the wave-theory.

Perhaps these considerations may be of use to-day. My reasons for saying this are that they seem to form a physical basis for quanta, for Einstein's (1905) photoelectric theory, and for the heat of stars, and also for Eddington's law of the mass-luminosity of stars.

Quanta.—The kinks, or saw-teeth, carried off by a corpuscle from a vibrating atom do not penetrate far below the surface of the corpuscle, and the feeblest radiation from an atom more than fills the capacity of the corpuscle. A vast number of corpuscles or quanta are required to carry off all the radiation-energy of an atom.

Source of Stellar Heat.—The best that can be done, by any hypothesis like those suggested by Kelvin and J. J. Thomson, for preventing the superheating of a star by the shock of Le Sage's gravity-corpuscles, leaves a certain residuum of heat due to corpuscular collisions. This may solve the present-day astronomical puzzle as to the source of the sun's heat.

Mass-luminosity Law.—If the heat of stars depend on collisions with ultramundane corpuscles, a star's temperature would be greater for the more massive star, and Eddington's law might follow.

Millikan's Rays might actually have been thought to be these corpuscles when their existence was first demonstrated. The laws that were found to govern them, however, do not seem to favour such an hypothesis.

GEORGE FORBES.
The Shed, Pitlochry.

The Fine Structure of Wool.

EXPERIMENTS were begun some eighteen months ago to determine the fine structure of wool by X-ray analysis with the object of attempting to explain its elastic properties. Some intimation of the earlier results was given at the discussion on the properties of colloids at the Leeds meeting of the British Association in 1927. The experiments have now reached the stage where it seems possible to draw some important conclusions.

The wool chosen in the first instance was a Cotswold wool purified by extraction with alcohol and ether in succession in a Soxhlet apparatus after preliminary soap scouring. The source of X-rays was a modified form of Owen's design with an iron anticathode. By means of a special continuous water-cooling device for both ends, the tube could be kept running continuously all day from a transformer. Since a fibre diagram was to be expected, the 'monochromatic pinhole' method was used, a bundle of fibres being arranged as nearly parallel as possible and at right angles to the pencil of rays.

Precautions were taken to avoid effects due to the rays striking the edges of the last pinhole, and were checked by blank tests. After some 200 milliampere-hours' exposure, the Cotswold wool, unstretched and dry, gave a very definite 'fibre' pattern, which is shown in Fig. 1. The features of this pattern are the two equatorial spots giving a spacing of 10·3 A., the two sharp polar arcs giving a mean spacing of 5·15 A., and the two less-defined equatorial arcs giving a spacing of 4·46 A. (mean). Analysis of this fibre diagram by the method suggested by Polanyi shows that the equatorial spots are caused by planes parallel to the fibre axis, the polar arcs by planes the normals of which lie within a cone of half-angle 17° about the fibre axis, and the equatorial arcs, which are nearly semicircles, by planes orientated almost at random.

Microscopic examination of the cells of wool fibres has shown that the cells consist of a cell-wall, within which are a number of fibrillæ, probably attached to the walls and to each other. Considering these facts with the X-ray fibre diagram, we suppose that the cell-walls are responsible for the equatorial spots, and the fibrillæ for the arcs. If this interpretation is correct, it means that the cell is of elongated spindle shape with its long axis along the fibre and its walls put down in layers of 10·3 A. spacing. The sharpness of the equatorial spots suggests that the wall is many molecules thick.

The longest fibrillæ, on this interpretation, are arranged in a cone of half-angle 17° (with the fibre-axis) connected by the shorter cross fibrillæ. Thus the polar arcs would be produced by the spacing along the fibrillæ, and the equatorial arcs by the side spacing. The sharpness of the polar arcs and the width of the side arcs indicate that the fibrillæ are many molecules long but only a few molecules thick.

There is not the space here to enter fully into the arguments for the preceding interpretation of the fibre diagram. One notable piece of evidence is furnished by photographs of wool stretched 30 per cent of its length. In this photograph the side arcs have sharp arcs superimposed on them, which would correspond to a lining-up of the fibrillæ and a conspiring of the lateral planes. Again, a photograph of the same wool stretched 30 per cent of its length in an atmosphere saturated with water vapour shows a broadening and decrease of definition in both the polar and equatorial arcs. It is known from studies of the stress-strain relationships of wool fibres that, under such conditions, the fibrillæ suffer plastic flow.

FIG. 1.

One other interesting feature of the photograph of dry unstretched wool is that there is no sign of a 'liquid' ring such as one would expect to be given by a gelatinous cell content—unless one attributes the long and broad equatorial arcs to a gelatinous cell content. In this case, the sharper side arcs produced by stretching would indicate a molecular orientation of this medium, a smectic state caused by stretching.

Carefully purified merino wool has also been photographed in the dry unstretched state and, again, a definite fibre pattern was obtained. This is similar but not identical with that for Cotswold wool. The two polar arcs are more or less isolated on a fainter scattered background. The side arcs cannot be discerned and the equatorial inner spots emerge only as slight thickenings on a heavy continuous circle contiguous with the central spot. Both the similarities and the differences are important. The spacing given by the polar arcs is exactly the same as in the case of Cotswold wool, indicating that the actual material of the fibrillæ is the same in the two cases. Differences in the elastic and other properties of the two wools are probably due to variations in the arrangement and relative amounts of cell-wall and fibrillæ. As regards arrangement in the case of merino wool, the pattern is accounted for by supposing the cell-walls to be thinner and more nearly spherical in shape than with Cotswold wool, the fibrillæ being arranged in a narrow cone along the fibre axis, and to be so few molecules thick as to give no side arcs. The absence of side arcs in this case is an argument against attributing their presence in the case of Cotswold wool to a gelatinous cell content.

Fuller details of the work and the remaining photographs will be published elsewhere. The examination of other wools is in progress.

J. EWLES.
J. B. SPEAKMAN.

The University,
Leeds.

Condensible Gas Modifications formed under the Influence of Electrodeless Discharges.

WHEN a liquid air trap is maintained in a gas subject to an electrodeless discharge, condensible products are frequently formed, and these are often recondensible over long periods. With hydrogen, oxygen, nitrogen, in well baked-out apparatus such products are formed. They have been variously attributed to atomic modifications, ozone, active nitrogen, and the like. Doubtless such modifications may be formed and be condensed in the liquid air traps, but in cases where repeated recondensations can be effected, such hypotheses cannot be readily adopted. So far as I know, no attempt has been made to find out whether these products are not simply water, carbon dioxide, or oxides of nitrogen. The lack of such an attempt arises apparently from the fact that in a discharge in pure hydrogen there is no obvious source of oxygen, and so on.

I have recently investigated electrodeless discharges in the common gases, using a seven-metre wave oscillator (for method see, *e.g.*, J. and W. Taylor, *Proc. Camb. Phil. Soc.*, **24**, 2, 259; 1928). Standard spectrograms of discharges in hydrogen, oxygen, nitrogen, carbon dioxide, water, and air were taken (pressures 2 mm. downwards), both with (where possible) and without liquid air traps on the apparatus.

The 'clean up' effects were then investigated both with 'cold' electrodeless discharges and with such discharges as those described in a previous letter (NATURE, May 5, 708; 1928), in which electrolytic currents were maintained, by suitable means, across the glass walls of the discharge vessel. In hydrogen, as 'clean up' occurred, a condensible product was formed when a liquid air trap was included in the apparatus. This product was of long life and capable of repeated recondensations. Moreover, its volume was approximately the same as that of the hydrogen that had been 'cleaned up.' In order to examine the product that had been condensed out, the whole apparatus was evacuated whilst the liquid air traps were still functioning. The liquid air was removed after the apparatus had been evacuated and closed, and the spectrogram of the condensible product itself was then obtained.

On again putting on the liquid air, it was found that part of the gas content was now not condensible, but became condensible after continued discharge. Its spectrogram was taken. In all cases the spectrogram of the condensible product was identical with the standard spectrogram for water at low pressure (in both cases the carbon dioxide bands were in evidence), and the spectrogram of the part of the gas that was not recondensible after running the discharge was identical with the non-condensible product formed after running a discharge in water vapour, and further, both of these latter were almost identical with that given by hydrogen. There can remain little doubt, then, but that the condensible product formed from hydrogen is water which partially breaks up to form hydrogen and oxygen under the influence of the discharge when there is no liquid air trap in the apparatus.

With oxygen a condensible product was formed, and this product yielded an exactly similar spectrogram to that obtained from a discharge in carbon dioxide (sometimes there were also weak hydrogen lines in the spectrum, but there was no evidence that any considerable portion of the condensible product was water).

The amounts of gas disappearing in these experiments, especially where electrolytic currents were passed through the glass, were considerable, being as much as 0·7 c.c. of gas at N.T.P. in certain cases, consequently, it is at once obvious that any products formed in minute quantity are not detectable.

The question arises as to the origin of the water and carbon dioxide. In a previous letter (loc. cit.) I have described results on the disappearance of gas under the action of an electric current passing through the glass walls of the containing vessel, and shown that laws similar to Faraday's Laws of Electrolysis are valid. Further work has confirmed the result that the quantity of gas disappearing is directly proportional to the electrical quantity that has traversed the walls. The number of atoms disappearing per electronic charge is, however, variable according to conditions. For example, at the beginning of a run with hydrogen, H_2 disappeared for every electronic charge transferred in many cases, but with continued running, H disappeared for every electronic charge transferred.

The results show that glass must be regarded as an electrolyte and the gas disappearance under the action of the discharge is consequently due to the chemical interaction of the gaseous ions with the electrolytic products and ions of the glass. In the simplest picture glass is to be regarded as a solution containing Na_2SiO_3 as electrolyte. For every two electronic charges transferred across the glass 2Na is liberated at the cathode. The SiO_3 radical at the anode breaks down into SiO_2 and O, which unites in the case of hydrogen discharges with one hydrogen molecule to form one molecule of water.

This simple picture may represent some of the facts, but it does not explain, for example, why under certain conditions H_2 disappears for every electronic charge, and why oxygen disappears even more readily than hydrogen. We must consider then that glass is a complex electrolytic solution probably containing peroxides (until they are reduced by continued discharge with hydrogen), and certainly containing compounds of carbon which produce chemical reactions with the gas ions impinging against the glass surface.

It must also be borne in mind that condensible products are formed when a liquid air trap is on the apparatus, but gas 'clean up' occurs also when there is no liquid air trap, when the products must be retained in the glass structure or absorbed in the walls.

JAMES TAYLOR.

Newcastle-upon-Tyne,
Aug. 6.

New Type of Interference Fringes.

IF a pair of optically flat plates, making a wedge angle of a few seconds, be placed in the beam from a collimator with a cross slit (to obtain effectively a point source) and the eye be placed at the focal plane of the telescope objective (without eyepiece), straight fringes are seen which are localised at the plates. Essentially they are the fringes observed by Fizeau, who used a back reflection method.

When the plates are half-silvered, the comparatively broad and feeble transmission fringes now become very narrow and clear, the multiple reflection in the silver films producing the same sharpening effect here as it does on the Haidinger fringes in the Fabry–Perot interferometer. This is somewhat surprising. With Fabry–Perot rings the plates have to be exactly parallel, so that the wave-fronts from successive reflections remain parallel; in this instance the successive wave-fronts are rotated by an amount equal to twice the wedge angle. The latter, however, is so small that even thirty or more such deviations are in aggregate less than the smallest angle resolvable by the eye.

With silver films of about 40 $\mu\mu$ thickness, and a spacing of about 1 mm. between the plates (so that any lack of homogeneity of the source should not enter) a bright fringe, using a monochromatic red source, seems to occupy less than a twentieth of the distance between consecutive fringes, the fraction increasing to about an eighth in the violet.

These fringes can be used to test the parallelism of a plate (*e.g.* Lummer–Gehrcke) or of the Fabry–Perot mirrors themselves, to a far higher degree of accuracy than is possible with the usual Fizeau fringes. Considering the latter example, as the adjustment for parallelism proceeds, the bands spread out. If it can be arranged that one bright band should cover the whole field of view, it means that with a monochromatic red source, a lack of parallelism or a local defect amounting to about $\pm \lambda/40$ in path difference will cause the field at point to change from red to black. This is very much more sensitive than with the Fizeau fringes, which require $\pm \lambda/2$ path difference to change from bright to dark.

One precaution must, however, be taken; when the plates are parallel, the effective separation must be such that it is a bright band that covers the field, and not the semi-dark background in between the bands, for if the separation is such that we are half-way between two fringes, an error of very nearly $\pm \lambda/2$ *could not even be detected.* By rotating the mirrors (as a whole) a small amount so that their normal is no longer coincident with the axis of the collimator, the requisite condition is readily obtained.

The same fringes can be used, for example, in place of Newton's rings whenever a small displacement or a small change of refractive index is to be measured, the gain in accuracy being between five and ten times.

W. EWART WILLIAMS.
Wheatstone Laboratory,
King's College, London, W.C.2,
Aug. 10.

Some Experiments on Water-Divining.

THE following affords a brief account of some experiments on water-divining carried out near Fyvie Castle, Aberdeenshire, on April 28, 1928, and indicates some inferences which may be drawn therefrom. The dowser was Mr. G. L. Cruickshank, of the Fyvie Castle Estates.

Tests were first made in places where running water was known to be. The dowser made use of a short forked twig, and when he stood over the water course the twig was forced up. If a piece of thick glass were placed under his feet the sensation ceased and the twig dropped. The same effect was got when the twig was held by two pairs of steel pliers, or if the ends held by the hands were first covered with rubber tubing. Likewise, no sensation was perceived if only one end was held by pliers or covered with rubber tubing, the other being held in the usual way by the bare hand.

Another set of observations was carried out with the dowser blindfolded. He was made to cross a line which he had previously marked out as being a water course. Nobody approached within several yards of him. When he passed over the line previously indicated, the exact position of which he had no idea, the twig moved upwards. As he passed beyond the line, the twig immediately fell.

In these experiments the external manifestation is a forcing upwards of the twig. This raising of the twig must be due to some muscular action on the part of the dowser. This would indicate that he is the mover, though in his own mind he is apt to consider that he is working against some external force. If then his muscles force up the twig, the nerve centres controlling these muscles must have been influenced in some way by an outside stimulus. May it be, therefore, that some kind of influence is radiated from water running under pressure, and that a 'receiving set' tuned to respond to such a stimulus is possessed by certain individuals? A definite arrangement of the body seems to be necessary for proper reception of such a stimulus, and certain substances appear to be able to prevent the arrival of the stimulus. As different individuals may respond in different ways to such stimuli, care must be exercised in drawing general conclusions from observations made on any particular individual.

It seems reasonable to conclude, however, (1) that the faculty of water-divining is possessed by some individuals; (2) that the individual responds to some, at present unknown, external stimuli; and (3) that certain substances can prevent the arrival of those stimuli, in which case the individual cannot respond.

A. E. M. GEDDES.
12 Louisville Avenue,
Aberdeen.

The Palæolithic Implements of Sligo, Ireland.

1. FROM an examination recently made by me of the Sligo shelter-site, I consider that the coast at, and for some distance east of, the beacon on Coney Island (that part illustrated by Messrs. Boswell and Jones in NATURE of June 2) is undergoing erosion under present conditions, but that at Rosses Point it is possible, though only just possible, that the remains of a rock-shelter could have survived since Palæolithic times, the odds against survival being of the order of at least 100 to 1.

2. The burden of the proof of age of specimens found at Rosses Point must depend, therefore, on internal evidence, and that evidence must be conclusive.

3. The specimens found by Mr. Burchell at Rosses Point and *in situ* in Boulder Clay in the neighbourhood are, as a suite, unlike the flakes produced by any natural forces with which I am familiar, but, on the other hand, carry such impress of design as compels me to regard them as of human origin.

4. The forms of those from Rosses Point are not those of quarryman's refuse, and the site is a most unlikely one for a quarry. On the contrary, they appear to belong to a crude Stone Age industry.

5. Their preservation, unrolled and with comparatively unblunted edges, despite the fact that the site has been within reach of wave-action since glacial times, would appear to be sufficiently explicable from the fact that they were recovered from beneath massive blocks of limestone.

6. The occurrence of similar flakes in glacial deposits in the neighbourhood *in situ* confirms, in my opinion, the provisional inference (par. 4) as to the age of the Rosses Point specimens. It would appear that the 100 to 1 chance has succeeded.

ERNEST DIXON.
H.M. Geological Survey,
28 Jermyn Street, S.W.1,
Aug. 14.

Reproduction of Scales by Electric Discharge to a Photographic Plate.

IT is a known effect that when a coin is placed on the film side of a photographic plate which rests on a sheet of tin-foil, and the coin and tin-foil are connected to the secondary of an induction coil, an image of the details of the coin is obtained on developing the plate after discharge. The effect appears to be due to the light of a brush discharge from the coin, the intensity of which depends in a somewhat complex way on the contour of the coin, and the distance of its parts from the plate.

I have found this method suitable for the accurate reproduction on glass of metal scales, for there is no uncertainty, as with a camera, about the magnification. The steel rule, carefully washed with benzene or alcohol to remove grease, was laid on the film, an even pressure being applied along the rule by weighting it. After these operations, which were performed in a red light, a discharge was passed between the rule and tin-foil, and the plate developed. In this way the scales were sharply reproduced—even the 1/100th inch divisions—as seen under a microscope (Fig. 1).

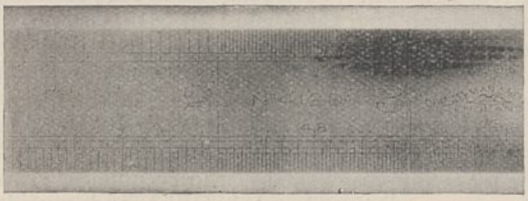

FIG. 1.

A trial with a half-tone copper block, such as is used for magazines, showed that much fineness of detail is attainable with the method, for a good reproduction was obtained in spite of the minute depth of etching. The method was also found applicable for the examination of the structure of coke, the specimen being ground to a plane face for the purpose. J. H. CHESTERS.

Physics Laboratory, University of Sheffield.

Excavations at Gough's Caves, Cheddar.

DURING the past winter months, the authorities now in charge of the caves, usually known as Gough's Caves, at Cheddar decided to widen the entrance way in order to cope with the increased tourist traffic. It will be recalled that discoveries of flint implements and the bones of living and extinct animals were made in the course of the excavations necessary to open up the cave to the public, and further, that in the early years of the present century, portions—the remainder is still *in situ*—of a human skeleton of upper palæolithic date were found.

Therefore, in view of these important discoveries, those now responsible for the cave determined to carry out the work of path widening in a scientific manner. Mr. R. F. Parry personally superintended the work and kept very careful records. Under his direction the floor material of limestone blocks, gravels, and red cave earth was removed in six inch layers, sorted, and the remains given their layer number.

This detailed labour was well rewarded by the discovery of more than one thousand flint implements and flakes, many of these being carefully worked and of typical late palæolithic form. In addition to these a fine *bâton de commandement* decorated with incised lines, some small bone points, and a number of teeth perforated for suspension, were found. This is only the second *bâton* to be found in England, the former incomplete one also coming from this cave.

Numerous remains of animals were found, and parts of two human skulls, one of a child and one of an adult. These, according to Sir Arthur Keith, compare very well with the skull of the original skeleton and with those from Aveline's Hole, Burrington Combe. The latter are also of late palæolithic date.

E. K. TRATMAN.

Spelæological Society, University of Bristol.

Can the Hand be thrust in Molten Lead without Injury?

AT p. 201 of "The Memoirs and Correspondence of Lyon Playfair," by Wemyss Reid (1899), an account is given of the Prince of Wales (afterwards King Edward VII.) having put his hand into boiling lead. This account appears to have been copied by Sir Sidney Lee at p. 73 of volume 1 of his "King Edward VII." I have often heard it stated that a finger or hand can be put into molten lead, and have had many opportunities of putting the matter to a practical test—but have not taken them! Hence I am writing to inquire whether this feat may be safely done, and if so, what is the explanation.

A. S. E. ACKERMANN.

Wave-length Shifts in Scattered Light.

(*By Cable, through Science Service, Washington, D.C.*)

PROF. RAMAN'S brilliant and surprising discovery that transparent substances illuminated by very intense monochromatic light scatter radiations of modified wave-length, and that frequency difference between emitted radiation and one exciting medium is identical with frequency of infra-red absorption bands, opens up wholly new field in study of molecular structure. I have verified his discovery in every particular, using improved apparatus which makes it possible to photograph strongest lines in few minutes. Anti-Stokes' terms of intensity nearly equal that of lines of wave-length greater than exciting line obtained chloroform, carbon tetrachloride, latter giving triplet each side 4046, 4358, 5461 lines mercury arc. Raman reported no trace modified lines excited latter line, but are strong with carbon tetrachloride. Triplets short wave-length sides exciting lines appear mirror images those long wave-length side, considering exciting line mirror. Crystalline quartz gives strong line identified as 20 μ absorption band, and fainter line very close exciting line corresponds infra-red absorption about 75 μ. Raman's discovery thus makes possible investigation remote infra-red regions hitherto little explored owing experimental difficulties. As yet I have found no line corresponding more generally known band quartz (eight and half μ). This expected as small energy exchanges between impinging light quanta and molecules more probable than large; these correspond absorption bands very long wave-length.

Many lines discovered Raman found double account very efficient method of illumination employed; considerable resolving power possible. Now preparing for spectrum photograph forty foot focus prism spectrograph. Certain lines are distinctly banded: structure, sharp intense red side, shaded off on violet; strength anti-Stokes' terms in case carbon tetrachloride in marked contrast with their faintness in case benzene and toluene, no trace appearing except after long exposures.

It appears to me that this very beautiful discovery, which resulted from Raman's long and patient study of phenomena of light scattering, is one of most convincing proofs quantum theory of light which we have at present time. R. W. WOOD.

Loomis Laboratory, Tuxedo, New York.

Down House as a Darwin Memorial.

MR. GEORGE BUCKSTON BROWNE, fellow of the Royal College of Surgeons of England and of the Society of Antiquaries, London, having acquired Darwin's home, Down[1] House, in the County of Kent, from Prof. C. G. Darwin, grandson of the naturalist, has transferred its possession to the British Association under the most liberal conditions, and with an endowment amply sufficient for its maintenance and preservation for all time. The Association have now issued a full description of the house, and from it the subjoined particulars have been extracted.

At present Down House serves as a private school. When the tenant's lease falls in or is acquired, Mr. Buckston Browne desires that the property be regarded as a gift to the nation and opened to visitors every day of the week between the hours of 10 and 6, without charge. He also desires that the Association should use Down House and grounds for the benefit of science. The donor has also suggested that certain of the rooms—particularly the old 'study,' in which the "Origin of Species" was written, should be furnished, as near as may be possible, as they were when Darwin lived in them. He has already taken steps to secure this end, and has obtained the willing co-operation and greatest assistance from various members of the Darwin family. Indeed, without the generous co-operation of the Darwin family the transfer of ownership could not have been effected. The late Mrs. Litchfield, the third daughter of Charles Darwin, bequeathed for Down House her father's study chair and letter-weighing machine. Mr. Buckston Browne has commissioned the Hon. John Collier to paint replicas of his well-known portraits of Darwin and of Huxley to be hung at Down House, commissions already completed.

It is hoped that the shelves of the old study may be filled with all editions of Darwin's works; and that Down House may become a Darwiniana where students will have an opportunity of consulting all original documents concerning Darwin and his writings. Such an end can be attained only if the British Association succeeds in enlisting the sympathetic co-operation of all who may be the fortunate owners of articles which were in the possession of Darwin or were associated with his life.

It may not be amiss to recount some of the circumstances which led up to the appeal for the preservation of Darwin's home. Some years before his death, the late Sir Arthur Shipley, Master of Christ's College, Cambridge, where Darwin was an undergraduate, wrote to a member of the British Association as follows: "It seems to me that Down House ought to be a national possession. Do you know of any means by which this can be brought about?" On the eve of the Leeds meeting of the British Association, on Aug. 31 of last year, the Council of the Association considered this matter and empowered the then president (Sir Arthur Keith) to make a public appeal at the close of his presidential address, with the happy result which all now know. It was with as much surprise as satisfaction that Sir Arthur Keith learned that the man who answered the call was a fellow of his own College. Indeed, he knew Mr. Buckston Browne as a generous benefactor to that College and to the Harveian Society, but was unaware of his love for Darwin and for Down. It was later that he learned that Darwin's friend Huxley had long ago exerted an abiding influence on the donor of Down.

Darwin was born at Shrewsbury on Feb. 12, 1809; Down House was purchased for him by his father, Dr. Darwin, and he took up his residence there on Sept. 14, 1842. Darwin was then in his thirty-fourth year; three years previously he had married his cousin, Emma Wedgwood. His two eldest children, William and Anne, were born in London; the third, Mary, was born and died just after arrival at Down. Then followed in 1843 Henrietta, who became Mrs. Litchfield; in 1845, George, who became Sir George Darwin, and whose son, Prof. C. G. Darwin, succeeded to the ownership of Down and is the fifth of a succession of father and son who have been elected fellows of the Royal Society —a unique record; in 1847 Elizabeth was born; in the following year Francis, who became Sir Francis Darwin—a distinguished botanist and president of the British Association. Leonard followed in 1850—Major Leonard Darwin, scientific worker, philanthropist, and the founder and still active supporter of the Eugenics Society. Then came Horace, now Sir Horace Darwin, happily, still alive; and last, number 10, Charles Waring Darwin, who died in childhood. Down was the home of a large and happy family, perhaps the most gifted family ever born in England. There the great naturalist died on April 19, 1882.

In that period Darwin made his first draft of the "Origin of Species" (1842); he wrote his researches on the zoology of the *Beagle*, on "Structure and Distribution of Coral Reefs," and prepared a new edition of his "Journal of a Naturalist." Before he settled down to work at barnacles, to which he gave seven years (1847–54), he prepared his papers on volcanic islands and on the geology of South America. Preparations for the "Origin of Species," which did not receive its final form until 1858–59, went on continuously from 1842 onwards. Then followed his inquiries into "Fertilisations of Orchids" (1862), "Variations of Animals and Plants under Domestication" (1868), "Descent of Man" (1871), "Expression of the Emotions" (1872), "Movements and Habits of Climbing Plants" (1876); "Insectivorous Plants" appeared in the same year; "Cross- and Self-Fertilisation" in 1876, and his last work of all, one which was begun soon after he settled at Down, "The Formation of Vegetable Mould through the Action of Worms."

No single home in the world can show such a record. Truly, from Down, Charles Darwin shook the world and gave human thought an impress which will endure for all time.

[1] On the Ordnance Survey maps the spelling is *Downe*, but as Darwin always wrote *Down* without an 'e,' the latter spelling has been adopted.

Some Recent Work on the Light of the Night Sky.[1]

By Lord Rayleigh, F.R.S.

Periodicities.

An annual periodicity was early suspected in my own observations in England. At the time of writing, observations lasting over five years are available, so far as the auroral component is concerned. To examine impartially whether or not an annual variation is present, the observations of each calendar month (say, November 1926) are averaged, and the mean is adopted as representative of that particular month, without further reference to the data for individual nights.

	August.	September.	October.	November.	December.	January.	February.	March.	April.
1922-3	..	..	..	..	..	..	−0·5	0·0	−1·9
1923-4	+0·0	+0·3	+0·7	+0·0	−2·2	−2·2	−1·6	−0·3	−1·7
1924-5	+1·0	+0·7	+1·6	−0·9	−0·8	−1·5	−1·2	−0·8	−1·8
1925-6	+0·8	+0·9	+0·8	+1·5	+0·0	+0·5	−0·3	−0·4	+0·0
1926-7	+0·5	+0·8	+1·3	+1·1	−0·4	−0·7	+0·0	+0·8	−0·5
1927-8	+2·0	+1·2	+1·8	+0·9	+1·0	−0·3	..	..	..
Sum .	+4·3	+3·9	+6·2	+2·6	−2·4	−4·2	−3·6	−0·7	−5·9
Mean	+0·9	+0·8	+1·2	+0·5	−0·5	−0·8	−0·7	−0·1	−1·2

The individual seasons and the mean are plotted in Fig. 2.

Although the results are not numerous enough to give complete statistical regularity, yet I think it is difficult to resist the indications of a definite annual period. The great fall of intensity usually occurs between November and December. In each of the four complete observing seasons (August to April) the mean of all months before this date is much greater than the mean after it. This fall must have its counterpart in a recovery, which would naturally be taken to occur six months later, that is, between May and June.

No observations can be made at that season owing to residual daylight. But in every one of the five cases available, a considerable recovery has occurred at some time between April and August, in the interval when residual daylight prevents observations.

Special attention is directed to the mean curve at the bottom of Fig. 2, which sums up the evidence for annual periodicity. The amplitude of annual variation indicated is about 2 units, or a factor of 1·6. The subordinate maximum in March may be due to coincidence of irregular variations, but it is well to keep an open mind on this point, particularly in view of certain magnetic periodicities.

Turning now to a second question, that of variation in the cycle of the sunspots, it is to be noted that the observations begin at about the time of sunspot minimum in 1923, and that according to present expectation the maximum will be reached in the present year, 1928. By analogy with other phenomena known to depend on the sunspot cycle, we should anticipate an increase in the light of the night sky during this period, if such an influence exists at all.

To eliminate any effect of the annual periodicity just discussed, it is necessary to compare the intensity in successive years at the same season. If we look at any given column in the table (say, October) we find a tendency to increase with time, though this tendency is not strong enough always to assert itself against the irregularities after the lapse of a single year. But in every one of the nine columns the last entry is substantially higher than the first. If the variations when cleared of the annual periodicity were quite unsystematic, the chance of this occurring would be only 2^{-9}, or 1 in 512.

For greater statistical regularity, we may take the mean of all the months in a given observing season, or in a given year. To include observations taken in the spring of 1923 and in the present uncompleted observing season, the latter course is adopted.

The result is shown graphically in Fig. 3. The mean annual increase is 0·3 unit, representing a factor of 1·07. Thus the results clearly indicate a general yearly increase of the intensity during practically the whole period of observation, relative to the uranium standard. This could be explained away if we assumed a slow loss of brightness in the standard, but there are reasons which seem adequate for rejecting this explanation.

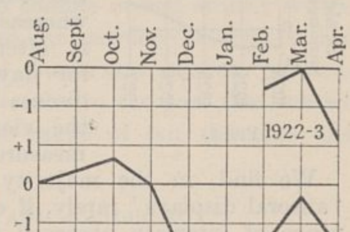

Fig. 2.

Returning to the question of annual periodicity, it seems probable that this depends on the sun's motion in declination. If so, the effect should be negligible at the equator, and should show itself in the opposite

[1] Continued from p. 317.]

phase in the southern hemisphere. There is some evidence from the available data that this is in fact the case.

POLAR AURORA.

It is important to distinguish between the polar aurora occurring typically in the auroral zones, and the non-polar aurora occurring all over the earth. Both have the green line λ5578, which has been shown by the work of McLennan and his colleagues to be due to oxygen, as the strongest feature of the visual spectrum. It may seem an arbitrary procedure to distinguish two separate phenomena when there is so much in common, and I know from correspondence and otherwise that some scientific men are unwilling to admit it. Nevertheless, after further experience and study, I am more than ever convinced that it is necessary.

The grounds on which this distinction was originally made were that the nitrogen bands (negative bands) occur only in the polar aurora; that the polar aurora has a distinctive distribution in latitude which the other has not; that the polar aurora often shows distinctive forms such as arcs and draperies, whereas the non-polar aurora is uniform; while, finally, the polar aurora varies enormously in intensity in the course of a few minutes, whereas the non-polar aurora is often sensibly constant for days. I wish now to discuss the subject from the viewpoint of intensity measurements.

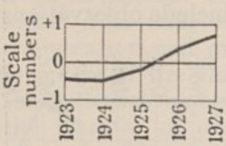

FIG. 3.

We find, in the majority of stations, where 'auroral displays' rarely, if ever, occur, that the range of intensity observed through the auroral filter, which I take as a measure of the intensity of the green line, has a fairly definite mean value of about 0·4 on my scale, with a standard deviation of 1·0. It is true that this intensity is subject to a yearly, and probably also to an 11-yearly, variation. But these variations are comparatively slight, and for the present purpose may be ignored. Lerwick (Shetland), Victoria (British Columbia), and Kingston (Ontario) are stations where auroral displays are comparatively common. At the Cape, or at Canberra, or Hawaii, they are practically unknown. The case of England is intermediate. Auroral displays occur occasionally, though not often.

Let us consider what happens in this intermediate case, where the statistical issue can be most easily presented. In the year 1926 my observations in England on 75 nights, in the absence of an auroral display, give for the auroral intensity:

Range	−2·2 to +3·0
Mean value	+0·2
Standard deviation . .	1·1

Now only one auroral display was observed, when it was found that

Auroral display gave . .	+16·0
Deviation from the mean .	+15·8

thus giving an isolated deviation of no less than 14·4 times the standard. As is well known in all ordinary cases of statistical distribution, values three times the standard are nearly the highest that occur. A value 14·4 times the standard is fantastic, and shows that we are attempting to classify in the same scheme values that are not properly comparable at all. In the case of barometric variations at sea-level, such a deviation would mean a barometric height of about 34·7 in.! This comparison shows that we must class auroral displays as quite a distinct set of phenomena.

As is well known, the visual light of an auroral display consists for the most part of the visual green line, and accordingly it is this component (auroral green) which is most strongly reinforced when a bright display is in progress. It is always found, however, that the red and blue components are strengthened as well. The following typical examples may be given:

Place.	Date.	Red.	Auroral.	Blue.
Victoria . .	Sept. 20, 1925	+2·6	+13·5	+13·0
Kingston . .	Mar. 5, 1926	+5·9	+13·0	+13·4
Lerwick . .	Jan. 13, 1926	+2·1	+16·7	+11·9

These may be compared with the normal values in the absence of a display, given earlier in this paper. The increase of intensity in the blue part of the spectrum is probably attributable in the main to the negative bands of nitrogen. The increase in the red is less marked. It may be due in part to the known red line of the aurora, but I believe more to an (apparently) continuous background, which may, of course, be an unresolved band spectrum.

CONCLUSION.

In conclusion, I must emphasise that much of the work of this paper, though necessarily organised and edited from one centre, would have been impossible without the friendly and generous co-operation of the workers whose names have already been recited. They have given their time and trouble without stint.

As regards the future, it has been borne in upon me that greater accuracy of photometric measurement is a chief requisite. This will be obtained by means of a photoelectric cell. Most of the difficulties have been overcome, and preliminary observations have been in progress for some months past. I have been able to follow the changes of intensity from hour to hour on clear nights; some evidence has been found suggesting a diurnal periodicity. The observed intensity nearly always increases between nightfall and midnight, beyond which the observations have not usually been carried.[2] Although no correlation has been found

[2] On June 28, Prof. J. C. McLennan arrived at a similar conclusion as to the course of change during the night in his Bakerian Lecture delivered before the Royal Society. I merely add this note to make it clear that Prof. McLennan's conclusion and my own were reached and recorded quite independently, this paper having been communicated to Prof. Chapman for publication on June 18.

(*Continued on p.* 373.)

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Craftsmanship and Science.

By Prof. Sir WILLIAM BRAGG, K.B.E., D.Sc., D.C.L., LL.D., F.R.S.,
President of the British Association.

INAUGURAL ADDRESS DELIVERED AT GLASGOW ON SEPT. 5.

WHEN, nearly a century ago, the founders of our Association drew up a statement of purposes and rules, they gave prominence to the words "to obtain more general attention for the objects of Science." Since that time we have tried continuously to fulfil our self-imposed task, not, I hope, unwisely, not untactfully, nor without success. For this purpose we have on many occasions and in many ways endeavoured to describe the progress of our researches, and to present the consequences of discoveries as they appeared to the discoverers. With your permission I would like this evening to add something to the story. I would claim as my justification for doing so the fact that in the last few years scientific inquiry has advanced at a rate which to all is amazing, and to some is even alarming. On one hand, the application of science to industry has become increasingly important and obvious, as was so clearly shown by our honoured president of two years ago. Especially at the present time, when our country is struggling to free itself from distress due partly to the War and partly to violent changes in economic conditions, is it of interest and importance to consider what science is doing and can do to accelerate recovery. On the other hand, in the less material realms the applications of recent research have aroused wide interest, as may be exemplified by the influence on philosophic thought of the new discoveries in physical science, or by the effect of last year's remarkable address from this chair.

I cannot deal in the time allotted to me with all the issues that are suggested by these considerations. I propose to limit myself in a manner which my choice of title will suggest, and in speaking of 'craftsmanship and science,' to pay attention more particularly to the relations between science and the craftsmanship of our own country. I shall not, however, be able to confine myself strictly within these limits, because the entrance of science into our most material businesses cannot be considered without reference to the part that science plays in the whole range of our thoughts and actions.

SKILL AND PRODUCTION.

The term craftsmanship requires definition. I am supposing it to mean the skill which is exercised in the production of whatever is wanted for human welfare. Imagine an island so cut off from the rest of the world that its inhabitants must depend on themselves for the satisfaction of all their desires, for their food, even if they have no more to do than pick fruit from a tree, for their clothing, for their housing, and other material things. They must also find their own means of satisfying less material cravings: for if they have intelligence they will look for means of studying themselves, their neighbours and the world round about them. Their eyes and ears will ask to be used for the satisfaction of a sense of beauty in form and colour and sound, and their minds will try to reach out beyond what can be seen and heard. It is impossible to proceed to the satisfaction of these desires without the handling of materials, and craftsmanship begins with the skill exercised in the handling.

What the islanders succeed in achieving by their craftsmanship may justly be described as their wages, they being their own employers. If their wages are to be raised, they must somehow increase one or more of the factors on which their success depends. They must be more diligent in the discovery of materials for which a use can be found; they must become better acquainted with the properties of those materials; they must develop their constructive skill. If they are too primitive to have developed the use of mechanical power, they must do everything with their own hands, guided by their own intelligence and their own feeling for what is beautiful and fitting. At every step enter the qualities that go to make craftsmanship, as I would interpret the term. There is knowledge of materials, there is imagination, there is technical skill; perseverance is wanted, love of the work itself, sympathy with the use that is to be made of it, and with the user. Clearly, on the craftsmanship of the islanders will depend whether they have enough food to go round, enough clothes to wear, whether they have leisure for anything beyond the labour that satisfies their barest necessities.

Of course, this isolated group of people will have some characteristic estimation of what kind of wages they want. Their energies may conceivably be devoted only to the production of things that satisfy bodily desires, or they may be bent also on nobler things. I need not consider that point, as I am not trying to picture Utopia. All that this image is meant to convey is the idea of craftsmanship and its fundamental importance. Nor is the account yet complete; far from it. It is not only that the products of craftsmanship are a necessity if the islanders are to live at all: craftsmanship has a value in itself. There is in men, more in some, less in others, the natural desire to use what faculties they possess. It is a fact that love of good work and delight in successful accomplishment are powerful motives, and when satisfied are sources of real happiness. Of all the motives that sway the world, these are among the purest and best.

The power to produce in plenty what is wanted is, of course, only one of the great problems that a community has to consider. There is also the endlessly difficult question of distribution, of the manner in which each working individual is to receive his share of the wages. The two problems cannot be separated entirely: the means directed to the solution of one contribute to the solution of the other. But I must not attempt too much: science is in the first instance concerned with the production problem; the distribution problem follows.

Let us extend our image a little; let our island be discovered and put into communication with the outside world. An exchange of craft work sets in: the islanders discover new wants that must be satisfied, and they pay for the necessary imports by exporting what they make themselves. But the exports must be made to satisfy the tastes of the outside peoples or there will be no trade. So the islanders now find that they must no longer consider their own tastes entirely: they must accommodate themselves to a more general conception which is only in part their own. It may happen that under the new conditions they become less and less self-contained. Some things which are necessary to life, such as food or clothing, may become imports, being no longer produced, at any rate in sufficient quantity, within the island itself. The people are now very firmly tied to the rest of the world; they must give that they may receive, and they must please in order that others may be willing to take. We may say that their craftsmanship is now judged more critically; and more than ever it becomes fundamental to well-being, even to existence. The conclusion I would draw from this very simple little analogy is that a people lives on what it makes or earns and that its success depends on its craftsmanship. A people cannot expect to be provided for: it has no rights.

Constructive Expression.

I would ask you presently to consider the difference between the craftsmanship of an early civilisation and that of our own more complicated times. But before doing so, let me say yet one or two words about the older forms.

We have a profound feeling for any example of an old craft, and for very good reasons. Among them I do not include the sentimental regret that, in some cases, a past time skill seems to have disappeared. We may be sorry, but after all it is but a receipt that has been lost and may be found again any day, if proper search is made for it. Modern knowledge and methods of analysis are at least good for that much. Nor is the collector's pride of rarity the worthiest feeling that the old specimen inspires.

Our affection for it and the reverential care with which we handle it are due to the fact that it represents to us the labour of a people, labour into which knowledge, imagination, love of beauty, technical skill have all entered. The most of what was once used in everyday life has long disappeared; even such more durable things as houses and ships, roads and cultivations, may have ceased to be. The few objects that survive must be taken as examples of what has been lost. On the showing of the student, a spirit will emerge from an old vessel as great as that which issued when the fisherman of the "Arabian Nights" unsealed the pot that had long been lying at the bottom of the river. It is the spirit of the bygone people that takes shape before us.

The Greek gave exquisite form to his vase and decorated its surface with equal art. He copied from the growing things of Nature the adjustment of lines and surfaces which give the sense of fitness for a purpose. The outlines of his vases are so perfectly adjusted that their representation in a drawing will not bear alteration by the width of a line. That the Greek should with so much skill take lessons from what his perception made clear to him, and should with so much care choose his materials and mould them to his purpose, is what we should expect from a nation that shows also in its literature a passion for justice and harmony. The fine accuracy of his line is in agreement with his delicate sense of differences in thought and words.

The Roman developed the principle of the arch, and enough remains of what he built to show the daring and the power of his work. The great arches that spanned his public buildings seem to stand for the Roman rule and law under which the whole world might find shelter and be at peace.

The sword of the Indian workman was gradually brought to its temper by an infinite series of local applications of heat alternating with the few blows that could be skilfully given while for a moment it was in the workable state. The poverty of the craftsman's appliances, the meagreness of his little fire and the scantiness of the tools with which he made his way bit by bit to his final achievement, are in consonance with his life of small details ruled by overmastering ideas.

I need not illustrate further. It is indeed well known to everyone that the craftsmanship of a people is an expression of the best of its very self. It is to the underlying reason that I would direct your attention now. The mind of a nation is so expressed because its craftsmanship, interpreted in its widest sense, represents its efforts to live. Under this strong compulsion, the nation produces results which range from pots to poetry, and all its products are stamped alike. That which we do ourselves is as representative as a Greek vase or a Roman aqueduct or a suit of armour from Milan. The craftsmanship of a nation is its very life. Even if we consider it only in relation to the production of material things, the state of a nation's craftsmanship is an index of its health.

Modern Aspects of Craftsmanship.

As a people departs from its primitive condition, so also does its craftsmanship. I would ask you to consider the nature of the change. The elements of craftsmanship in its original form centre round the individual. In his brain are the knowledge and imagination, in his hands is the skill, and round about him lie the materials and the tools of his craft. But as the years go by it becomes impossible that all the knowledge and all the technical skill should be found in one person, and all the tools be owned by him. The craftsman becomes an association of men, a great manufacturing firm, even, we might say, a nation, if all the members of the nation contribute through government intervention and control to the maintenance of some industry. Many hands, working in an alliance which is often unconscious, are employed in bringing a product to its finished form. It is a long step from the simple workshop of the old single-handed craftsman to the vast complex factory of modern industry.

If now we ask ourselves what has brought us to this new kind of modern craftsmanship, this dependence on machinery with its wealth of production, its clattering, bustling activity, and its compelling influence on the lives of all of us, we find that one simple cause has been continuously operative. It is nothing more or less than the urgent wish of the individual to better his own condition; and, in his disinterested moods, the condition of his neighbours. The change could never have been prevented.

When Hargreaves thought that by a mechanical arrangement he could manipulate several spinning-wheels at one time, and succeeded, so that he had more wages to spend on his wife and children, he was obeying a universal and natural impulse. Hargreaves' neighbours, being left behind in the competition for wages, pulled his house about his ears. But in the end they, too, found themselves to be turning many spinning-wheels where formerly they had handled only one. Then they, too, had more money to spend. What other turn could things have taken in the circumstances? What happened in this isolated incident is repeated again and again in every craft, and in consequence change after change marks the road that stretches far from its beginnings.

Quite apart from all considerations as to whether the new is better or worse than the old, more beautiful or less beautiful, whether it calls out the best in man as well as the older ways, or whether it fails to do so, apart from all comparisons of this kind stands the fact that the change is due to natural impulses which will not be gainsaid. The results have to be accepted. We cannot put the clock back. We cannot, let us say, wipe away the great steelworks of the world and replace them by thousands of individuals each with his single anvil and single hammer. We cannot replace the great ships of Glasgow by a multitude of little sailing boats. The plain truth is that modern craftsmanship with all its noise and ugliness is giving food and clothing, warmth and interest, to millions who otherwise must die. It is ungrateful to find fault except with sympathy. Let us try in all possible ways to mend its offences and soften its hardships, but in all honesty let us recognise that we live on modern craftsmanship in its modern form. We are each and every one of us responsible for the present conditions so long as we insist on spending money to the best advantage.

At this point it is convenient to refer to a matter which would be of little importance if it did not seem sometimes to put modern craftsmanship in a wrong light. We are continually discovering examples of the marvellous skill of the craftsman of thousands of years ago. There is here, however, no disheartening implication, as has sometimes been asserted, that men can no longer do what was once in their power. To those who look into what goes on in a factory or a mine, in the field or on the sea, there are innumerable examples of beautiful craft work, beautiful because of their fitness for their purpose, their balance of design, their ingenuity, their history, their growth under human perseverance and thought. Every one of us can bring to mind examples of technical skill demanding imagination and intelligence as well as manipulative power which could be set alongside any instance in history. Let me name only one: could anything surpass the drawing of fibres of quartz, finer by far than a human hair, by means of the bow and arrow? It was a feat to imagine that it could be done, to anticipate that when done it would fill so perfectly an urgent need in the construction of many important instruments, and, finally, to do it.

Now we come to the point at which I would ask you to consider the relation of science to the craftsmanship which I have been trying to define. I would direct your attention to the manner in which, under the urgent drive of self-preservation, the craftsman has called scientific knowledge to his aid. Sometimes the moment has been dramatic on account of the great need of the occasion and the prompt effectiveness of the reply. When, for example, coal-mining was at a low ebb because the mines were becoming waterlogged and no available power was strong enough to clear them, Savery and Newcomen made use of the new discoveries respecting the pressures of gases and vapours which Torricelli and Pascal, Papin and Hooke, had just been examining and trying to explain. The steam engine thus came into being and saved the situation. When, at a somewhat later date, James Watt, by further application of the same physical laws, added fresh powers to the engine, the modern steam engine came into view, with all its applications to railways and steamships and many other marvels of to-day. In 1831, Faraday, in the course of certain systematic searchings, found out the way in which one electric current could bring another into being, the so-called electromagnetic induction. With that single day's work began the whole development of electrical engineering in its innumerable forms. I need not increase the number of my illustrations.

More often it happens that scientific knowledge enters with less instantaneous and startling effect into the history of a craft. It is only when we come to consider the various details of some modern product of craftsmanship that we suddenly realise how closely every detail is connected with the advance of science, and indeed, to be more particular, with the scientific laboratory.

Let us think for a moment of one of those magnificent ships for which the Clyde is famous. Let us survey its various parts in our minds. Its hull of steel recalls the great forges of Britain, and the wealth of research that has been spent in works and metallurgical laboratories on the nature and qualities of steels of all kinds, research which is still in progress. Within are the engines, turbines perhaps, or reciprocating, or it may be internal combustion engines, Diesel or others.

What a range of inquiry and trial and development lies in every detail, depending always on principles of physical and chemical science, tested at every stage by instruments which are a craft in themselves! You may think of the screw and of its design. You picture the curious and most efficient thrust-block by which the force of the screw is brought to bear upon the ship, and remember that Michell lately designed it on the basis of the physical laws of liquids. You look aloft and see the wireless and are reminded that this sprang directly from the physical laboratory. Your sounding apparatus is based on Kelvin's designs; it may be that you have fitted your ship with the wonderful and still more recent apparatus for sounding by echo, which enables her to find the depth of water, shallow or deep, even when she is travelling at high speed. The War forced this adaptation of the laws of acoustics. She is sure to carry some form of refrigerating apparatus, and now we are reminded of all the investigations into the production of cold by students of science like the Frenchmen Cailletet and Pictet, by Onnes in Holland, and by Dewar, whom, as befits the occasion, I will call a Scotsman rather than an Englishman. So you pass from one great feature of the ship to another, and presently from detail to detail; and you find that the whole structure is linked by innumerable ties to the research work of the laboratories. Craftsmanship in its urgent need has called upon scientific knowledge for aid, and the mighty growth is due to the response. Indeed, it is not only craftsmanship that has grown, but also science itself.

If you hinder the growth of science in any way, you hinder the growth of craftsmanship. Now it is an important fact that science advances over a wide front, and the various branches of it move on together; not absolutely keeping step with each other, but preserving a general line. It has been suggested that science might refrain from development in some directions or, even as our good friend the Bishop of Ripon said at Leeds last year, we might proclaim a ten years' holiday. But you cannot prevent interested men from making inquiry. You cannot prevent the growth of knowledge; you cannot even make a selection of those points of advance which will lead to certain select classes of results. No one knows what is over the hill. The vanguard moves on without any thought of what is before it. That is why, if the march of science is to be conducted in an effective and orderly way, were it only for the purposes of industry, there must always be a certain number of laboratories or parts of laboratories where scientific research has no immediate thought of possible applications.

Science in Industry.

If I read modern industrial conditions rightly, the closeness of the connexion between craftsmanship and science may be illustrated in yet another way. It is, I think, a fact, and a remarkable fact, that the most active of our modern industries are those which are founded on recent scientific research. The most notable is, of course, that of electrical engineering. The year that sees the celebration of our Association's centenary will witness also the ceremonies that commemorate the basic experiment of Faraday. It is difficult to sketch in a few words the great edifices that have been built upon the discovery of electromagnetic induction. We might look upon it financially and picture, as some of my hearers can do, the amount of capital involved in electrical undertakings throughout the world, electric lighting, electric transmission of power, cables, and now wireless, not to mention all the minor uses to which electricity is put. The transference of matter, of intelligence, of thought, of sound, even of vision, is largely dependent on electromagnetic action. If we are not familiar with financial quantities, let us just think for a moment of the change in our lives if every electric current ceased to run; and let us realise that the whole mechanism of modern intercourse would fail, and that populations born to use it would be brought to dire distress.

Though the electrical engineering industry with all its branches may be said to have its source in a single laboratory experiment, yet it has grown by the continuous adaptation of fresh streams of knowledge. The huge American corporations maintain research laboratories costing millions of pounds annually, and find that the financial return justifies their policy. The General Electric Company found that a costly research into the structure of the electric lamp repaid itself over and over again. The very important technical discoveries of Langmuir and Coolidge were consequent upon an attempt to find out what happened on the surfaces of the glass bulb and of the glowing filament. The point is that the electrical industry was not merely launched by a single discovery; it is continually guided, strengthened, and extended by unremitting research.

Consider the very active motor industry. The most important of all the problems connected with the internal combustion engine is that of the nature of the explosion, the effects of varying the mixture, the movement of the gas in the cylinder before the ignition, the actual occurrences at the moment of ignition, the movement of the subsequent explosion wave. The problems are exceedingly intricate. They have been and are the subject of intense research in various laboratories in Great Britain. The research is new and the industry is new. The construction of the engine depends on the use of alloys possessing the most remarkable properties, all of which were practically unknown until recent researches of the metallurgists brought them to light. The motor car is connected, too, with the laboratories in which chemistry and physics are applied to the study of rubber. Here again is a whole story in itself, which would tell of the work done on the intricate consequences of various kinds of mixings and of treatment, of the vulcanising and of the use of 'fillers.' Not many know the story; they are only aware that motor car tyres last longer than was once the case.

The aeroplane, like the motor car, has become possible because of the advent of the internal combustion engine; but it has a unique feature—its element of romance, its motion through the air. The laws of aerodynamics are becoming better known, and with every advance in their knowledge the efficiency of the aeroplane increases. Their intricacy is gradually resolved, but the process demands, in the first place, mathematical skill, and in the second the fascinating research that is carried on in the wind channels of our laboratories. On this splendid work the progress of the aeroplane depends. I saw not long ago in a London shop window a coloured print of a flying machine. From across the street it might easily have been taken for a drawing of a modern aeroplane; a closer view showed still the same general spread of wings, the same whirling screws, the same discharge from the exhaust, a boat not at all untrue to modern design, and wheels to bear it when on land. Moreover, the proportions were quite familiar. Yet the date was 1843. For all its resemblance to the modern aeroplane, how far it was from flying not only in time but also in capacity! The difference between old and new in the form and materials of the wings may not be obvious to the casual observer, but in reality a wealth of trial and calculation lies between the crude projections of the old invention and the modern machine that flies. The turn of a line in the sectional outline of the wing may make the difference between success and failure, though it is only one of innumerable and equally essential details. The scientific worker grasps the meaning of that turn, and the airman tries it out, and that is the combination which brings success at last. The point is that the construction of the flying machine is a new industry based directly on knowledge recently acquired in the laboratories and continually growing under laboratory experiment. Ever thing depends on this careful, well-informed concentration on essential details.

If we enter the chemical province, we find that there are thriving industries based on recent scientific discovery; instances at least as remarkable as those possessing a more physical basis. The chemical industries are so many and various that even a brief summary is beyond me; yet the whole of them are of comparatively recent origin. Quantitative chemistry is little more than a century old; and the more modern and more vigorous of the chemical industries depend on very recent chemical research, as, for example, those which deal with dyes, explosives, fertilisers, rubber, artificial silk, and many other things. It is the same story: the craft is based on science, and in this case very obviously so. Chemical industries are based on scientific discovery, and lean on it the whole time.

It is natural to compare the condition of the newer industries with the older industries known as basic, because they have long constituted by far the major portion of the country's industrial effort and are still pre-eminent: coal and steel, cotton and wool. In some of these industries there is serious depression. What has the fact to do with science and scientific research?

It is obvious that we cannot say of any industry or craft that its condition depends only on scientific knowledge and imagination. The difficulties of the coal trade are due in large part to the powerful cause of competition. We had a good start in the knowledge of the existence of our coal deposits and in the practice of working them, in the means of distributing coal, and in methods of making use of it. We reaped our harvest. But as time went on other nations gathered way in pursuit of us; they also found coal deposits, they learnt how to work them, and could even improve on our practice because they could profit by our mistakes to a greater extent than we ourselves. They had not so much old machinery to scrap. Means of transit were developed in these countries; in fact we helped to develop them, as also the industries that used the coal. Such conditions must inevitably have tended to diminish our lead. The War acted suddenly and violently in the same direction. It is reasonable, though deplorable, that the industry should find itself in difficulties. The situation is not wholly irremediable, though the older conditions can never completely return. But at least a partial retrievement is possible, and we know that various research organisations, some instituted by the State and some due to private enterprise, are grappling with the question involved. It is deeply interesting to see in what way the necessary efforts are being made, and indeed must be made.

Now, whatever is done, and in whatever way it is done, the results of such endeavour, whether related to the coal or to any other industry, depend on those relations between craftsmanship and science which I have been trying to define. I would now consider these relations from one or two separate points of view. In the first instance let me say a word concerning the general connexion between science and that condition in industry which is known as mass production.

Significance of Mass Production.

It must always be the aim of an industrial organisation to devise and set going one of those systems of manufacture on a large scale with which we have become familiar in recent years. With the aid of suitably designed machinery and methods, great numbers or quantities of some article in general demand can be produced at a comparatively small running cost. Generally, however, the initial cost is heavy, for the designing of the machinery and the planning of the methods call for great experience and skill, and they demand much time spent in the acquirement of the necessary knowledge and its utilisation in design. Once the process is under way it may be possible, and it seems to happen on a sufficiently attractive number of occasions, that a smooth and peaceful running of the machinery brings in the wished-for returns. But every such phase of production comes to a natural end. An improved process is devised, and the new displaces the old. Or it may be a factory is set up in another country where labourers can be hired more cheaply ; they may be intrinsically inferior, but that will not matter if they can be drilled into the mechanical process ; and, so long as the machine runs true, the standard will not fall below a certain value. The event is in accord with expectation, because men will always try to improve their productivity by the use of new knowledge or more favourable conditions, so that those who fail to recognise the principle will be left behind by those who do not. The stereotyping of some process can be fruitful only for its allotted time. Mass production is in its way splendid, ministering to the necessities and conveniences of many who must otherwise have gone without. But, if it is brought to such a pitch that its processes call for little intelligence in their working, then cheap people of little intelligence will be found, in the end, to be in charge.

The relation of science to mass production is therefore both that of builder and that of destroyer. Mass productions are temporary lulls in the movement of imagination and knowledge. Much skill and thought and care may be required to arrange for one of those quiet and profitable times ; the machine is set going and for a while goes by itself. But new applications of scientific knowledge, new ideas, new processes, new machines must always be in preparation. In the parks the gardeners are always nursing fresh plants to take the place of the old, and preparing them for their useful time of flowering. So we see the meaning of the various research organisations which have been set up in the basic industries, such as the Fuel Research Board, the Cotton, the Woollen, and the Silk Research Associations, the research laboratories of the steel masters at Sheffield. Much of our hope for the future is built upon their work.

Industrial Adaptation.

If craftsmanship, to fulfil its task of providing for the people, must be continually improving its processes, then the nation that is to be successful must possess the means and the will to improve, and here we come, I think, to a notable point. May it not be said that in Great Britain the means exist even to a remarkable degree ? Our craftsmen, as a whole, including all grades, are possessed of qualities, intelligence, skill, accuracy, and so on, which make improvement possible. How could our enterprises in the past have been so often successful if this had not been so ? How can we be succeeding so well in respect to the new industries of the present if the capacity is not there ?

Should it not, therefore, be our policy to take advantage of our country's qualities by continually seeking for fresh industries or fresh adaptations of the old ? We should surely not cling unduly to older activities when they have reached the stage in which many others have learnt to do them with equal efficiency, and when we can go on to something new and, it may be, more difficult. We can, of course, bolster up old industries by political methods, and I have no wish to decry such methods as always incorrect. But clearly the best protection of all is the knowledge and skill which can enable us to produce what others must ask us for because they cannot so well make it themselves.

Absorption of Scientific Discovery.

These considerations lead naturally to a second aspect of the relations between craftsmanship and science. The improvement of craftsmanship depends in large part on the absorption and adaptation of scientific discovery. How is the process to be encouraged?

We here come to a point which must be emphasised with all possible vigour, because its importance is not always realised. Scientific knowledge and experience, if they are to be of full service, must be in direct practical contact with the problem that is to be solved. This must be clear to every one of us from actual experience. If you have expert knowledge on any subject and your advice is asked, your first instinct is, as you all know, to ask to be allowed to see for yourself. It is only when all the circumstances are clear to you in their relation to the difficulty that the solution is likely to suggest itself; and it may take much watching and patient observation before you are successful. It is the combination of actual experience with scientific knowledge that is essential. As the principle is so fundamental, I may be allowed to illustrate it by an actual experience:

It was in the early years of the War that a body of young scientific students from our universities was assembled for the purpose of testing on the battlefield the value of such methods of locating enemy guns as were already known. In their mutual discussions and considerations it became clear to them that the great desideratum was a method of measuring very exactly the time of arrival of the air pulse, due to the discharge of the gun, at various stations in their own lines. If the relative positions of the stations were accurately known, it would then become a matter of calculation to find the gun position. But the pulse was very feeble: how could it be registered? Various methods were considered, and among them was one which no doubt seemed far-fetched and unlikely to be successful. A fine wire is made to carry an electric current by which it is heated. If it is chilled, for example, by a puff of cold air, the resistance to the passage of the current increases, and this is an effect which can be measured if it is large enough. If, then, the hot wire could be made to register the arrival of the air pulse from the gun, a solution of the problem was in hand.

No doubt this method occurred to several members of the company; it was certainly turned over in the mind of one of them who had had considerable experience of these fine heated wires. They had been in use about thirty years, having been employed for the measurement of temperature in many circumstances where their peculiar characteristics gave them the supremacy over thermometers of the ordinary form. But, and this was the important point, was it to be expected that the effect, though it must be there, would be big enough to see? Could the faint impulse from a gun miles away produce an obvious chill on a hot wire? On first thoughts it did not seem likely, and the suggestion lay in abeyance.

It happened, however, that one summer morning an enemy aeroplane came over at daybreak on a patrolling expedition. The officer of whom I have spoken lay awake in his bunk listening to the discharges of the anti-aircraft guns and the more distant explosions of their shells. Every now and then a faint whistling sound seemed to be connected with the louder sounds. The wall of the hut was of felt; it was in poor condition and there were tiny rents close to his head as he lay. The gun pulses made a feeble sound as they came through. This set the officer thinking: if the pulse was strong enough to make a sound, it might be strong enough to chill a hot wire perceptibly. So the method was proposed to the company as worth trying. It was tried, and proved to be a complete success. The sound ranging of the British armies was based upon it, with results which have already been described and are fairly well known.

It is clear that the all-important suggestion could have been made only by a man who had had scientific training and experience. That is one point of the first significance. The second is that it could have been made only by such a man actually on the spot. He could not have realised the details of the problem if he had been anywhere else.

It is worth while to consider this last point a little more closely. What precisely was the difficulty which could be resolved only by a combination of knowledge and of being on the spot? It was really the difficulty of making a true estimation of quantities. It was a question of magnitudes and measurements. Anyone possessed of scientific knowledge could have said, if asked, that a gun must make an air pulse, and that an air pulse would chill a hot wire to an extent which might or might not be measurable. But there is all the difference in the world between such vague general knowledge on one hand and, on the other, the realisation that such a method is likely to work and give the desired result. It is the difference which so often escapes attention, but everyone of experience knows that it is to be reckoned among the essentials. It is so easy to talk generalities or to think of them, and so difficult to get down to the details which make the effort a success. It may be the last little adjustment of magnitudes that turns the scale, and the last step the one that counts.

Are we, then, in Great Britain, putting our scientific knowledge into the position where it is really effective? I would direct your attention to a most interesting and important movement which is attaining a notable magnitude.

Research and Service.

A new class of worker is growing up among us consisting of the man engaged in research associations and industrial research laboratories throughout the country. We must place a high value on their services, for they are actually and personally bringing back with them into craftsmanship the scientific knowledge which is one of its essentials. They bring the interest and the outlook of scientific inquiry into touch with both employer and employed, and I cannot but think that they may be to some extent the flux that will make them run together. For they can speak with the employer as men also trained in university and college, exchanging thought with ease and accuracy; and, at the same time, they are fellow workers with those in the shops and can bring back there some of the interest and enthusiasm which spring from the understanding of purposes and methods. It is to be remembered always that personal contact has, on the whole, thanks to the better qualities in human nature, a marvellous effect in smoothing out differences. I do not think it is unduly optimistic to welcome the growth of this new type of industrial worker, because it can, being in personal intercourse with both capital and labour, supply to each a new outlook on their whole enterprise, especially as that outlook is naturally illuminating and suggestive. For, after all, this is but going back to first conditions. The primitive craftsman has been replaced by separate persons or groups of persons who have slipped away from each other almost without our realising the fact. In the most recent times the separation has become more obvious and more dangerous, and that is why in so many directions efforts are being made to stem it. Can it be good that the workman has a part demanding little intelligence, merely the capacity to repeat? Can it be expedient that mere manipulation should be left in the shop, while design and imagination have gone into the drawing office and shut the door behind them? Can it be right that the factory directorate should not be in immediate contact with the vast body of scientific knowledge?

The present number of industrial research workers is relatively small; it seems likely to increase, however, in proportion to the extent to which the province of science is better understood. The better understanding I think of as manifesting in the first place in industry itself. I am sure that here it is happily on the increase. There is also a broader view to be taken. There is a public estimation of the value of any calling which affects the numbers and the quality of those who respond.

I doubt if there is in the first place sufficient appreciation of the interests and rewards in the life of a student of industrial research. The pioneers have suffered unnecessary restrictions and discouragements, but their followers will be in better case. Surely it does not need much imagination to realise the splendid side of such work? The succession of fresh difficulties to be overcome, and of new and interesting views into the nature of things and ways of the world; the unforeseen value of results, sometimes an immediate prize, sometimes the clearing of an obstacle in a manufacturing process, never less than the discovery of facts which may some day be of use; the personal association with a living enterprise and with the human spirit behind it. When it is realised that this kind of work is wanted badly, that it is really serviceable to the community, that there is opportunity for devotion, that it is in touch at once with human needs and with the furthest stretches of thought and imagination, it surely takes on to us the final touch of nobility.

We must remember also that the road of the student of science is still none too clear. The very methods of teaching science are a constant subject of discussion. I will say no more now than this: that the best methods must take time to elaborate, and cannot be expected to have arrived at their final form. The difficulty is increased by the fact that science itself grows rapidly, and the extent of its application is only now revealing itself.

That the knowledge of the immensity of Nature and the study of the natural laws have an educative value is well recognised. That science can be used as an educational drill is also known and made use of. But there still remains the human side; the continuous effect of the growth of knowledge upon thought and enterprise: the realisation of the immense part that science is playing in modern life and is likely to go on playing. Education by scientific instruction is still apt to lack the comprehension of the human side, without which the classroom is a dull place.

There are even some who think that science is inhuman. They speak or write as if students of modern science would destroy reverence and faith. I do not know how that can be said of the student who stands daily in the presence of what seems to him to be infinite. Let us look at this point a little more closely.

The growth of knowledge never makes an old craft seem poor and negligible. On the contrary, it often happens that under new light it grows in our interest and respect. Science lives on experiment; and if a tool or a process has taken shape from the experience of centuries, science seizes on the results as those of an experiment of special value. She is not so foolish as to throw away that in which the slowly gathered wisdom of ages is stored. In this she is a conservative of conservatives.

Progressive Science.

What is true of a tool or process is true also of those formulæ in which growing science has tried to describe her discoveries. A new discovery seems at first sight to make an old hypothesis or definition become obsolete. The words cannot be stretched to cover a wider meaning. By no means, however, is that which is old to be thrown away; it has been the best possible attempt to express what was understood at the time when it was formed. The new is to be preferred for its better ability to contain the results of a wider experience. But in its time it will also be put aside. It is by a series of successive steps that we approach the truth: each step reached with the help of that which preceded it.

Nothing in the progress of science, and more particularly of modern science, is so impressive as the growing appreciation of the immensity of what awaits discovery, and the contrasted feebleness of our ability to put into words even so much as we already dimly apprehend. Let me take an example from the world of the physical sciences. There is a problem of which the minds of physicists have been full in recent years. The nineteenth-century theory of radiation asks us to look on light as a series of waves in an all-pervading ether. The theory has been marvellously successful, and the great advances of nineteenth-century physics were largely based upon it. It can satisfy the fundamental test of all theories, for it can predict the occurrence of effects which can be tested by experiment and found to be correct. There is no question of its truth in the ordinary sense.

In the last twenty or thirty years a vast new field of optical research has been opened up, and among the curious things we have found is the fact that light has the properties of a stream of very minute particles. Only on that hypothesis can many experimental facts be explained. A wave theory is of no use in the newer field. How are the two views to be reconciled? How can anything be at once a wave and a particle? I do not believe that I am unjust to any existing thinker if I say that no one yet has bridged the gap. Some of you who were present at the Liverpool meeting may remember that Bohr—one of the leading physicists of the world—doubted if the human mind was yet sufficiently developed to the stage in which it would be able to grasp the whole explanation. It may be a step forward to say, as we have been saying vaguely for some years, that both theories are true, that there are corpuscles and there are waves, and that the former are actually responsible for the transference of energy in light and heat, and for making us see; while the latter guide the former on their way. This is going back to Newton, who expressed ideas of this kind in his "Opticks," though he was careful to add that they were no more than a suggestion.

We are here face to face with a strange problem. We know that there must be a reconcilement of our contradictory experiments; it is surely our conceptions of the truth which are at fault, though each conception seems valid and proved. There must be a truth which is greater than any of our descriptions of it. Here is an actual case where the human mind is brought face to face with its own defects. What can we do? What do we do? As physicists we use either hypothesis according to the range of experiences that we wish to consider. To repeat a phrase which I employed a few years ago in addressing a university audience familiar with lecture timetables, on Mondays, Wednesdays, and Fridays we adopt the one hypothesis, on Tuesdays, Thursdays, and Saturdays the other. We know that we cannot be seeing clearly and fully in either case, but are perfectly content to work and wait for the complete understanding.

When we look back over the two centuries or so during which scientific men have tried systematically to solve the riddle of light, or even go further back to the surmisings of philosophers of still older time, we see that every conscientious attempt has made some approach to the goal. The theories of one time are supplanted by those of a succeeding time, and those again yield to something more like the first. But it is no idle series of changes, of vagaries of whimsical fashion; it is growth. The older never becomes invalid, and the new respects the old because that is the case.

Surely it is the same in regard to less material affairs. The scientific worker is the last man in the world to throw away hastily an old faith or convention, or to think that discovery must bring contempt on tradition.

There is a curious parallelism here to a relation between science and industry of which I have already spoken. Just as any particular case of mass production can be regarded as a temporary condition which the growth of knowledge brings about, and in the end supersedes, so also it may be said of any law or rule or convention or definition that knowledge is both the parent and eventually the destroyer. Time devours its own children. Even if a statement retains its outward form, its contents change with the meanings attached to its terms: and change, moreover, in different directions when used by different people, so that constant re-definition is necessary. How much more is this the case when the contents themselves have to be added to. The distinction between truth itself and attempts to embody it in words is so constantly forced upon the student of science as to give his statements on all matters a characteristic form and expression. This is, I think, one of the reasons why men are often needlessly alarmed by the new announcements of science and think they are subversive of that which has been proved by time.

To this consideration I may add yet one more, which may be illustrated by the same analogy. Scientific research in the laboratory is based on simple relations between cause and effect in the natural world. These have at times been adopted, many of us would say wrongly, as the main principle of a mechanistic theory of the universe. The relation holds in our experimental work; and so long as it does so, we avail ourselves of it, necessarily and with right. But just as in the case of research into the properties of radiation we use a corpuscular theory or a wave theory according to the needs of the moment, the two theories being actually incompatible to our minds in their present development, so the use of a mechanistic theory in the laboratory does not imply that it represents all that the human mind can use or grasp on other occasions, in present or in future times.

Ultimate Aims.

The proper employment of scientific research is so necessary to our welfare that we cannot afford to allow misconceptions to hinder it; and the worst of all are those which would suppose it to contradict the highest aims. Science, as a young friend said to me not long ago, is not setting forth to destroy the soul of the nation, but to keep body and soul together.

Some perhaps might say that in considering science in relation to craftsmanship I am pressing the less noble view; that I am not considering knowledge as its own end. It is said that uselessness in science is a virtue. The accusation is a little obscure, because it may justly be said that knowledge is never useless. If I have thought of science in relation to craftsmanship, it is because I have tried to set out the vast importance of what craftsmanship means and stands for. I have not forgotten that there are other aspects of the inquiry into the truths of Nature. Indeed, I could not carry out the lesser task without considering the whole meaning of science.

No clear line can be drawn between pure science and applied science: they are but two stages of development, two phases which melt into one another, and either loses virtue if dissociated from the other. The dual relation is common to many human activities and has been expressed in many ways. Long ago it was said in terms which in their comprehensiveness include all the aspirations of the searcher after knowledge: "Thou shalt love the Lord thy God with all thy heart, and with all thy soul, and with all thy mind"; and "Thou shalt love thy neighbour as thyself." In the old story, every listener, from whatever country he came, Parthians and Medes, Cretans and Arabians, heard the message in his own tongue. A great saying speaks to every man in the language which he understands. To the student of science the words mean that he is to put his whole heart into his work, believing that in some way which he cannot fully comprehend it is all worth while, and that every straining to understand his surroundings is right and good; and, further, that in that way he can learn to be of use to his fellow men.

Summaries of Addresses of Presidents of Sections.[1]

The Volta Effect.

In his presidential address to Section A (Mathematics and Physical Sciences) on the Volta effect, Prof. Alfred W. Porter endeavours by a restatement of the problem, approached from the thermoelectric point of view, to make clear what the usual equations represent. The usual equation for the electromotive force in a thermoelectric circuit is not a description of what occurs at different points of any one circuit, but is an equation connecting together the e.m.f.'s of distinct circuits for which the terminal temperatures are different. Much of the confusion which abounds in the Volta controversy is due to inattention to this fact. Another source of error arises from the assumption of 'perfect gas' relations for cases to which such relations do not apply. It is not true, in general, that the external work done by a system (at constant temperature), and the heat taken in by the system, are a measure of one another. It would be true for a 'perfect gas'; but even this is an ideal case, and for real gases it is not true. Nor is it even approximately true in the majority of systems: examples are given to illustrate its failure. Consequently, it is quite unsafe to take the supposed equality of the heat and external work as a starting-point for discussions on the Volta effect.

Modern developments in electricity have made the thermodynamical arguments much more cogent than they were in Maxwell's days, when the substantial nature of electricity was regarded as a provisional hypothesis which might ultimately be dispensed with. There is now no doubt about its corporeal character—using the adjective in the sense in which we apply it to other forms of matter. The term specific heat applied to electricity means now just what it means when applied to iron: but it has to be remembered that when inside a metal, the electricity (from the thermodynamic point of view) is in a solution. It is therefore the properties of solutions that need to be considered. The boundary between zinc and copper acts as a semi-permeable membrane, since the electrons and nothing else get through it. There is a difference of pressure (or potential) between the two sides. The electrons can also escape to some extent from the sides of the wires, that is, they have a vapour pressure. If the temperature is raised this evaporation becomes very conspicuous as thermionic emission. When equilibrium exists between two metals, the vapour pressure of the electrons must be the same for both. To such cases Margules' thermodynamical theorem must apply. By applying this theorem to simple cases, results are obtained very similar to those obtained by applying Boltzmann's theorem. Moreover, the latent heat of transference of electricity from one metal to the other is connected with the specific heats of electricity in the two metals.

When we pass to electrolytic regions, that is, voltaic cells, there is much more uncertainty as to what happens at the boundaries. Physical chemists, under the influence of Debye, are revising their conceptions in regard to solutions. The old dissociation theory assumed that positive and negative ions moved about quite freely except when appropriate collisions occurred when combination might take place, the amount of combination being calculable from the law of mass action. Debye, however, assumes complete dissociation (at least for dilute solutions), but with attraction between the ions due to their charges. Philosophically, there is not much distinction between the old and the new conceptions. The numerical results, however, are different as calculated by the two methods.

At a boundary between metal and solution no electricity gets through except as a rider on an ion. At least this must be so in all cases in which Faraday's laws of electrolysis are valid.

On the other hand, the boundary between two solutions (for example, in a Daniell's cell) acts as a membrane more nearly of the metallic kind. Electrons riding on an ion in one solution get through, leaving their mounts behind and seizing others in the second solution. It is not unlikely that the voltage there may be of the same order as that at the outside copper–zinc junction but of the opposite sign; for in both cases electrons alone are passing. If this is so, then the electromotive force of a circuit may, at least approximately, be the sum of those arising at the metal–liquid junctions.

It is necessary to be cautious and to avoid dogmatism on the question of the voltages at the individual boundaries. Much more detailed experimental knowledge is required before the electric circuit is really understood. The electronic theory in metals still has its difficulties, which it is of no use to ignore. On the other hand, the experimental difficulties in connexion with the direct

[1] The collected presidential addresses delivered at the meeting are published under the title "The Advancement of Science, 1928." The volume is obtainable at the Glasgow meeting for 4s. 6d., or at 6s. of all booksellers or from the British Association, Burlington House, London, W.1.

determination of the Volta effect are also very great, as all who have made experiments on it know.

Though the voltage at the metal–metal junction is likely to be much larger than the chemical school demanded, there is nothing to justify one in going to the opposite extreme and expecting that the *whole* of the electromotive force of a circuit is located at that junction. Opposing schools should take comfort in the thought that in some respects they are both right.

Fluorescence, Phosphorescence, and Chemical Reaction.

Prof. E. C. C. Baly, president of Section B (Chemistry), has selected for his address the fascinating subject of phosphorescence, fluorescence, and chemical reaction, a field of study in which observations of high accuracy concerning the physical properties of molecules, in contradistinction to those of atoms, have been made. In his survey of the results already obtained and the trend of research, Prof. Baly states that the present position is very far from being satisfactory. On one hand, large and increasing numbers of photochemical reactions which are obviously stimulated by the absorption of radiant energy are known ; on the other hand, the radiation hypothesis, which is based on premises apparently theoretically sound, has been proved to be untenable, so that the general consensus of opinion has swung over to activation by collision in thermal reactions. He has therefore 'exhumed the body' of the radiation hypothesis, in order that the cause of death might be more fully investigated.

Summarising the position, Prof. Baly says that the radiation hypothesis states that the first stage of a chemical reaction is the activation of each molecule of the reactant by the absorption of one quantum of energy. Photoluminescence evidence supports the reality of this critical quantum of activation, but not the supposition that the molecule gains this quantum by a single absorption process. The 'exhumation,' however, of the radiation hypothesis raises the question of thermal reactions in an even more acute form than previously. Unless some mechanism exists whereby a molecule can gain its critical quantum of activation from a source of infra-red radiation, photochemical activation must be viewed as an abnormal event and the radiation hypothesis must be promptly re-interred.

Prof. Baly next refers to experiments on the photosynthesis of carbohydrates. Carbonic acid in aqueous solution is not acted on by white light, and when adsorbed on a coloured surface does not react in the dark, but when adsorbed on a coloured surface and irradiated by white light it reacts to form carbohydrates. Hence the complete activation of the carbonic acid must take place in two stages : partial activation by adsorption with formation of a molecular state capable of adsorbing some rays within the visible spectrum, whereby the activation is completed by photochemical means. Further, the number of partly activated molecules which are able to enter into the final reaction is in linear proportion to the temperature. Evidently the adsorption process alone is not sufficient to bring the molecules into a state which enables them to react photochemically under the influence of visible light, the supply of heat energy being necessary to complete the partial activation. The hypothesis that a complex, A^-B^+, where B has gained its critical quantum of activation at the expense of the rotational energy of A, is formed is, however, applicable both to the synthesis of carbohydrates and, for example, to the behaviour of phenolic ethers with sulphuric acid. It also offers an explanation of the phenomena of photoluminescence. Moreover, this hypothesis is supported by the fact that the most effective method of deactivating an activated phosphor is by exposing it to infra-red radiation.

Prof. Baly considers that the success which has attended the application of the hypothesis of complex formation justifies its general application to all thermal chemical reactions, and that the known catalytic activity of water in inorganic chemical reactions may be connected with its great ionising power, for it is possible that ionisation itself is the result of complex formation between solvent and solute.

The Palæozoic Mountain Systems of Europe and America.

Mr. E. B. Bailey's presidential address to Section C (Geology) is a natural development of the writings of Suess and Bertrand. It deals with folded mountains, and explains that geologists can recognise such mountains by their internal structure even where old age has deprived them of their original height and form. Both in Europe and North America, there are immense regions that have escaped mountain-folding since the dawn of the Cambrian. In Europe we find Baltica, a triangular area with its base along the Urals and its apex in South Wales. In North America the corresponding area is Laurentia, situated between the southwardly convergent Atlantic and Pacific mountain belts.

The north-western edge of Baltica is furnished by the Caledonian Chain of Britain and Scandinavia. The folding of this chain is of early Palæozoic date, not later than Devonian. Törnebohm has described its south-eastward overthrusting on to Baltica in Scandinavia ; Callaway, Lapworth, Peach and Horne, its north-westward overthrusting on to the European representative of Laurentia, in the north-west Highlands of Scotland. This last relation recurs in Newfoundland, maritime Canada, and northern New England, as demonstrated by Logan.

Throughout the address, emphasis is laid on subsidence preparatory to mountain-building (Hall, Dana, Haug). This subsidence originates and maintains tectonic slopes. Where sediment is delivered at the top of such a slope, it may be sorted out through arrest of its coarser material in deep water. Where sediment is delivered at the foot of such a slope, it remains at the bottom, and any submerged platform at the top of the slope may therefore furnish a propitious site for the growth of clear-water limestone. The former condition is illustrated in the preparatory history of the Southern Uplands of Scotland, elucidated by Lapworth ; the latter in that of eastern Canada.

The more southerly of the two chains which meet about the western angle of Baltica in South Wales belongs to the Hercynian System of Carboniferous date. Its northward overthrusting in Belgium has often been described. The history of its preparatory subsidence is reflected, first, in the geographical distribution of Old Red Sandstone and marine Devonian, and secondly, in that of the Carboniferous Limestone and Culm facies of the Lower Carboniferous.

The Hercynian Chain begins to cross the main Caledonian Chain in South Wales and Ireland. The process is continued in southern New England. In Pennsylvania the Hercynian Chain steps clear of its Caledonian predecessor and marginally overrides Laurentia. Of late years, Wegener has developed the idea of continental drift on a grandiose scale. He has accounted for many recognised correspondences in the geology of the two sides of the Atlantic by supposing that the ocean has flowed in between the Old World and the New, as the two continental masses, with geological slowness, drift asunder. One cannot help feeling that Wegener may perhaps be telling us the truth. The available evidence is crude and ambiguous; but it is certainly startling to be confronted on the coasts of Britain and New England with what read like complementary renderings of a single theme : the crossing of Caledonian Mountains by Hercynian.

Origin and Evolution of Larval Forms.

In his address to Section D (Zoology), Prof. W. Garstang selects the Mollusca as a large and representative class of marine Invertebrata, and after a survey of the larval forms within the group, puts forward certain general results which define his point of view. Haeckel's 'Biogenetic Law' is rejected as inconsistent with the unity of the inheritance established by modern genetics (" The Child is father of the Man "). The larva is regarded as a specially locomotive phase of the life-history with a double task, to distribute the species, and to grow up into the adult ; but the extent to which a given larva proceeds with the development of adult characters during its pelagic career is conditioned by its ability to carry the additional weight. The primary larva in each order of Mollusca is a simple trochosphere like that of Annelids. It later develops the adult characters of shell and foot to a degree which varies with the power of its locomotive girdle or prototroch. The larva of *Chiton*, with a weak girdle, develops merely the cuticular rudiments of its shell-plates, but no foot ; those of *Dentalium* and *Yoldia*, with a large girdle, develop the complete adult form. In the higher and more modern types of Bivalve and Gastropod, the larva, equipped with an extended velum, is provided with shell and foot from the first ; and these organs—which in the more primitive groups (*Chiton*, *Dentalium*) are mere anticipations of adult form and larval encumbrances—now become integral parts of the larval organisation, thus creating a new and higher type of larva (*e.g.* veliger).

The question is then raised how far the modification of incipient adult characters can be carried in a larva without breaking the unity of the inheritance and affecting the final form. Temporary modifications of shell and foot are easily rectified by later growth, but what if the larval modification involve the internal organisation and rectification be impossible ?

Prof. Garstang claims the torsion of Gastropods as a case in point. Torsion makes the Gastropod. In the adult sequence, as expressed in classification, torsion appears as a true saltation, complete from the first, with no trace of intervening stages. In the development of limpets it has been shown by Boutan to take place suddenly during the free larval life, apparently by a muscular twist, which in the course of two or three minutes reverses the relations of head and foot to the developing mantle-chamber. It thus provides the larva for the first time with a space into which its head and velum can be instantaneously withdrawn on the approach of danger, under cover of a pedal operculum hitherto lacking. In higher Gastropods this rapid larval mode of development is replaced by a more gradual growth-process during the embryonic period. The facts accordingly point to the origin of torsion from an adaptive larval mutation, the persistence of which into the adult stage transformed an early creeping Mollusk into the first Gastropod.

The rest of the address is devoted to corroborative evidence, largely based on the significance of the 'marginal slit' which has characterised mantle and shell of Zygobranchiate Gastropods from Cambrian times to the present. The early development of this slit at the outset of the adult life is regarded as the response of the adult to the unsatisfactory respiratory conditions imposed upon it by the rotation of the branchio-cloacal chamber from back to front, where the free exit of water was blocked by the animal's head and neck. In limpets a new set of gills has been developed outside the chamber altogether, while Azygobranchiates have sacrificed the right gill, and set up a single direct current through the chamber, in place of the original double one. All the evidence, therefore, direct and indirect, points in the same direction : torsion was not developed step by step in the interest of the adult, but suddenly in that of the larva, while the adult adapted itself to the results of the mutation, and created the primary suborders of Gastropoda by so doing.

Ancient Geography in Modern Education.

Prof. J. L. Myres deals in his presidential address to Section E (Geography) with aspects of ancient geography in modern education. Retrospect of the gradual recognition of the educational value of geography, and anticipation of the further changes which the 'next phase' should require, both in preparatory and in adolescent education, justify re-formulation of the scope and function of geography as co-partner with history in the distributional study of the factors in Nature which the departmental sciences, both 'physical' and 'moral,' respectively study in isolation. In such distributional study the regional or geographical aspect is inseparable from the chronological or historical, both in research and in all phases of utility as an element in education. Both the 'physical' and the 'moral' sciences acquire regional and historical aspects as soon as they come to be applied to human ends and problems, and their systematic treatment should be (and often has been) supplemented by regional and historical examples. But there is need, and frequent opportunity, for fuller correlation of programme, and co-operative team-work among teachers of geography, history, and the departmental 'pure sciences.'

Geographical teaching, like historical, is necessarily regional, and regional studies traverse and interconnect the study of historical periods. Principal illustrations of this are: (1) in the study of the 'home-land,' which is (or should be) central in primary education; in the study of the historical 'legacies' of the cultures (2) of Israel and (3) of Greece and Rome, on which modern European civilisation rests in all its higher aspects. Both these cultures owe most of their characteristics to the regional peculiarities of their 'home-lands,' and are imperfectly presented or appreciated when the geographical presentation of these is neglected.

All phases of education, therefore, which include study of 'biblical' or 'classical' history or literature, need to be co-ordinated with the geographical study of the Mediterranean region and the Nearer East. For the full significance of the national experience of Hebrews or Greeks is only realised when presented as a career of acclimatisation; in Israel, of a nomad-pastoral folk plunged into a sedentary agricultural regime and thereafter exposed to competing influences of neighbouring cultures, Babylonian, Egyptian, Assyrian, and Persian; in Greece, of diverse ethnic ingredients interfused in the highly specialised environment of the Ægean archipelago. Comparative geographical study of the same regional surroundings at successive historical periods has the further advantage of emphasising the reaction of human societies on their environment, especially the exhaustion of natural resources, and transfigurement of what passes in long-civilised countries for 'open country-side.'

For historical reasons, connected with the political history of the Near East, and the social history of our own country, the correlation of studies which was normal at the Revival of Learning became obsolete later, and the present problem is how best to restore it without overloading the time-table. The divorce between geographical study and the humanities being most serious in the 'classical' curriculum, through which the majority of educational administrators pass, as well as most of the teachers in higher secondary schools, it would seem that reform is most urgent at this point. Specific suggestions are: (1) systematic training in map-work throughout; (2) correlation of classical courses with the geography of the Mediterranean and the biblical study with that of the Near East; (3) more frequent reference to geographical literature of all periods, to supplement text-book instruction and encourage 'geographical thinking'; (4) initial and persistent recognition that geography as a science rests on observation and field-work, without which classroom teaching is sterile.

Increasing Returns and Economic Progress.

In the course of his presidential address to Section F (Economic Science and Statistics), Prof. Allyn Young points out that the older economists thought that increasing returns (increased output *per capita* as the total output grows) were characteristic of manufacturing industries, taken as a whole, but not of agriculture. Modern economists have probed into the details of the processes through which increasing returns are secured and have tried to ascertain just how the prices of commodities produced under conditions of increasing returns are determined. In particular, they have scrutinised the economies which come with the growth of the size of individual firms and of particular industries. Unfortunately, in the course of these special inquiries, the problem of increasing returns has been confused with other problems, such as the problems of monopoly and of industrial combination, and the larger features of the economic changes which account for increasing returns have been obscured. Increasing returns are primarily a matter of large production and only incidentally a matter of 'large-scale' production or of the size of individual firms or even of particular industries.

The secret of increasing returns is still to be found in Adam Smith's theorem that "the division of labour depends upon the extent of the market." The most important form of the division of labour is found in the use of what are called indirect, roundabout, or capitalistic methods of production. 'Mass-production' is a relative term. All roundabout methods involve a larger or smaller degree of mass-production. The degree in which it is advantageous to use such methods depends always upon the extent of the market. Mr. Ford's methods would be wasteful in a small automobile factory for precisely the reasons which would make it wasteful to construct a hammer to drive a single nail. The relatively high productivity of labour in a number of representative American industries is to be explained, of course, by the extent of the domestic market, unimpeded by tariff barriers, which is open to them, rather than by any superior efficiency on the part of their management.

The market grows, not only with geographical extension and the increase of population, but also with the general growth of production. In one sense, therefore, the division of labour depends upon the prior division of labour. Once set in motion, economic progress is continuing and cumulative. Even in the absence of the discovery of really new technical processes, increasing returns would be sure to continue to be realised—within the limits imposed by the scarcity of necessary natural resources. While there is, then, no effective tendency towards economic equilibrium, there is, nevertheless, an effective tendency towards an equilibrium rate of progress. Both the technical and the psychological costs of securing an increased annual national dividend increase disproportionately if the rate of change is accelerated beyond a certain point. This does not mean that increasing returns are illusory, that their advantages are negatived by their costs. Because a mountain climber adjusts his pace to his physical powers and to the conditions of the ascent, it should not be inferred that he might as well have stayed at the foot.

Engineering and Civilisation.

Under the title of "The Influence of Engineering on Civilisation," Sir William Ellis deals in his presidential address to Section G (Engineering) with the interesting subject of the direct association during the latter part of the last century between engineering and the amenities of modern life resulting from the great developments which have taken place in all branches of engineering. The address sets out very clearly how dependent civilisation is on each and all branches of engineering.

In connexion with civil engineering, it is pointed out that the very existence of the population in our large cities in health and comfort is to a large extent dependent on the work of the civil engineer in ensuring an ample and reliable supply of water of good quality and an efficient drainage control. The prosperity of various countries has largely resulted from irrigation works, in many cases the development of produce-growing being limited only by the fact that irrigation works have so far been insufficient. The work of the civil engineer appears also in the construction of larger docks and harbour basins rendered necessary by the great increase in the tonnage of ocean-going vessels and the designing of bridges for carrying the heavy traffic brought about by the development of railways all over the world, many of them in difficult mountainous countries.

Great changes have been brought about in railway transport in the last fifty years, and this side of engineering is of importance to the potential wealth of the great corn-growing countries. The growth of road transport has a direct bearing upon the railways, and attention should be given to the desirability of the construction of by-pass roads to divert heavy traffic from passing through towns and villages.

There have been wonderful developments in tonnage and horse-power of ocean-going vessels; and the safety and comfort of travelling to-day, compared with forty years ago, have been greatly increased. Sir William Ellis alludes to the great services which the engineering branch of the Navy rendered in the War, and to the developments which are taking place in connexion with internal combustion engines and the use of higher pressure steam for boilers.

The activities of mechanical engineers have led to many remarkable advances. Reference is made in the address to the advent of a new type of tool steel, and a suggestion is offered to machine toolmakers that they should keep more in touch with the actual users of the machines, who from time to time may have useful ideas based on personal knowledge of the output of the machines.

Sir William Ellis refers also to the progress of mining engineering and the use of electricity and compressed air engines in underground workings. The various developments of electricity, the telegraph, the telephone, electrical driving, lighting, etc., have contributed greatly to improve the domestic amenities of the general population. The wider use of electricity, both for lighting and heating, would be of great advantage for reasons of cleanliness and health. An interesting reference is made to the introduction of the telephone by Prof. Graham Bell at the British Association meeting in 1877. The address also refers to the great services which the introduction of radio has brought about to ships at sea.

Scottish Archæology.

Sir George Macdonald in his presidential address to Section H (Anthropology) deals with some aspects of the archæology of Scotland. Its systematic study may be said to have begun in 1780, when the Society of Antiquaries of Scotland was founded by the eccentric Earl of Buchan. Smellie's very complete contemporary "Account" of this foundation, and of the institution of what is now the National Museum of Antiquities in Edinburgh, shows how crude were the beginnings of what has since developed into one of the finest prehistoric collections in Europe. The process by which the dilettante is transformed into the scholar, the antiquary into the archæologist, is very much the same in all countries. But Scottish archæology was peculiarly fortunate in that its infant footsteps were guided by a man of the exceptional capacity and gifts which characterised the late Dr. Joseph Anderson. His memorable series of Rhind Lectures, delivered forty or fifty years ago, placed the subject once for all on a solid, because a thoroughly scientific, basis.

Anderson's analysis revealed the fact that, while the archæology of Scotland had much, very much, in common with that of other areas, it also presented certain features which had no parallel elsewhere—the brochs, for example, a notable group of earth-houses, the curious carved stone-balls, the massive bronze armlets, the so-called 'Pictish' symbols, and the heavy silver chains on which these last occasionally appear. As compared with the southern half of Britain, too, Scotland enjoys a great advantage in respect of the abundance of prehistoric material still available for study. The Royal Commission on Ancient Monuments is collecting much valuable information as to its distribution. But there remains a great field for excavation, properly organised and conducted.

Meanwhile, it is worth while asking how this wealth of material is to be accounted for. That so large a proportion should have survived is not surprising. The prehistoric settlers had naturally selected the treeless areas, and in Scotland the areas which were treeless in prehistoric times are precisely those which lend themselves least readily to cultivation under modern conditions. Many monuments which would have been swept out of existence by the plough have thus been spared all damage save that of natural decay. This, however, is only one side of the problem. It is more difficult to explain the relative density of the population that seems to have tenanted districts like the Western Islands, Sutherland, Caithness, the Orkneys and the Shetlands in prehistoric times.

It has been suggested that metal was the lure which attracted these early immigrants. The suggestion has about it the glamour of romance. But the area is not metalliferous, and, even if it were, one would still have to reckon with the neolithic wanderers. Geographical conditions afford a much more likely clue. In those far-off days the English midlands were thickly wooded, while the way through central Scotland was barred by swamps and morasses and, above all, by the Caledonian forest. The stream of population that moved northwards along the western fringe of Europe seems to have travelled through Ireland by way of the Western Islands into Scotland. There is archæological evidence to show that the Scots were by no means the earliest invaders. What had happened long before is fairly obvious. The set of the current of migration was always towards the north. At intervals a surplus of humanity would be spilled from Ireland, and for the folk who were thus driven out there would be but one open road. That road, however, was a cul-de-sac. Those who followed it would find that northern Scotland was literally the end of the world. When they reached Unst, they would scan the horizon in vain for any sign of land to tempt their frail craft farther. The ocean was for them an insurmountable barrier. As the pressure from the south increased, congestion in the rear of the barrier would be inevitable. That is why prehistoric monuments are so numerous in a region that is but sparsely peopled to-day.

Relation of Physiology to Other Sciences.

In his presidential address to Section I (Physiology), Prof. C. Lovatt Evans discusses the relation of physiology to other sciences. Physiology has a threefold appeal, in its relations to medicine and philosophy, and as a science with a distinctive position of its own. Physiological knowledge has always had the closest association with medicine; clinical observations and deductions drawn from them have shown that disease is always the result of a quantitative change in some physiological process. Athough there have been many striking advances in treatment during the last few decades, yet true discoveries, as distinct from inventions, are probably the results of chance observations, which lead to the formation of hypotheses, later deliberately tested by experiment; but it is given only to the few to realise the relationships of such chance observations and so to make the discovery. The importance of experiment in the ascertainment of physiological knowledge is stressed; in fact, no medical man can adequately treat his patient without utilising, at every turn, knowledge derived from animal experimentation and obtainable in no other way.

Advance in knowledge leads to specialisation, and the difficulties of selecting suitable minimum requirements of knowledge for the student in the different branches are increased; their solution appears to lie in modification of the present examination system and, on the part of the teacher, a proper perspective of the relation of his own subject to the requirements of the curriculum as a whole. It is impossible to give the average student such physiological training as will fit him to carry out research; those who wish to take it up must spend a further year or two in studying the subject.

Physiology takes its place as a science in proportion as its data are accurate and its principles fall into line with those in other sciences. With improvement in the accuracy of its methods, and by progress in the formulation of its problems, mathematics can be profitably employed in the manipulation of its data, but only when it leads to clarification of thought in both the author and his readers. Thus, help is obtained by the application of the theory of errors when the interpretation of a group of physiological experiments is rendered difficult by the occurrence of chance variations; important conclusions should not be drawn from a few observations unless the conditions are so well controlled that individual chance variations can only occur to a slight extent. Similar considerations affect the application of the other exact sciences in physiology. Physiology is something more than biochemisty and biophysics; it is, and always will remain, a biological subject.

Thus the exact sciences cannot furnish an explanation of physiological phenomena, nor, without direct reference to physiological facts, can they allow of their prediction. Pure physics, chemistry, or mathematics would not have enabled physiologists to predict the physico-chemical equilibria in blood, since these adaptations depend, among other things, on the presence of membranes round the red blood cells, the properties of which could only be determined by experiment. Once the phenomena were known, it was possible to describe them more accurately in physico-chemical language.

In discussing the philosophical position of physiology, it is pointed out that mechanistic interpretations of life tend in the long run to become superficial as the vitalistic ones predispose to scientific nihilism. It is unnecessary to attempt to decide between these two opposed views of the nature of life. Physiology should adopt a new point of view; the idea of adaptation should be taken as its basal principle. Life is conserved by adaptation, and it is essential to treat the organism and its environment as one if a proper insight into the adaptations manifested by the former is to be attained.

Psychology of Skill.

The subject discussed by Prof. T. H. Pear, in the presidential address to Section J (Psychology), is "The Nature of Skill." In the many studies of skill for the purposes of pure theory, education, industry, and sport, the word seems to have covered a heterogeneous collection of performances. In this address an attempt is made to give some idea of the mental and bodily happenings which constitute skill; to supply a scientifically useful meaning for the term, by filtering the popular meaning and rejecting irrelevant ones.

The definition of skill proposed is "an *integration* of well-adjusted performances." This will mark off skill from a mere congeries of habits, which might or might not be well-adapted. A habit is further defined as "an acquired specific response to a specific situation." Experimental work upon transfer of training has shown the futility of the concept of 'general habits.' The essence of habit, if the term is to retain any relation to ordinary language and remain useful, is specificity.

It would be premature to speculate upon the relation of skill to conditioned reflexes. Possibly they stand at opposite ends of a long scale of transition. The impressive fact that to ensure the certain conditioning of a reflex, the control of external surroundings must be complete, contrasts with the amazing difficulties against which a human being may acquire high-grade skill.

Skill implies the power, or powers, of 'patterning' responses. Of this an interesting form is 'knack,' which is discussed in detail, as well as the relation of human skill to natural aptitude. Many features attributed to skill in games and sports are, to borrow the language of logic, 'accidents' rather than 'propria.' This is even more true of skill in industry, where definite agreement concerning the nature of skill seems needed, a subject which will be discussed at the joint meeting of Sections F and J on Sept. 10. Owing to this ambiguity, many discussions concerning skilled trades, skilled jobs, skilled workmen and the disappearance of skill, are of little scientific interest. A classification of skills is attempted in the address.

The relation of intelligence and intellect to skill —a problem obscured by the current phrases 'clever with one's hands' and 'clever with one's head'—is discussed. It is suggested that many psychologists and intelligence testers have too little respect for the intelligence which thinks in terms of things rather than symbols for things. Abstract thinking is not confined to the use of auditory and visual symbols.

The relation between different 'muscular' or motor abilities, and the transfer of training from one ability to another, are discussed in the light of recent experimental investigations.

Sex and Nutrition in the Fungi.

In 1927 the president of Section K (Botany) dealt with the elementary types of holophytic plant life; this year attention is turned to saprophytic and parasitic forms. These have sometimes been assumed to be derived from diverse phyla of green plants, but Prof. Dame Helen Gwynne-Vaughan, in her presidential address, takes the view that they are more probably a separate group originating among the Protista.

Few of the fungi liberate gametes; in the great majority of those possessing a sexual process this consists of the union of cœnocytic gametangia which may be similar or may differ in size and form. In most of the Oomycetes male and female organs are borne on the same plant, but *Phytophthora Faberi* and species of *Dictyuchus* are diœcious. In the Mucorales the union of similar gametangia is common, but these are often borne on separate plants, and appear only when two appropriate mycelia meet. Blakeslee, who first observed this phenomenon, designated the mycelia as (+) and (−), and described those species with (+) and (−) mycelia as heterothallic. It seems clear that the distinction is one of sex, though, in the absence of visible distinction between the mycelia, or between the gametangia which they bear, the terms male and female cannot be used.

In the higher fungi only a few diœcious species are known, with male and female organs borne on different plants; but a large number are heterothallic, two or more mycelia co-operating in the production of fruits. One of the most striking characters both of the Basidiomycetes and Ascomycetes is the tendency of the vegetative hyphæ to fuse. Branches link up neighbouring filaments, whether of the same or different origin, and germ-tubes from distinct spores flow into one another. This condition has probably a nutritive value; it raises in a special form the question of the meaning of an individual.

In a considerable number of species mycelial fusions are required before fructifications can be developed; in most of these species there are two kinds of mycelia, in some there are four, in a few there are three. In all such cases only fusions between appropriate mycelia are immediately fertile, though in several of these heterothallic forms fruits will ultimately appear in single spore culture. Most investigators have considered the difference between the mycelia as one of sex, in spite of the complete lack in many cases of sexual organs, and the difficulty occasioned by the occurrence of three or four 'sexes.'

Alternatively, it is possible to regard the difference between the fusing mycelia as nutritive even when associated with the production of fruits. This hypothesis involves a consideration of the physiological conditions affecting the formation of fruits, and of the occurrence of saltation in fungi; it is strengthened by unpublished work on one of the Ascomycetes which is to be described in detail during the meeting of the Section.

The problem is one which affects our conception of the significance of sexual reproduction in all groups of organisms, and may serve to throw light on the primitive sexual process.

Education: the Next Steps.

Dr. Cyril Norwood, president of Section L (Educational Science), refers in his address first to the growing belief in the value of education which has characterised the twentieth century in England. But, since its history has been the story of satisfying practical needs as they have arisen, English education is as a system neither logical nor complete, and there are many gaps still to be filled.

The system of dual control in elementary education means the lack of simplicity, economy, and efficiency, and it is argued that in spite of the danger of raising the 'religious' question, the proper course is to transfer the voluntary schools to the local education authorities so long as facilities of entry shall be maintained for the denominations at certain regular and definite times. Besides this administrative problem the need for rethinking the whole of education from eleven to fifteen years of age on a psychological basis is urgent, and the proposals of the Hadow Report are commended.

It is pointed out that in England now, out of 700,000 children in any one year, 300,000 are outside instruction altogether at the age of 14+, and at 15+ the number is 520,000; it is argued that this sacrifice of the children at a critical age is the cause both of unemployment and unemployability. It is necessary to develop a system of universal scope and much variety, and to carry into it that spirit which in the last thirty years has changed the character of the elementary schools, and made them no longer merely the places of mechanical instruction in the three R's, but more living centres for the training of hand, eye, and voice.

The great growth of secondary education is described: since 1904 the schools have increased from 575 to 1489, and the pupils have multiplied four times. So sudden and large an increase has developed considerable strains in the fabric of the system, which was designed to meet the needs of university and professional students. It is argued that it is no longer right to force all into this single mould, and that there should be a double system of certificates, one to be given to those who follow the old academic course, which has proved its value, and the other to be given to those who have followed a general course suited to their needs, but do not intend to carry their education beyond the secondary school. The question whether the higher work of the schools is unduly specialised is raised, and a conference of all the universities is asked for in order that they may, if possible, arrive at a common mind both as to the age of entry of their students, and the kind and standard of knowledge which they wish them to possess.

In the field of technical education it is urged that it has been too isolated, and that there is need of much fuller contact, of more knowledge and sympathy, not only between technical education and industry, but also between all forms of industry and commerce, and all forms of education.

The question is raised, What is the proper part which formal and external examination should play in the educational course? While it is allowed that the attacks on examinations are frequently unreasonable, it is argued that the proper use of external examination is as an avenue to the universities and professions, but that the case of the average boy or girl should be met in the future by the issue of a certificate that he or she has followed the full course of an efficient and recognised school. No child under fifteen years of age should in any case be examined save by his own teachers, and the common entrance examination for the public schools is held up as an example of the examination method at its worst, necessitating mechanical teaching and work in the preparatory schools, and impairing the mental development of the pupils.

The address ends with a statement of the vital importance of the work of teachers in this generation, when the country is committed to the experiment of unrestricted democracy, and everything depends on the production of a citizen body capable of discussing the true values of life.

The Live Stock Industry and its Development.

The address of Dr. J. S. Gordon, president of Section M (Agriculture), deals with the important position which live stock and live stock products occupy within the British Empire. This is shown by comparing the relative importance of crops and live stock production in several countries of the Empire. In the British Isles the decrease in tillage between 1871 and 1926 has been very striking in comparison with the maintenance of the live stock population during the same period. Arable farming has declined greatly in face of trans-oceanic competition, while live stock has been maintained in the face of almost equally serious competition from the Argentine and the New World. Price levels have ruled more heavily against crops than stock and stock products. The changes and improvements in the live stock industry during recent years have been extraordinary, especially in regard to early maturity and quality in the production of beef, mutton, and pork, in high yields of milk and butter-fat in dairy cattle, and in large egg records in poultry. These changes during recent years in beef, mutton, and pork are attributable to the demand for small joints, and the influence of pedigree sires in the development of fine quality and early maturing animals. Although the average weight of beef cattle has only decreased by 6 per cent since 1913, the most striking feature is that the reduction in age is considerable.

Great Britain has the reputation of having the finest pedigree stock in the world, and yet probably nowhere else in the British Empire is improvement in the cross-bred cattle more urgently needed. It is a strange anomaly that pure-bred stock are exported to all parts of the Empire and to foreign countries for the improvement of the native stock, while at home cross-bred stock are in comparison so inferior to the pure-bred stock. This can be altered and improved by the increased use of pedigree sires, and in this direction the State can give considerable assistance with great advantage to itself. The State can also help by the elimination of the scrub bull, which will only be accomplished in an effective manner by legislation. The agricultural scientist can assist in this improvement along four distinct lines of research—animal nutrition, animal diseases, animal breeding, and marketing.

An extension of our knowledge of animal nutrition in connexion with the economic rationing of early maturing animals would be of considerable value to the live stock industry. The whole question of malnutrition is of fundamental importance, particularly in its relationship to health, fertility, and disease resistance. Nutrition is no longer a question of protein and energy requirements. The work in progress on mineral metabolism is opening up new lines of advance and broadening our conception of the close connexion between nutrition and disease. The need for extended research into the diseases of farm animals as the best method of protecting the live stock industry against epidemics which annually threaten it so seriously is beyond question. The problems of animal breeding are equally important. To the system of marketing live stock products pursued in Great Britain is largely due the inferior position which these products occupy on the home markets. British methods of marketing stock and stock products require a comprehensive reorganisation.

As progress is made in grading up stock by breeding methods, it is imperative that there should be corresponding developments in our knowledge of nutrition, disease resistance and elimination, and in marketing. The funds devoted to such work are quite inadequate when viewed in the light of the importance of the live stock industry, which in England and Wales alone is worth approximately £154,000,000 per annum.

If we are only prepared to attack these problems in a live and organised manner, there is a future, and a bright future, for the live stock industry.

Preservation of Scenic Beauty.

In his presidential address to the Conference of Delegates of Corresponding Societies, Dr. Vaughan Cornish points out that the great work of preserving scenic beauty in town and country calls for division of labour, and the special task of academic bodies and their learned members is to establish a sound æsthetic of scenery. For this it is necessary to discover and define the harmonies of scenery, those combinations which produce the aspects more than merely pleasing which fill the mind with joy. When these are known, it becomes possible to discriminate with certainty between the change that threatens irreparable damage and that which, although at first unpleasing, will introduce a novel beauty when the new pattern is complete.

He that aspires to be instructor or guide in matters of scenic beauty must submit himself to the discipline of contemplation. In his walks abroad he must let busy thought quiet down that the mood of receptive attention may become dominant. Then the whole being can be stirred, for the emotions aroused by scenic harmonies are not merely primitive, they result not only from physical inheritance but also from the sum of all the past action, feeling, and thought of a man's own life. It is only the jostling, obtrusive thought of the hour which must be eliminated in order to reach the contemplative state, and to all who attain this condition the harmonies of scenery bring an integration of the personality which is beyond the reach of those who neglect the correlation and synthesis of thought and feeling.

Of the practical problems relating to the scenery of cities, that of smoke abatement is still the chief. Remove the smoke-cloud, and cornice and colonnade shadowed by the sun produce their architectural effect ; vegetation flourishing in park and boulevard relieves the eye and brings the fragrance of the country into the heart of the town ; and the *al fresco* habit induced by clean, bright, fresh air imparts new interest and animation to the scenery of urban life.

The problems of motor traffic in relation to the amenities of village street and country road, difficult as they are of solution, have at least been clearly stated, but that of seaside planning has not received due attention. The fishing village was rightly placed to hug the shore, but the prevailing practice of developing the seaside resort with building-line close to the beach is radically wrong. There should be a broad lea in front, for a mere roadway and footpath between the houses and the beach is utterly inadequate as pleasaunce for a considerable town, and the message of the free and open ocean is lost amidst a jostling crowd.

The purely agricultural districts of Great Britain are both decorative and full of human interest, but for the development of personality it is needful that the contemplation of untouched, spontaneous Nature should come as a rhythmic variation, hence the national need for the reservation of complete landscapes of the wild. In respect of such reservations, it may be well to warn the enthusiasts of forestry that if the culminating heights of down and moor be planted with trees, their beauty as distant sky-line will be completely ruined.

In one prospect of untouched, elemental Nature our island home is pre-eminent, the view of the sea from precipitous cliffs, an image of infinity and eternity inestimable in its influence upon the loftier imaginings of the people. Without question, the time has come when no further encroachment should be permitted upon customary access to the sea cliff.

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in the irregular variations at distant stations, there must be correlation at stations close together, and it is important to determine limits of distance. By the photoelectric method this should be comparatively quick and easy.

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The work here described is discussed somewhat more fully in *Proc. Roy. Soc.* A, vol. 119, p. 11, 1928. The figures are here reproduced by kind permission of the Society.

See also on some points earlier papers—*Proc. Roy. Soc.* A, vol. 106, p. 117 (1924), and *Proc. Roy. Soc.* A, vol. 109, p. 428 (1925).

The results of these earlier papers are, however, in part superseded.

A paper on *Visual Observations of the Aurora Line in the Night Sky* appears in *Gerlands Beiträge zur Geophysik*, May 1928.

Oceanographic Observations between Greenland and North America.

By DONALD J. MATTHEWS.

THE history of the exploration of the seas between Greenland and America begins in the year 982, when Erik the Red founded on the south-west coast of Greenland the Norwegian colonies which were abandoned about the end of the fourteenth century. To oceanographers, the interest of this episode lies in a suggestion by Otto Pettersson that such voyages could not have been made in the open ships of the Norsemen unless the ice conditions had been much more favourable than they are now, and that the colonies were eventually abandoned because the climate had become more severe. The second stage in the exploration was the series of attempts to find a Northwest Passage, which came to an end with the discovery of Baffin Bay in 1616, and the third brings us down to the present time and includes the whaling voyages, the Danish voyages of discovery along the Greenland coast, and modern Arctic exploration. The reports of the ice masters contained a great store of information as to the general set of the currents and the distribution of icebergs and sea ice, but little else of oceanographical value, and in particular they throw no light on the cause of the great variation from year to year in the amount of ice which drifts southwards to the trans-Atlantic traffic lanes.

The circulation of the water is fairly simple. The East Greenland Current flows south and west to Cape Farewell, round which it turns to the north-west under the directing force of the earth's rotation and the density gradient across the coastal fringe of lighter water. It then becomes the West Greenland Current and flows northwards, probably as far as Melville Bay; according to some oceanographers, however, it does not penetrate beyond Disko Bay, and the northerly coastal current in Melville Bay is of the nature of an eddy. No east coast bergs are found on the west coast north of Julianehaab, about 100 sea miles beyond Cape Farewell; and in the Godthaab region, in about 65° N. lat., the cold current comes in contact with a warmer salter Atlantic current, in which the last of the sea ice melts. There appears to be a tendency for the current to spread westwards on the surface in these latitudes, but it carries no ice with it. Much less is any ice carried southwestwards from Cape Farewell to Newfoundland by a direct extension of the East Greenland Current, in the way shown on some of the older charts, with complete neglect of the necessary effect of the earth's rotation.

In Baffin Bay there is a northerly set on the east side in Melville Bay with many bergs, and westwards of this two great southerly drifts of heavy ice which are derived from Smith Sound, the western Sounds, and from Melville Bay, which are known as the Middle Ice and the West Ice. Between them, at the head of Baffin Bay, lies one of the most interesting features of these regions, an open space called the North Water, said never to freeze over, and generally attributed to a current of warm salt Atlantic water welling up from below. The Middle Ice and the West Ice unite at the northern entrance to Davis Strait, and as the Labrador Current flow south and east along the continental shelf of the Labrador coast as far as the Tail of the Grand Banks.

Little is known of the oceanography of these waters. The *Scotia* and the *Chance* have shown that the current on the Labrador coast is confined to the shallow water of the continental shelf, and that to the eastward of it lies warmer and salter Atlantic water in which the lines of equal density are horizontal, as if the water were at rest, at least so far as density currents are involved. This is somewhat remarkable, since there must be a continual movement northwards to compensate for the water removed on the outer edge of the Labrador Current, and in any event it is known that this water, or at least a similar water, dives under the fresher and colder surface layer in about the latitude of Cape Farewell and flows over the ridge in Davis Strait as undercurrent at a depth of 125 metres. In Disko Bay it is found at 200 metres, and at 250 metres in Melville Bay. In the north of Baffin Bay it meets the rising bottom at the entrance to Smith Sound, and is forced upwards to form the North Water and feed the Middle and West Ice. The permanent existence of such a warm layer between two colder ones necessitates a permanent northward flow from the open Atlantic.

The currents described account for the general trend of the movements of the ice but do not explain their changes. In 1906, Mecking published a discussion of the material then available from the years 1888 to 1896. According to his results, the bergs are for the most part formed in the Disko region, on the west coast of Greenland north of Davis Strait, and are set free in the summer. If the barometric gradient is such as to set up strong east winds in this region, the bergs are blown across to the Labrador Current, which carries them southwards so as to reach the waters south of Newfoundland in the following spring and summer, with a maximum in May and nearly as many in June. If, on the other hand, the wind is weak or deviates much from east, the bergs either are held up near their birthplace or else they wander northwards to Melville Bay, where they may drift about for years before they break up or are carried over in to the south-going Middle Ice.

A favourable summer gradient in the Disko region is thus necessary for a rich berg season in the following spring, but it is not sufficient by itself. The bergs are off Labrador during the winter months, when the mean wind is parallel to the coast in a south and east direction. If there is an on-shore component in the wind the bergs may strand or be held up in the pack along the coast, so that they reach the traffic lanes late or very probably not at all. An off-shore component, on the other hand, keeps them in the strength of the current, and a rich ice season follows. The wind affects the field ice on the Labrador coast in the same way, but earlier than the bergs, and Mecking pointed out that it should be possible to make forecasts concerning the bergs from the amount and movements of the pack earlier in the year.

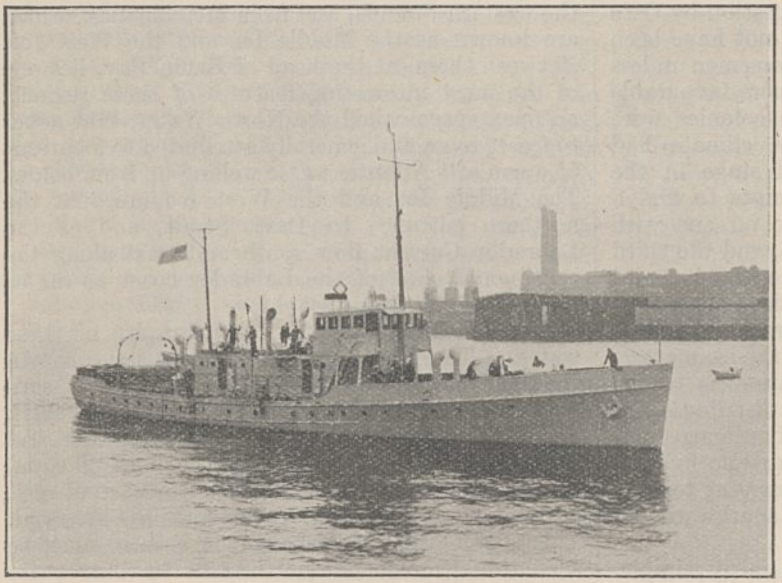

FIG. 1.—The U.S. Coastguard Patrol Ship *Marion*.

The officers of the U.S. Coast Guard engaged on the International Ice Patrol which was instituted after the loss of the *Titanic* in 1912, have recently repeated Mecking's work with the assistance of the Meteorological Office and the U.S. Weather Bureau, making use of a much larger number of observations. A preliminary report shows that they attach more importance to the winter barometric gradient on the coast of Labrador than to the summer gradient in the Disko region. They consider that the sea ice on the Labrador coast acts as a fender which keeps the bergs from grounding and gives rise to a rich ice year ; bergs and sea ice therefore vary in the same way, but not for the reasons given by Mecking. Methods of forecasting the amount of berg ice depending upon the use of an equation into which the gradient enters, and also upon reports of field ice, have been devised and are being tested.

Lieut.-Commander E. H. Smith, of the U.S. Coast Guard, has been oceanographer of the International Ice Patrol for many years, and has worked out recently, on the lines laid down by V. Bjerknes, Helland-Hansen, and Sandstrom, a remarkable system of forecasting the drift of the bergs on the Tail of the Banks. The salinity of the water samples collected at a number of positions and depths down to 750 metres is determined on board by an electrical method, and from these and the temperatures are calculated the density and the height of the surface of the water above the layer, assumed to be at rest, at which the pressure of 750 decibars occurs and which is at a depth of nearly 750 metres. These heights are plotted on a chart, and the resulting contour lines are drawn for intervals measured in millimetres ; they correspond to the isobars of a weather chart, and for all practical purposes are the stream lines which the bergs follow. This method is still under test.

The work of the Ice Patrol is confined to the water south of Newfoundland, but now that the ice season on the traffic lanes is over for the present year, Lieut.-Commander Smith is at sea in command of the *Marion* (Fig. 1), making oceanographical observations and soundings in the region between Greenland and America south of Davis Strait, and working in close co-operation with a Danish expedition in the *Godthaab*. His ship, a coastguard patrol vessel, is 125 feet in length, has twin screws with Diesel engines, and a radius of action of 3000 miles at 10 knots. She is well equipped for oceanographical work, and carries an echo-sounding machine, the fathometer, which allows soundings to be made at short intervals without stopping the ship, and also with wire sounding gear for controls and for collecting samples of the bottom. She will be at sea for two months, during which it is hoped to cover 4000 miles on zigzag courses. Lieut.-Commander Smith has a nearly clear field for his work and should be able to make large contributions to oceanography. In particular, he should be able to obtain dynamical sections across the whole area, from which it should be possible to deduce the currents, and especially the strength of the undercurrent in Davis Strait.

Other interesting problems relate to the warm water which meets the cold current near Godthaab, the reason why the west coast is so favoured climatically in comparison with the Labrador side, and the drift of the bergs in the Disko region. Finally, there is the whole subject of the depth and geological history of the basin. The results will be awaited with keen interest. The *Marion* is equipped with a short-wave wireless outfit, and it is hoped to keep up communication with headquarters through the help of amateurs.

News and Views.

THE report of the Council of the British Association for 1927–28 refers to the meeting to be held in South Africa next year. Mr. O. J. R. Howarth, secretary of the Association, has recently visited South Africa and conferred with the authorities there, with the result that the following provisional arrangements have been made :—CAPE TOWN, July 22–July 28–29. Inaugural meeting, July 22, at which it is proposed that the president of the South African Association should address the meeting first, and that the new president of the British Association, Sir Thomas Holland, should then be installed, and reply. Sectional meetings, mornings only, July 23–26. Evening discourse, public lectures, excursions, etc. Call at Kimberley, July 29–30. JOHANNESBURG, July 30–31–Aug. 4. Presidential Address, July 31. Sectional meetings, mornings only, July 31–August 3, and other arrangements as above. PRETORIA—Sectional transactions, etc., as appropriate in connexion with the co-operating congresses; continuing to Aug. 7. After the meetings, extended tours through the Union, to Victoria Falls, Rhodesia, Lourenço Marques, etc., as to which members will be afforded opportunity to indicate their preference.

IT is proposed that in consideration of a grant by the South African Association to the British Association of a sum not exceeding £500 and reckoned at £1 per head of the number of persons involved, the British Association should admit to membership members of the South African Association in good standing down to June 1929, entitling them to attend the meeting and receive the report if desired. From 300 to 400 members are expected under this category, and the arrangement resembles that made in 1905. An offer has been received from the Rhodes trustees, and has been gratefully accepted by the Council, to make a grant of £200 towards any further authoritative investigation at the ruins at Great Zimbabwe undertaken in connexion with the South African meeting. A generous invitation has been received from L'Association française pour l'Avancement des Sciences, and from the City of Le Havre, for members unable to take part in the South African meeting to attend that of the French Association in Le Havre, as was done in 1914.

THE British Association, like the great majority of scientific societies, has been unable to recover income tax previously remitted upon income from invested funds. The cases regarded by the Inland Revenue authorities as test cases upon the liability of societies to taxation (Geologists' Association; Midland Counties Institution of Engineers) have been decided against the societies by the Special Commissioners and in the High Court of Justice. The Council is informed that appeals against these decisions have been lodged. An article upon this subject appeared in the issue of NATURE of Aug. 25. The treasurer of the Association points out in his report that by those decisions the Association is deprived of one-fifth of the income derived from invested funds.

BENMORE and Puck's Glen, a charming region of mountain and stream at the head of Loch Fyne in Argyll, has been given by Mr. Harry George Younger of Benmore to the Forestry Commission acting on behalf of the nation, as recorded in our issue of July 21 (p. 105). It is a handsome and appropriate gift, for the former bare valley had been transformed into a forester's paradise where native and foreign trees grow in great variety and luxuriance, by a former owner, James Duncan of Benmore. Mr. Younger built upon his predecessor's foundation, with the result that Benmore seems destined to be the chief training, experimental, and demonstration area for State forestry in Scotland. Its importance is enhanced because it borders on properties already in the hands of the Forestry Commission. The Commission has decided to hold a formal ceremony at Benmore on a most appropriate occasion. On Saturday, Sept. 8, the Botanical Section of the British Association will make a special excursion to the property, and in the presence of representative botanists of this and other lands, the Right Hon. Sir Herbert Maxwell will dedicate a memorial to the late Sir Isaac Bayley Balfour, in recognition of his lifelong service to arboriculture. Puck's Glen, a mountain gorge full of beauty in itself, affords magnificent glimpses of the wonderful scenery of the district, and the finest view point is now capped by the Bayley Balfour Memorial Rest Hut, a charmingly fantastic structure designed by Sir Robert Lorimer. The hut is built of wood, every variety of timber grown on Benmore being represented in the panelling, the roof-shingles, weather-boards, and the like. Two dedicatory panels are placed within, one to Bayley Balfour and the other to commemorate James Duncan's participation in the afforestation of the area. A small brochure, containing photographs of the memorial hut and of characteristic views in the Glen, has been prepared by the committee in charge of the arrangements.

THE results of the excavations which Prof. Gordon Childe has been carrying out this summer in the Orkneys have now been made known to the public by his letter in the *Times* of Sept. 3. The site on which he has been at work on the southern shore of the Bay of Skail, parish of Sandwick, Orkney, is in many ways remarkable. It is a village consisting of a congeries of chambers or huts of dry masonry, all roughly square, with each course of the masonry projecting slightly beyond that below as if they had once had corbelled roofs. The walls are extremely well preserved, and niches and shelves are intact. The huts opened on to streets which, curiously enough, were roofed over with stone slabs. These roofs had been used either as camping-places or kitchen middens, for they were covered with kitchen refuse. The excavators had to cut through some five feet of kitchen refuse before they reached the stone slabs. The interior of the huts showed hearths at several levels, traces of later occupation for which evidence of date was afforded by the remains of the red deer. When the original floor was reached, it showed signs of hasty evacuation and a state of indescribable filth.

PROF. CHILDE found that relics were relatively plentiful and, being for the most part of stone, in an excellent state of preservation. Pens of stone pointed to the fact that domestic animals, probably pigs, were kept there. Two finds of outstanding importance were made. One was that of two skeletons in a stone receptacle, of which the slabs were built into the wall in such a way as to form an integral part of the structure. They may well, as is suggested, be the vestiges of a foundation sacrifice. Secondly, on one of the slabs were regular marks which Prof. Childe thinks may represent a script. The culture is neolithic in character; but the occurrence of a script suggests a late date. It may be a survival, which would not be impossible in such a remote district, notwithstanding the existence of a pre-Viking iron-using settlement near by.

ARRANGEMENTS for the programme of the Folklore Congress, to be held in London on Sept. 19–25 in connexion with the jubilee year of the Folklore Society, are now approaching completion. The Congress will open at the rooms of the Society of Antiquaries at 4 P.M. on Wednesday, Sept. 19, when a reception of foreign delegates and members will be held. In the evening, by kind invitation of Dr. Henry S. Wellcome, a conversazione will be held at the Wellcome Historical Medical Museum. Thursday will be taken up by papers, the presidential address at 10 A.M. being followed by communications by Prof. Sayce on Egyptian folklore, Dr. G. Roheim, Prof. Starr on Filipino folklore, and others. In the evening a lecture, illustrated by a cinematograph film, on the folk-dances and ceremonies of eastern Europe, will be given by Prof. Pospišic of Brno in the lecture theatre of the Imperial Institute. The papers on Friday include Prof. Rose on mummers' plays in Attica, Prof. R. M. Dawkins on the study of folklore in modern Greece, Mrs. Hasluck on the games of the Turks, and Prof. Schütte on bull-worship among the Kimbri. On Saturday excursions will be made to Oxford and Cambridge. The papers on Monday cover Celtic folklore, and on Tuesday Dr. Ernest Jones deals with psycho-analysis and folklore, and Prof. Elliot Smith with a survival in British folklore from the Rig Veda. The membership fee for the Congress is 10*s*. 6*d*. Full particulars may be obtained from Mr. Allan Gomme, Hon. Sec. Folklore Congress, c/o the Royal Anthropological Institute, 52 Upper Bedford Place, London, W.C.1.

AN interesting programme of excavation in Iraq is announced for the coming autumn. Not only is the number of expeditions increased from five to eight, but also both France and Germany resume their pre-War activities. Germany, indeed, has already sent workers to Iraq who have received from the Government a share of the finds made before the War, but this year two parties will be actively engaged in excavation: one under Dr. Julius Jordan will dig at Erech, north of Ur, and the Deutsche Orient-Gesellschaft, which was working at Babylon before the War, will now dig at Ctesiphon on the Tigris. Under the auspices of Le Louvre, Père Legrain is resuming the French excavation of Sumerian culture at Tel-lo. Two American expeditions will be at work: one under Prof. Waterman, of the University of Michigan, will work at Tel-Omar in Ctesiphon, and the joint expedition of Harvard University and the American School of Oriental Research, now in its third year of excavation, at Tarkalan, near Kirkuk. The excavations at Ur of the British Museum and the University of Pennsylvania, and the Oxford University and Field Museum excavations at Kish, will, of course, be resumed as usual.

THE use of ether and certain other chemical vapours for the purpose of shortening the rest period of plants has been an important factor of success in the florist's business, enabling him to meet the demand for blooming specimens at Christmas. A good many different chemicals have been tried; quite recently two have been found especially valuable, particularly for inducing early germination of potato tubers. A paper by F. E. Denny, read at the annual meeting of the Society of Chemical Industry in New York and published in the *Transactions* of the Society, describes the use of ethylene chlorhydrin, a chemical which is now made in quantity at a reasonable cost in the United States and has also recently become available in Great Britain. The potatoes are either cut and dipped into a weak solution of the chlorhydrin and kept in a closed container for twenty-four hours before planting or, on the large scale, whole tubers are exposed to the vapours in a suitable tight room for twenty-four to forty-eight hours. These are stored for a week, at which time sprouting begins, cut, and planted.

THE gain in time induced by the treatment with chlorhydrin was at least one month; some varieties of potato may be treated as soon as lifted. The application of this in industry may enable two crops of potatoes to be grown in one year in the southern States of America, and facilitates the planting of the potato crop in Bermuda, Cuba, Florida, and similar countries, which is done in the autumn, when normally it is difficult to obtain tubers that will sprout. From the point of view of cost and safety to workmen applying it, ease of application and uniformity of result, the use of chlorhydrin leaves little to be desired. The explanation of the phenomenon is well known: as was pointed out by Farmer and Waller in 1898 and by the Armstrongs in 1910, many chemical stimulants check the protoplasmic currents in the plant and cause certain hydrolytic or downgrade changes, thereby releasing the previously insoluble intracellular enzymes without rendering them inactive. In consequence growth begins.

THERE seems to be feverish activity in the United States at present as to who will broadcast the first news radiovision service. We hear from Science Service, Washington, that radiovision has arrived, and a list is given of eight radiovision stations, with technical details of the emission. For example, 3XK, Washington, will send out ' radiomovies ' on Monday, Wednesday, and Friday between 8 and 9 p.m., Eastern standard time. The frequency of the radio waves will be 6420 kilocycles (46·7 metres). Forty-eight lines of light are used to produce the pictures, and there are fifteen pictures per second. The General Electric Company of Schenectady, WGY, sends out twenty pictures per second, the frequency of the radio waves being 790 k.c. (380 metres), but there are only 24 lines per picture. This Company broadcasts from 1.30 to 2 p.m., Eastern time, on Tuesday, Thursday, and Friday. On Tuesday also it broadcasts from 11.30 to 12 midnight, and on Sunday from 10.15 to 10.30 p.m. On Sunday and Friday it also sends out 13660 k.c. (21·96 metres) waves at the same time as the 790 k.c. waves, and on Thursday and Tuesday at 9550 k.c. The Westinghouse Co.'s Station at Pittsburgh, Pa., and several other stations, are sending out irregular broadcasts for experimental purposes. To suggest that the radiovision pictures are anything like so good as sound radio broadcasting was in 1921, is scarcely fair to the many able engineers engaged on the problem and discounts the advances they will doubtless make in the future. The pictures are still very crude, and no doubt many difficulties have still to be overcome before any radiovision service can be considered satisfactory, but every encouragement should be given to those who are devising even slight improvements of existing apparatus or methods.

THE nineteenth meeting of the German Society of Naturalists and Physicians, a counterpart of the British Association, is to be held in Hamburg on Sept. 15–22. The invitation programme now available may be obtained from the secretaries, Hamburg 13, Universitäts-Gebäude ; tickets cost 25 RM. or less; bedrooms 3·50 RM. or more. The more important addresses are timed for 9 A.M. or 3 P.M., evening hours being reserved for festivities. Lectures begin with Senator F. H. Witthoefft on world economics and national food supply, followed by Prof. Walden on the importance of Wöhler's synthesis of urea. The medical group is to deal with the onset and disappearance of epidemics and the influence of psychic factors on the sympathetic nervous system. On Tuesday, Sept. 18, the lectures are on the blood-group problem, photochemistry of iron carbonyl compounds, combatting cattle plagues, Naegeli's micellar theory, and the importance of isostasy in the shaping of the earth's surface. On Wednesday, Sept. 19, general lectures are continued—scientific results of the voyage of the *Meteor*, short-wave telegraphy, chemistry of hormones and the female sexual hormone. Popular evening lectures will deal with the ultramicroscopy of the molecule by the use of Röntgen rays, the world and environment, health and housekeeping, colour and scent of flowers, communities of men and bees. The detailed programmes of thirty-five sections are cross referenced with invitations and entangled with the meetings of about as many separate but allied societies. There will be cinema shows, an exhibition, zoological gardens, and an institute for tropical diseases to visit. The meeting ends with a visit to Kiel (milk research institute and model dairy), and alternative excursions to Cuxhaven, Heligoland, Westerland, Wyk, Borkum, Nordeney, Lübeck, Schwerin, Lüneburg, Denmark, Norway, and Sweden.

SIR JOHN RUSSELL finished a very strenuous tour in Australia at the end of July and then sailed for New Zealand. His lectures in the capital cities aroused considerable interest amongst agriculturists. In the intervals he travelled by train, aeroplane, and motor over long distances, and was enabled through the co-operation of universities, State departments of agriculture, and the Council for Scientific and Industrial Research to make a close study of many features of Australian agriculture. Chief attention was given to problems arising in the irrigation areas of South Australia, Victoria, and New South Wales, and Sir John was able to examine numbers of typical soil profiles. Difficulties associated with sodium clays, impermeable clay-pans, the rise of salt, the duty of water, and so forth, are being acutely felt in these areas, and the need for close study of them is becoming more imperative each year. Steady progress in soils work is being made under Prof. J. A. Prescott as the result of a co-operative arrangement between the Council for Scientific and Industrial Research and the Waite Institute (University of Adelaide) and it is anticipated that close and effective association with the proposed Soils Bureau at Rothamsted will be rendered possible as the result of this visit. The proposal to establish a new irrigation research station in the Murray watershed is in abeyance pending the report of the Irrigation Sub-Committee of the Committee of Civil Research, of which Sir John Russell is a member.

AN earthquake of moderate intensity was recorded at Kew Observatory at 6 hr. 18 min. 39 sec. G.M.T. on Sept. 1. The epicentre was about 3900 miles away, but the initial impulse was too small to give any indication of the bearing.

THE annual report for 1927 of the National Institute for Research in Dairying, University of Reading, recently issued, contains an account of the Institute and of the research work that has been carried out, as well as of some of the problems awaiting study were the necessary funds available.

THE July issue of the *British Journal of Physiological Optics* completes the second volume of the journal. It contains the concluding part of the retranslation and republication of the "Atlas of Opthalmoscopy" of Prof. Haab of Zurich, which has been carried out by the editor of the journal, Mr. W. B. Barker. The numerous coloured plates of the Atlas reflect great credit on the printers.

The discussion on colour vision is continued by a paper by Mr. D. C. Henry, who considers that the trichromatic theory is the most satisfactory one in the field, and that when it is supplemented by some form of photo-chemical theory of the retinal mechanism, it may provide explanations of fatigue and contrast phenomena which at present it cannot do.

MESSRS. Watts and Co. announce the early publication in their Shilling Forum Series of "Craftsmanship and Science" — Sir William Bragg's presidential address to the British Association; also of Sir Arthur Keith's Ludwig Mond lecture on "Darwinism and what it implies."

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A resident lecturer (man) in rural science and gardening, with mathematics as second subject, at the Bangor Normal College—The Principal, Normal College, Bangor, North Wales (Sept. 14). A warden of the Moulton Farm Institute and assistant county agricultural organiser for Northamptonshire—The Secretary for Education, County Education Offices, Northampton (Sept. 14). Junior assistants at the National Physical Laboratory—The Director, National Physical Laboratory, Teddington (Sept. 18). A pathologist at the Miller General Hospital for South-east London—The Secretary, Miller General Hospital for South-east London, Greenwich Road, S.E.10 (Sept. 20). An assistant pathological chemist at St. Mary's Hospital—The Secretary, St. Mary's Hospital, W.2 (Sept. 24). A scientific officer under the Directorate of Scientific Research of the Air Ministry, primarily for research at the Royal Aircraft Establishment in connexion with aircraft power units—The Chief Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (Sept. 25). A Milroy lecturer on State medicine and public health for 1930—The Registrar, Royal College of Physicians, Pall Mall East (Sept. 26). An instructor at the Government Technical School, Makerere, Uganda, capable of giving instruction in carpentry and joinery, fitting and turning, blacksmithing and tinsmithing, etc.—C. A. (N), The Secretary, Board of Education, Whitehall, S.W.1; *for Scottish candidates*—(N), The Secretary, Scottish Education Department, Whitehall, S.W.1 (Sept. 30). A principal and professor of medicine, and a professor of pathology and bacteriology, at the Veterinary College, Patna—The Secretary to the High Commissioner for India (General Department), 42 Grosvenor Gardens, S.W.1 (Oct. 15). An irrigation engineer under the Government of Ceylon—The Crown Agents for the Colonies, 4 Millbank, Westminster, S.W.1 (quoting M/732). A headship of the Junior Technical School for Boys of the Borough Polytechnic Institute—The Principal, Borough Polytechnic Institute, Borough Road, S.E.1. Two temporary engineering assistants under the Air Ministry, capable of preparing detail drawings, reinforced concrete work and steel structures—The Secretary, Air Ministry, Adastral House, Kingsway, W.C.2. A museum assistant at the Norwich Castle Museum—The Curator, Castle Museum, Norwich. An entomologist at the Indian Lac Research Institute, Ranchi, Bihar and Orissa, for research work on the bionomics of *tacchardia lacca*—"India," c/o Richardson and Co., 26 King Street, St. James's, S.W.1.

Our Astronomical Column.

A NEW STAR CATALOGUE FROM OBSERVATIONS WITH THE GREENWICH ALTAZIMUTH.—The present Greenwich altazimuth was erected in 1897, taking the place of Airy's smaller instrument which had been in use for half a century. It was used for observing the moon in the first and last quarters of each lunation, at which periods meridian observations are untrustworthy. For the rest of the time it was used in the meridian as a second transit circle. When Brown's new tables of the moon were introduced into the almanac in 1923 there was such an improvement in the representation of all the short-period terms in its motion that it was considered that meridian observations of it would suffice for the future. The altazimuth was then placed in the Prime Vertical for the observation of fundamental stars, and a catalogue of these, based on observations extending from June 1923 to January 1927 has just been issued; it contains all stars of magnitude 5·4 and brighter, the declination of which lies between N. 11° 40′ and N. 50°, their number being 601. Observations were made in azimuth only; the declination, which is found with greater accuracy than the right ascension, depends on the interval between the east and west transit of each star; refraction is not directly introduced, and the results form a useful check on meridian observations.

The results show that the declinations of Boss in this zone need to be increased by 0·45″, this correction being 0·02″ less than that of Eichelberger's new fundamental catalogue, and 0·27″ greater than that of the First Greenwich Catalogue for 1925 (observed with the transit circle). It is generally agreed that Boss's proper motions in declination have appreciable systematic errors, due probably to imperfections in the older catalogues employed by him; small as the corrections are, they are large enough to have some effect in problems concerning the structure and motions of the stellar system.

THE MELBOURNE ASTROGRAPHIC CATALOGUE.—Melbourne Observatory undertook the photography of the most southern zone of the Astrographic Catalogue extending from south declination 64° to the south pole. The printing of the catalogue has been greatly delayed by shortage of funds, but two volumes have now been published. Vol. 1, which has just come to hand, contains the measures of the plates, the centres of which are in declinations - 67° and - 68°. The x and y co-ordinates of each star are given to the third decimal of a minute of arc, also the measured diameters, and, in the case of C.P.D. stars, the reference number and magnitude given in that catalogue. The stars used as reference stars are in heavier type: these were measured twice. The usual provisional constants are given for reducing the rectangular co-ordinates to right ascension and declination.

Vol. 2 contains 291 pages: a full page contains 240 stars, but as many pages are incompletely filled, the average per page is probably about 200; but the stars in the volume are not all different, since those between - 67° and - 68° occur twice over, owing to the overlap of zones.

Research Items.

EDUCATIONAL STATUS AND FECUNDITY.—There is a widespread belief that a correlation exists between education and sterility, and this belief has had some support from statistics gathered in America and dealing largely with college alumni. It is important, therefore, that due weight should be given to analyses which give another aspect to the relationship between education and fecundity. In the *Journal of Heredity* (vol. 19, No. 7, 1928) N. J. Butt and Lowry Nelson discuss in this connexion data obtained by the survey method from the homes in two Utah communities, one with a population slightly more than 2000, the other slightly more than 3000. In both, agriculture is the basic occupation, although all the chief occupational divisions as used by the United States Census are represented. Comparison was made of the families of parents with no education, with various grades of elementary and high school education, and with college education. The authors realise that the data are not comprehensive enough to warrant dogmatic statements, but they consider that their method should bear at least as much weight as statistics gathered from highly selected groups. Their results indicate that the families in Utah, men and women, who have had higher education, are not committing race suicide. The correlation secured (– 0·09) shows that education has very little influence on the size of the families, which average about 5 children born, of which more than 4·5 survive until after the parents are past the child-bearing age.

THE GIBRALTAR SKULL.—Anthropologists and others interested in the early history of man now have an opportunity to study in detail and at their leisure the evidence relating to the new Gibraltar skull discovered by Miss Garrod two years ago at the Devil's Tower. A full report on this relic of Neanderthal man appears in the recent issue of the *Journal of the Royal Anthropological Institute* (Vol. 58. Pt. 1), and may also be obtained separately. In addition to the very full and detailed account of the discovery and of the archæology and geology of the cave by Miss Garrod herself, the report contains the results of the examination of the specimen itself and of the attendant conditions and associated finds by various specialists. It is, of course, generally agreed that the skull is that of a child, probably male, of about five years old. Mr. L. H. Dudley Buxton, in the course of his anatomical report, compares it with the skulls of other immature Neanderthal specimens, as well as the modern child. Prof. Elliot Smith's description of the endocranial cast brings out certain differences between it and those other children of Neanderthal age, but regards these differences as variations within the type. Miss Dorothea M. Bate deals with the very interesting series of animal remains. In addition there are reports on the sands by Mr. R. C. Spiller, on fossil voles by Mr. Martin A. C. Hinton, and on fossil mollusca by Paul Fischer. Even a captious critic must agree that the collaborators have used every effort to cover all aspects of the evidence which a reasonable degree of foresight may regard as likely to be of value to the future historian of man.

THE OUTRIGGER CANOE.—In *Man* for August, Mr. J. Hornell describes and illustrates some South American balanced canoes which appear to exhibit a stage in the invention of the outrigger. While lying off the coast of Gorgona, an island in the Pacific off the coast of Colombia, in 1927, his ship was visited by a number of dugout canoes from the mainland. These canoes were graceful dugouts with terminal platforms fore and aft, and with rounded bottoms without vestige of a keel. The dimensions varied considerably, especially in length. A medium size was 18½ ft. over all. Paddles were used for steering and propulsion, but some of the canoes were fitted with a sail, the mast passing through a hole in a board lashed athwart the gunwales well forward of amidships. The characteristic feature, however, was the outrigger balance fittings. These were fitted to boats with a low freeboard and consisted of a log of the extremely buoyant *balsa* wood, approximately one-half of the total length of the canoe. The log was lashed to one side of the dugout by cords close to the fore and aft ends, the lashing passing through a hole bored in the side of the boat. In the centre it was fastened, not to the side of the canoe, but to a short projecting pole, with a piece of wood inserted between it and the pole to keep it depressed at the proper depth in the water. Afterwards, in the course of a trip inland, it was found that these canoes were one of several types, of which the final stage was a double outrigger. In one type the logs were tied in true outrigger fashion to stout outrigger booms laid athwart the hull, while in another type, a small local coaster, the dugout had superimposed upon it built-up strakes of one, two, or three planks. Although not previously recorded off the coast of Colombia, similar canoes were noticed early in the last century in Chile. As regards their origin, apart from independent invention and in view of the unlikelihood of a Polynesian source, it is probable that they were introduced by Spaniards from Manila, where a similar balanced canoe has been recorded.

ASIATIC BIRDS IN ALASKA.—The proximity of north-western America to the north-eastern coast of Asia and the probability that in earlier days the relationship of the two continents was still closer, suggests that there may be a more or less regular migration of birds from one side of the narrow sea to the other. It is known that certain Asiatic birds habitually cross Bering Sea, and Harry S. Swarth now adds a few more to the Asiatic forms which have been found in Alaska (*Proc. Calif. Acad. Sci.*, vol. 17, July 1928). These include the Japanese pipit (*Anthus spinoletta japonicus*) a former American identification of this race having proved to be erroneous ; Middendorff's grasshopper warbler (*Locustella ochotensis*), and a Siberian hedge-sparrow (*Prunella montanella*), the former belonging to a genus new to North America and the latter to a family (Prunellidæ) hitherto unrecorded from that continent.

SEX STUDIES ON SCHISTOSOMA.—A. E. Severinghaus (*Quart. Jour. Micr. Sci.*, vol. 71, p. 653-702 ; April 1928) records observations on the stages in the life cycle of *Schistosoma japonicum*. The adults are dimorphic, but no dimorphism is apparent in the miracidium, primary and secondary sporocyst, and cercaria. The hamster was the mammalian host employed. The incidence of infection of the snails (*Oncomelania*) with the miracidia of *S. japonicum* in the Soochow region was found to be about two per cent, and owing to this low incidence it was found possible to plan mammalian infections by cercariæ from a single snail, and to be reasonably sure that practically all such snails would have been infected with a single miracidium. Exactly half of the snails harboured cercariæ which produced female flukes, while the other half produced male flukes. All the flukes recovered from the mammals infected by cercariæ from one snail were of the same sex. Male flukes alone develop in the mammal normally as regards size, form, and the production of mature germ cells, but if female flukes develop in the mammal in the absence of males they reach only one-fifth the normal length and the reproductive organs fail to develop with the exception of a blind tube (the uterus) and an aggregate of germ cells resembling early oogonia. It is suggested that the male produces hormones without which the female will not develop. New points in the anatomy of the reproductive system in both sexes are noted. The male is heterozygous; one half of the spermatids receive eight chromosomes and the other half six. There are two *X*-chromosomes, and sex is determined in the fertilised egg. The oogonial cells have 16 chromosomes (diploid), and though the maturation stages were not observed, there is little doubt that the female is homozygous and that the haploid number in each egg is eight. The life cycle exhibits the interesting condition that male-determined individuals produce parthenogenetic eggs at one stage and spermatozoa at another.

INDIAN TERTIARY MOLLUSCA.—An appendix to Cossmann and Pissarro's "Mollusca of the Ranikot Series" (noticed in NATURE, Aug. 20, 1927, p. 275) has now been published by the Geological Survey of India (*Pal. Ind.*, New Series, vol. 10. No. 4). It was the work of the late E. W. Vredenburg and has been edited with notes by Dr. G. de P. Cotter. The author discusses the types of the specimens described by d'Archiac and Haime in their "Description" (1853–54) now preserved in the Natural History Museum at South Kensington, of which, unfortunately, the exact localities cannot now be ascertained from want of record or other reason. Some of the original diagnoses have had to be revised, while some new species from more lately obtained material are added. The memoir extends to 75 pages and there are 9 plates that are excellently reproduced from photographs by the Survey itself.

BUFUMBIRA VOLCANIC ROCKS.—The annual report of the Geological Survey of Uganda for 1927 contains a preliminary account by Mr. W. C. Simmons of the volcanic rocks of that part of the Bufumbira area which lies in the extreme south-west corner of Uganda. The region was geologically explored by Mr. Combe during 1925 and 1926. Of the three large volcanoes on the border, Sabinio is the oldest; its older lavas are basaltic or andesitic, while the later flows consist of olivine-basalts and leucite-basanites. These two rock-types also make up many of the investigated flows of Muhavura and Mgahinga. In some of the rocks of the latter, which is the youngest of the three, radiating groups of plagioclase laths occur giving a very characteristic appearance to the lavas. Numerous small craters are scattered over the country to the north, between the great volcanoes and Lake Mutanda. Their lavas range in composition from basalt or trachybasalt to leucite-bearing types, some of which contain conspicuous biotite. It is noteworthy that felspar-free rocks are not restricted to the area outside Uganda to the extent that was thought likely by Finckh, but so far the variation in rock-types found in Uganda has a narrower range than that recognised by Finckh in his work on the collections made by the Mecklenburg expedition of 1907–8. Nevertheless, the Bufumbira volcanic field is evidently one of the world's most extensive areas of leucite-bearing rocks.

THE THEORY OF FERROMAGNETISM.—An important advance in magnetic theory has been made by W. Heisenberg, in a paper in the *Zeitschrift für Physik* of July 16, which deals with the nature of Weiss's intermolecular forces. The use of these has always been unsatisfactory from the fact whilst they accounted for ferromagnetism formally, it was impossible to refer them specifically to electric or magnetic interactions between the magnetic molecules. In the present analysis they are derived from a quantum resonance phenomenon between electrons moving in different places with otherwise equivalent paths, a procedure which has already proved useful in other connexions. The new theory is to some extent approximate both in its assumptions and development, but it leads to equations for the magnetic moment which are identical in their main features with those of Weiss, and has the additional merit of predicting two further conditions which must be satisfied for ferromagnetism to occur. One is that the space-lattice must be such that each atom has at least eight neighbours, and the other is that the total quantum number of the electrons responsible for the magnetism must not be less than three, both conditions being satisfied by iron, cobalt, and nickel, although not to the exclusion of other substances. The author proposes to extend the theory to the case of a more complicated atomic model.

THE UNIMETER.—In the *Chemiker-Zeitung* of June 20, Messrs. Bloch and Frühling describe a new instrument, the unimeter, which is designed for the rapid examination of the optical properties of materials of most diverse types. The instrument is likely to prove extremely useful in laboratories and factories, since transparent, translucent, and opaque objects can all be examined with equal ease and there is usually no necessity to detach samples for the purpose. It can be used for the examination of such objects as paper, metals, coloured glass, solutions, powders, gelatine, textiles, painted surfaces, etc., or for the comparison of the intensities of light from different sources. The unimeter, which is manufactured by the firm Franz Schmidt und Haensch of Berlin, is mounted like a microscope, its essential feature being a polarisation-photometer. The two halves of the circular field consist of the object under examination and a comparison-plate of dull milk-glass respectively. By rotating the photometer about its axis the dividing line between the two halves vanishes when the latter are equally illuminated. The eyepiece carries a rotating diaphragm, which is also fitted with three coloured glasses for use in examining coloured objects. The necessary calculations are greatly simplified by the attachment to the graduated circle of a scale showing the squares of the tangents of angles of rotation. Both daylight and artificial light can be employed, and various accessories can be screwed into position if desired for the purpose of widening the range of application of the instrument.

MAGNETOSTRICTION OSCILLATORS.—In the *Proceedings of the American Academy of Arts and Sciences* for April 1928, Prof. G. W. Pierce has published an important paper on 'magnetostriction' oscillators. He describes a newly discovered method of using magnetostriction to produce and to control the frequencies of electrical and mechanical oscillations ranging from a few hundred to several hundred thousand cycles per second. The method is based on the interaction of the mechanical vibrations of a magnetostrictive rod and the oscillations of current in an electric circuit. By a phenomenon called magnetostriction the oscillating electric currents cause the rod to vibrate longitudinally and the vibrations of the rod react on the electric circuit maintaining the frequency constant. The constancy of frequency obtained compares favourably with that obtained by using the piezo-electric oscillator. The construction and adjustment of the magnetostriction vibrators is so simple that large numbers of standards of frequency can be made at little cost. In particular these new oscillators will be most useful for the range of frequencies below twenty-five thousand cycles per second, for at these low ranges crystal control is impracticable owing to the prohibitive cost of sufficiently large crystal vibrators. For frequencies between twenty-five thousand and three hundred thousand cycles per second the magnetostriction oscillators and the crystal oscillators will have a common field of usefulness. For higher frequencies the present make of magnetostriction oscillators do not work well, although they function up to two million cycles per second. It was observed that a rod of nickel when magnetised shortened by about one millionth of its length for a magnetising field of one gauss. When, however, it is magnetised by a force that increases and decreases in an oscillatory manner at a period resonant with its free mechanical oscillation, the shortening and lengthening may be more than a hundred times as great. Methods of calibrating these new oscillators for use as wave-metres are given. Very interesting data are also given on the velocity of sound in various metallic alloys.

THE EFFECT OF DRYING ON THE SYSTEM NITROGEN PEROXIDE – NITRIC OXIDE – OXYGEN.—The influence of intensive drying on the reaction between nitric oxide and oxygen was studied some years ago by Baker, who found that the dry gases did not combine. Later workers have obtained different results, and a further investigation carried out by J. W. Smith is described in the *Journal of the Chemical Society* for July. It was found that when nitrogen peroxide is heated with phosphoric oxide it dissociates to a greater extent than the moist gas, and the nitric oxide and oxygen do not recombine on cooling. The nitric oxide also decomposes into its elements at about 300° more readily than in the presence of moisture, but this reaction may be catalysed by the large surface of the phosphorus pentoxide. The formation of an addition compound between nitrogen peroxide and phosphorus pentoxide above 200°, as observed by Hartung, was also noticed. Nitrogen peroxide after intensive drying at the ordinary temperature only decomposed slightly even at 550°, but if heated to 620° and then cooled, it behaved normally. This effect may be due to partial decomposition of the glass surface at the higher temperature. Polymerisation of nitrogen peroxide to the tetroxide occurs less readily when the gas is dry.

PREPARATION AND PROPERTIES OF SELENOPHEN.—Although a few of its complex derivatives have been described, selenophen, the selenium analogue of thiophen, has apparently remained unknown. Foa (1909) claimed to have obtained it in small quantities, but his product had properties very different from those of the selenophen now isolated by H. V. A. Briscoe and J. B. Peel. Their method of preparation and many of the properties of this interesting substance are described in the *Journal of the Chemical Society* for July. Selenophen was obtained by passing acetylene over selenium heated to about 400° in a silica tube and condensing the reaction products in a cooled receiver. Several hydrocarbons were produced, but much of the brown oil formed consisted of selenophen, which was purified by careful fractionation. In the pure state it is a colourless, highly refractive liquid, freezing at about − 38° and having a slight odour. Molecular weight determinations showed that it is unassociated. Chemically, selenophen resembles thiophen in being inactive and very stable. It is not reduced by ordinary reducing agents and yields no methiodide even when heated with methyl iodide at 160° for twenty-four hours. At the boiling-point it readily dissolves sulphur. Treatment with bromine or chlorine in carbon disulphide yielded the tetrabromo or tetrachloro derivative, but the corresponding iodine compound could not be isolated.

A THERMIONIC VOLTMETER.—It is well known that in general, when the electric stress between two electrodes in air attains a definite value, a spark will ensue or brush discharges will begin. This limiting value of the stress depends on the magnitude and shape of the electrodes. If alternating pressures be employed, then in computing the electric stress the peak value of the voltage and not the voltmeter reading has to be taken. In the August number of the *Journal of the Institution of Electrical Engineers*, E. B. Moullin describes a thermionic voltmeter which can measure both the peak and the mean value of an alternating voltage. The dial has two scales corresponding to peak and mean values respectively, and a change-over switch converts the voltmeter from one reading to the other. The peak value is measured by the mean grid current of a cumulative grid rectifier. It is shown by experiment that the mean grid potential is practically proportional to the peak value, no matter what the wave shape may be. The accuracy of the measurements is about the same as that obtained from oscillograms. The mean value measurement is made by omitting the grid condenser. The author discusses the accuracy of the method analytically and gives experimental results in support of it. The use of the voltmeter is illustrated by giving curves which show the distortion produced by a four-stage thermionic amplifier.

A 500 KV. TESTING TRANSFORMER.—The great advances that have been made in high tension technique during the last few years have led to continually increasing high pressure tests being specified for insulating materials. A 500 kilovolt testing plant which has been installed by the A.E.G. (Allgemeine Elektricitäts Gesellschaft) at the Enfield Cable Works, Brimsdown, is described in *AEG Progress* for August. Unlike other firms, the A.E.G. produces the high pressure by a single transformer erected in a plain boiler plate tank filled with oil. This tank can be earthed, and so there is little danger to the operator. In view of the large charging current taken by the cables during test, it was necessary to have a large continuous output. The transformer can supply at 450 kv. single phase or 260 kv. three phase continuously. The maximum pressure is only to be applied for five minutes. The spark gap is between two spheres each of 75 cm. diameter placed horizontally. The length of the spark gap is adjusted electrically by means of a motor driving a worm shaft. The maximum distance apart of the two spheres is 50 cm. and it takes four minutes before the spheres touch one another. The exact distance between the spheres is read by both mechanical and electrical indicating devices. The former is in the shape of a clock dial which can be read from a considerable distance. The voltage can also be read by means of an electrostatic voltmeter shunting the two condenser plates which are nearest the earth of a chain of condenser plates. Very elaborate safety devices and interlocks are employed. The test generator can only be excited after all the doors of the wire netting enclosure are closed. A number of red lamps are arranged round the enclosure and automatically light up when the main switch is closed. It is stated that the set is not required simply for practical purposes but also for impressing visitors and customers with the thoroughness of the methods of testing adopted.

Universities in the United States of America.

INFORMATION about higher education and research in the United States is available in great, to the uninitiated, indeed, in embarrassing abundance. Besides the 'catalogs' and reports of a thousand colleges, universities, and professional schools, there are the excellent statistical summaries and surveys of the Bureau of Education, a plentiful stream of articles in American periodicals, reports of investigations carried out under the direction of great educational associations and foundations such as the Carnegie Foundation for the Advancement of Teaching, and records of impressions of visitors from Europe. The conceptions current in Great Britain owe their origin largely to the last-mentioned source and, perhaps not less, to unpublished impressions of other visitors to America, to contact with American visitors to Europe, including Rhodes scholars, and to references in popular fiction. Anyone desiring to apply to conceptions thus formed the test of a purely objective, well-authenticated, comprehensive, and up-to-date survey could not do better than study the handbook [1] recently issued by the American Council on Education.

This volume gives, first, an admirably lucid account of the organisation of education in the United States and the character and relations of college, university, professional school, and graduate school of arts and sciences, and, secondly, particulars indicating the general character and resources of each of the 398 universities and colleges accredited by the five great standardising bodies [2] which, in the absence of a central governmental authority, provide for the development of co-operation among these institutions and between them and the schools. These bodies have all adopted and applied standards formulated by the American Council on Education which was constituted by the leading educational associations and universities and colleges in 1918.

The American 'college' stands between the British secondary school and university, offering a general education during four years and conferring a bachelor's degree. Its first two years are comparable with the last two of a European *lycée* or *gymnasium*, and its last two with the first two of the French or German university. The 'university' comprises "a college or colleges of Arts, Literature, and Science—historically the first part of the American university to come into existence—and professional colleges or schools of Law, Medicine, Theology, etc., and, especially, a graduate school of Arts, Literature, and Science."

For admission to one of the 'accredited' lists, a college has to fulfil a number of minimum requirements, among which are: an adequate staff (for example, for a college of 100 students, in a single curriculum at least eight full-time heads of departments); a moderate 'teaching load,' normally not more than 16 hours a week for an instructor or classes (exclusive of lectures) of more than 30 students; annual operating income, exclusive of payment of interest, annuities, etc., of at least 50,000 dollars, of which not less than 25,000 dollars should be derived from stable sources, other than students, preferably from permanent endowments; a library of at least 8000 volumes, exclusive of public documents. No college is accredited until it has been inspected and reported upon by agents regularly appointed by the accrediting organisation.

Co-education prevails in the west; separate colleges for women exist particularly in New England and the Atlantic States, north and south. The organisation and influence of men and women who have been students together are extraordinarily effective in America. Their secretaries have become so numerous and energetic that since 1913 they have had their own association, which has published, in addition to reports of their conferences, a "Manual of Alumni Work." A statistical study of campaigns conducted recently by sixty-eight institutions for raising funds shows that of a total sum of 150 million dollars, nearly half was obtained from alumni. Their influence has been felt not only in financial campaigns but also in matters of educational policy, and they show an increasing willingness to co-operate with employment bureaux and appointment offices.

The resources of higher education in America have expanded rapidly since the War. The latest statistics of the Bureau of Education show that between 1920 and 1926 the total annual receipts of colleges, universities, and professional schools (numbering 975 in 1926) increased from 240 to 480 million dollars, the money value of their buildings and equipment in almost equal proportion, and the number of professors and instructors from 42,882 to 62,224. So great, however, has been the simultaneous expansion of the demand for admission to these institutions that their resources have been overtaxed and they have been driven to adopt protective measures against the danger of being swamped by excessive numbers. They have imposed new and stricter conditions of admission, designed to ensure the selection of those best qualified to carry their studies to a successful issue, and there has been much discussion of fundamental questions as to the aims and purposes of higher education and what are the types of student best fitted, from the point of view of the interests of the community, for admission to its benefits.

The overcrowding with which the colleges have been afflicted has not been without compensating benefits. Whereas formerly colleges competed injuriously one with another for students, and there was excessive emphasis on externals—buildings and equipment—they are now in a position to insist on higher standards of qualification for admission, and emphasise quality rather than mere numbers. In some States the State university is required to accept any applicant for admission who has obtained a leaving certificate from the principal of any accredited high school. In more cases, however, the college requires the completion of specified work in English (3 units), foreign language (3), mathematics (2), history (1), science (1), and many admit only those students who ranked in the first seventh or first quarter of their class at the close of their school course.

Nor is this new emphasis on the quality of the student confined to the testing of his fitness for admission. The responsibility of the college for developing the individual student is increasingly recognised, and elaborate records are prepared both at entrance and afterwards for use by professors and future employers. In 1927 the American Council on Education received a grant of 20,000 dollars a year for the development of 'personnel procedure'—a term signifying the various efforts by which it is sought to bring the college into closer individual touch with its students. Many of these efforts are directed

[1] "American Universities and Colleges." Edited by David Alan Robertson. Pp. xii+884. (New York and London: Charles Scribner's Sons, 1928.) 12*s*. 6*d*. net.

[2] Association of American Universities, North Central Association of Colleges and Secondary Schools, Association of Colleges and Secondary Schools of the Southern States, Association of Colleges and Secondary Schools of the Middle States and Maryland, and the North-West Association of Secondary and Higher Schools.

towards placing the student in some appropriate employment. "With the development of personnel procedure," says Dr. Robertson, "including greater attention to the analysis of individual abilities and achievements, there has come a desire to have useful occupational information. . . . When the world's work has been analysed and the skills and qualities required for particular jobs have been specified, the schools and colleges can shape their curricula and methods of instruction to attain more quickly and effectively the objectives of education as they pertain to vocations." This passage is significant of the trend of much of recent American research in the field of higher education. Attention is focused more on brains and service, and less on bricks and mortar.

Meristematic Tissues of Plants.

IT should be unnecessary to emphasise the importance of focusing attention on plant meristems, and yet the subject is one which is either sadly neglected or receives but scant attention. Botanists with a progressive or inquisitive turn of mind will therefore read with interest Prof. J. H. Priestley's paper on plant meristems (*Biological Reviews*, vol. 3, No. 1).

Different types of meristem are passed in review from a 'causal' viewpoint, and an attempt is made to show that each stage in development depends on preceding events, and releases in turn a system of internal correlating factors which control the progress of growth. The author draws a sharp distinction between shoot meristems, which are superficial, and root meristems, which are deep-seated, and gives some tentative reasons why their continued developments are markedly different. Repeated microchemical tests have confirmed his conclusion that the walls of the root meristem cells are in a more undifferentiated state than those of the shoot, being still impregnated with fatty and protein materials.

Now, postulating the passage of nutrient substances along differentiated cellulose walls, Prof. Priestley considers that most of the divisions in root meristems are internal because food material has some difficulty in passing to the outermost layers of cells. At the same time, divisions occur for the most part in a plane transverse to the root axis, giving the *Rippenmeristem* of Schüepp. Both of these factors are used to explain why the root grows mostly in length. In the shoot meristem, on the other hand, sap passes readily along the more differentiated cell walls, with a resulting greater division of cells in the superficial layers. Thus the primordia of bud-scales, leaves, and flowers are laid down. The repeated tangential divisions of cambium cells, contrary to Errera's Law, are explained by the fact that cambium cells are never in equilibrium with the surrounding cells, lying as they normally do across a hydrogen ion gradient between phloem and xylem.

Some interesting suggestions are put forward regarding the position of the cambium elements formed just behind the root tip. In a former paper by Dr. Pearsall and Prof. Priestley, it was shown that the reaction of cambium (in terms of hydrogen ion concentration) is intermediate between the relatively alkaline phloem and the relatively acid xylem. This reaction is approximately the reaction at which most plant proteins are isoelectric, and in the vicinity of which most protoplasmic synthesis takes place. In the young root, the protophloem groups and the protoxylem groups, on alternate radii, exude their saps respectively alkaline and acid, and in the regions where these saps intermingle, the hydrogen ion concentration necessary for the formation of cambium obtains.

Orientalists at Oxford.

NOT only was the Seventeenth International Congress of Orientalists, which was held at Oxford on Aug. 27–Sept. 1, the first meeting of that body since the War, but it was also the largest gathering that had ever taken place. It is an encouraging sign of the position of orientalists' studies at the moment that, in addition to the ordinary members, there were present two hundred official delegates, who represented the principal governments and universities of the world. Notwithstanding the fact that the meeting took place in mid-vacation, Oxford provided ample entertainment for her guests in the form of garden parties, etc. An official luncheon was given by the British Government in the hall of Christ Church on the opening day, at which Sir William Marris, member of the Council of India, presided. In welcoming the delegates he paid an eloquent tribute to the work of Sir George Grierson in the Linguistic Survey of India. A banquet was held on the evening of Aug. 31.

The Congress met in eight sections, each with its own chairman, Lord Chalmers presiding over the whole. The sections with their presidents were as follows: (1) General, Prof. J. L. Myres; (2) Assyriology, Prof. S. P. Langdon; (3) Egypt, Prof. F. Ll. Griffith; (4) Central and Northern Asia, Prof. F. W. Thomas; (5) the Far East, Prof. W. E. Soothill; (6) (*a*): 1. Ancient India, 2. Modern India; (*b*) Iran, Armenia, and the Caucasus, Prof. F. W. Thomas; (7) Hebrew and Aramaic, Prof. G. A. Cooke; (8) Islam and Turkey, Prof. D. S. Margoliouth; (9) Oriental Art, Sir Michael Sadler.

The proceedings covered a wide range, as may be gathered from the fact that one paper even dealt with the languages of Australia. Perhaps Assyriology held pride of place in attracting attention, and justified the title applied to it by Prof. Langdon when he called it the "Queen of modern Historical Research." In his survey of recent developments in the subject, he emphasised the value of the German discoveries in Hittite Boghaz Keui, the extension of our knowledge of Sumerian, the recovery of the lists of early dynasties at Ur, and the "astonishing" discoveries in the Indus Valley. Mr. Woolley's account of his excavations at Ur and the evidence for human funerary sacrifice aroused much interest; but perhaps the most appropriate of all the items in the programme was the opening of this section on the first full day of the proceedings of the Congress with a paper by the veteran scholar, the Rev. A. H. Sayce, now in his eighty-third year.

It was significant of the breadth of interest of the Congress as a whole that the chair in the Section of Oriental Art was taken by Sir Michael Sadler, Master of University College, Oxford. His presidential address on "Recent Influences of Oriental Art upon Western Painting and Literature" showed remarkable discernment in tracing the influence of eighteenth century *chinoiseries* in the drawings of Cozens and Gilpin, while pointing out, with a characteristically stimulating grasp of essentials, the affinity between Wordsworth's attitude to Nature and that of the great Chinese painters.

Except for the specialist who confines himself to one subject, the variety of the Congress was rather bewildering; while the number of papers precludes mention of more than a brief and entirely inadequate selection. Many, of course, were highly technical in their interest. Among those of wider appeal, even if technical in character, may be mentioned Prof. Zeitlin's discussion of the authenticity of the recently discovered "Jesus" passage in the Slavonic Josephus, to which Dr. Gaster stated that he had found similarities in a Rumanian version discovered by himself; Dr. H. Farmer's analysis of the information relating to Greek music to be found in Arabic writers; and a paper by Kuoprulu Zade Fuad Bey, which in discussing Omar Khayyám's belief in metamorphosis, produced fifty-three new quatrains of his verse.

Some remarkable customs were described by Mr. B. Thomas in a thrilling account of his travels in parts of southern Arabia never trodden by Europeans, during which he discovered non-Arab tribes speaking four different languages, possibly Semitic, not understood by the Arabs. It was suggested that these tribes were Hamitic. Of both linguistic and cultural significance was Dr. Alan Gardiner's communication on the Sinai script, in which he held that his decipherment proved the origin in the Sinai script of both the Phenician and our own alphabetic script. The Commission from Malta brought forward a paper which supported the view that the Maltese language originated in an Arabic tongue of North Africa with Phenician elements.

The work of archæological excavation in areas covered by the Congress was well represented. Mr. Woolley, on Ur, has already been mentioned. Mr. C. Firth on the excavations at Saqqara, and Mr. Guy on the work in Palestine at Megiddo, which brought to light buildings conjectured to be the stables of Solomon, were also highly appreciated. Prof. Chiera, in describing a wealthy Babylonian's house excavated by the American School of Oriental Research at Nuzi, near Kirkuk, brought forward some interesting suggestions as to the domestic arrangements of the period. The house had been destroyed by fire, presumably at the hands of Assyrian raiders, and the condition of the remains of the clay brick walls, which had evidently been subjected to intense heat, suggested that the rooms had contained a considerable quantity of wooden furniture.

In more purely literary and scholastic subjects, the Institute of St. Joseph of Beirut received well-merited recognition for the account of its work on the preparation of the "Bibliotheca Arabica Scholasticorum."

Finally, mention must be made of two resolutions passed by the Congress: one was in response to a paper by Pater Schmidt, urging the establishment of an organisation for the systematic study of Australian languages; and the other urged upon the governments of the Near and Middle East the need for increasing the facilities granted to accredited excavators, and removing certain disabilities to which they are at present subject—a question raised by Mr. Guy of Palestine.

The next meeting of the Congress will be held in 1931 in Holland, probably at Leyden.

University and Educational Intelligence.

OXFORD.—Under the will of Mr. W. W. Rouse Ball, of Trinity College, Cambridge, who died on April 4, 1925, sums of money were bequeathed for the foundation of Rouse Ball chairs of mathematics at Oxford and Cambridge. Early this year, Prof. J. E. Littlewood was appointed to the Cambridge chair, and now Prof. E. A. Milne, Beyer professor of applied mathematics in the University of Manchester, has been appointed as from Jan. 1, 1929, to the Rouse Ball professorship of mathematics at Oxford. Prof. Milne's duties will be to give instruction in mathematical physics, and he may also give lectures on the history of mathematics in accordance with the wishes of the founder. Subject to certain conditions, a non-stipendiary fellowship at Wadham College is attached to the chair.

DALHOUSIE University at Halifax, Nova Scotia, has instituted a chair of fisheries and a degree of bachelor of science in fisheries. In co-operation with the Biological Board of Canada, through which the Ministry of Marine and Fisheries controls the Marine Biological Station at Halifax, the University is providing a four-year course combining with instruction in the fundamental sciences practical teaching of the general principles of fish culture, salting, drying and canning methods, freezing and smoking methods, and marine biology. Instructors will be provided by the Biological Board.

FOR four years past the Polytechnic, Regent Street, London, W.1, has, in an experimental way, provided courses of instruction in industrial administration. A co-ordinated course has now been arranged, and examinations will be under the joint control of the Institute of Industrial Administration and the Polytechnic. The course is designed to help those ambitious men and women who have the personal qualities of leadership but require in addition a sufficient training in the technique of industrial administration to undertake the management of business organisations. Related courses of lectures on "The Effect of Government on the Economic Structure of the United Kingdom" will be given at the Polytechnic by the Right Honourable Dr. William Graham, and by diplomatic representatives of South American States on "The Economic Resources of South America." Details can be obtained from the Director of Education of the Polytechnic.

THE depressed state of the coal industry has directed attention to the need of more scientific treatment of fuel, and it is pleasing to note that the Sir John Cass Technical Institute, London, E.C.3, has arranged a five-year course dealing with coal carbonisation, the classes being held in the evening in order to meet the requirements of those engaged during the day. Every phase of the subject is covered, and students attending the course can enter for the certificate examinations of the Institution of Gas Engineers. It is particularly interesting to notice that post-graduate students are also encouraged to offer coal carbonisation as a subject for the M.Sc. degree. The scheme will be inaugurated in the forthcoming session by a course of lectures on gas manufacture by Mr. H. D. Greenwood. The general extent of the curriculum is indicated by the inclusion of lectures dealing with such subjects as fuel and refractories, applications of engineering, and gas analysis. Those wishing to qualify for executive positions are offered a course on English law as related to chemical industry, and chemists will be interested in a course on chemical plant by a panel of special lecturers.

Calendar of Customs and Festivals.

September 12.

Winchester fair, once one of the great fairs of the British Isles, exemplifies the customary surrender of civic authority. The keys of the four gates were surrendered to a magistrate appointed by the bishop.

September 14.

HOLY ROOD OR HOLY CROSS DAY.—In Great Britain the day is specially associated with nutting. It was the custom of Eton that a holiday should be given for nutting on this day. In the Highlands of Scotland the night succeeding Roodmas was called 'the Night of the Holy Nut.' It was a popular belief that on this day the devil went nutting. If on the night before Roodmas it were wet, it was said that "the deer took his head wet into the rutting season," and there would be a month of fine weather and the farmer need have no fear for his crops.

September 15.

FESTIVALS IN ANCIENT MEXICO.—In the latter part of August or early in September a festival was held in honour of 'the Mother of the Gods,' when a woman clad in the ornaments of the goddess was sacrificed. Her body was immediately flayed and a young man dressed in the skin, with the exception of the skin of the thigh, which was worn by another man as a mask, who called himself the Maize Goddess, and the 'daughter' of the Mother of the Gods. A similar sacrifice in honour of the maize goddess took place on Sept. 15. This was in part a purificatory ceremony, as it was preceded by a fast of some days, at the end of which a woman personating the Goddess of the Lepers was sacrificed. It was also in part a fertility ceremony, as the blood of the 'Maize Goddess' was sprinkled over corn, fruits, the image of the goddess, and the walls of the room in which the sacrifice took place. A procession followed the sacrifice, which was headed by a man dressed in the skin, clothes, and ornaments of the 'goddess.'

HARVEST.—In the primitive agricultural year the two solemn festivals of the spring sowing and the harvest of late summer correspond to the observance of the opening of summer in May and the beginning of winter in November in the pastoral year; and just as the winter festival is associated with the cult of the dead, it is sometimes found that a part of the harvest observance is a propitiation of departed spirits. It marks the end of the old and beginning of the new year.

Owing to the conservatism of the peasant and the vital character of the operations with which they are connected, harvest customs long retained features more readily to be identified as survivals of primitive belief than almost any other groups of folk practices. Their importance among the heathen was early recognised by the Church, though they were sometimes thought to have been borrowed from the first-fruit ceremonies of the Jews, and notwithstanding the aversion from pagan practices, some of the ritual, for example, such as that of Vacuna, to whom Sabine rustics sacrificed at the end of harvest, was countenanced in the Christian thanksgiving—"chaplets of corn which She (the Roman Church) suspends on poles" and "offerings . . . on the altars of her tutelar gods." Indeed, a puritanical writer of the seventeenth century censures as a breach of the second commandment "the adorning with garlands or presenting unto any saint whom thou hast made special choice of to be thy patron and advocate, the first-fruits of thy increase, as corne and grains and other oblations."

It is a custom widespread throughout Europe that the last sheaf of corn to be cut should have a special name, should be woven or tied into a special shape, should sometimes be cut by a special person and with special ceremony, and usually be preserved for a year or more. Sometimes the grain from this special sheaf is mixed with the seed corn of the next sowing. This is the spirit of the corn known as the 'corn' or 'kern baby,' 'corn maiden,' 'corn mother,' 'corn dolly,' and so forth. The spirit is sometimes known by an animal name such as the 'hare,' for reasons apparent to anyone who has watched the cutting of corn in a hare country, or the 'mare' in Hertfordshire, where the last sheaf was cut by the harvesters throwing sickles at it. An interesting blend of Christian and pagan observed a few years ago in northern Italy consisted of a corn baby on a small stool or platform surrounded by a circle of twelve other corn babies.

Some significant ceremonies are recorded when the corn baby had been cut. In North Devon, where the figure was known as a 'neck,' a ring was made. The reaper in the centre held the neck in his two hands near the ground, while the others, taking off their hats, lowered them to the ground, then all cried "the neck" in harmony. As the central figure raised the neck they lifted their hats slowly above their heads to the full extent of their arms three times, and then changed their cry to "wee yen."

This circle—an act of adoration—reappears in certain East Anglian customs. In Norfolk any stranger entering the field during harvest operations was approached by the leader with a demand for 'largess.' If a gift was received the largess was 'holloed' by all the reapers standing in a circle around the giver with their arms holding their sickles extended towards him. They then shouted three times at the command of their leader, who stood on any elevated post near by. Largess given at the harvest supper—the 'Horkey Supper'—by the farmer's guests was holloed in similar fashion, the central figure holding a *gulch* of ale and a horn, the circle all holding each other's hands. At the blowing of the horn the clasped hands were elevated as high above the head as possible without losing the hand-clasp. Three whoops then followed and all drank of the ale in turn.

That the blades of corn last cut were regarded as a person was shown not only by the semblance of the human form into which they were woven, but also by the way in which they were treated after cutting. In Perthshire 'the maiden' was entrusted to the most personable of the girls, who bedecked it with ribbons. In Kent it was the business of the women to deck the 'ivy girl,' which was composed of the finest corn the field produced, with paper trimmings cut to resemble cap, ruffles, and handkerchief, etc., of point lace. In Northumberland the 'harvest queen' was an image which was apparelled in great finery with a garland on its head and a sheaf of corn under its arm and a scythe in its hand. This was carried out of the village on the concluding day of harvest, and fixed to a pole in the field. There it remained all day and was carried home at night when the reaping was finished. In the Cotteswolds at the beginning of the last century, a gaily decked girl, who apparently represented the goddess of the harvest, rode on the first of the horses bringing home the last load.

The last load generally, though not always, carried the corn baby, and was usually gaily decked. Its ceremonial character was emphasised in Gloucestershire. It came from the farthest field, and it should be the smallest, not topping the rail, so that women and children might ride on it. By taking it from the farthest field it was ensured that its beneficial influence should cover the greatest stretch of ground.

Societies and Academies.

PARIS.

Academy of Sciences, July 23.—G. Bigourdan: Some sunspot observations hitherto unpublished, made at the Paris Observatory from 1683 to 1719 by Ph. La Hire and by G. Ph. La Hire.—L. Blaringhem: The fertility of *Hemerocallis fulva*.—P. Helbronner: The figure of the earth deduced from the measurement of the arc of the meridian of the French Alps.—Léon Pomey: The theory of algebraical curves.—E. Cartan: The Betti numbers of spaces of closed groups.—Silvio Minetti: An upper limit of the increase of the maximum modulus of an integral function of finite genus.—R. Duchêne: The influence of lead tetraethyl on the deflagration of gaseous hydrocarbon mixtures. The effect of the addition of 5 per cent of lead tetraethyl to a hexane-air mixture, and the photographs of the flame produced on explosion, point to the fact that the lead compound exerts an antidetonating action in a homogeneous gaseous mixture.—L. d'Azambuja: Images of the solar chromosphere obtained in the spectroheliograph with the infra-red line λ8542 of ionised calcium.—Louis Pirot: Determinations of astronomical positions by means of the prism astrolabe.—A. Launert: The action of mixtures of salts on copper. The mixtures used were potassium and strontium chlorides, potassium and barium chlorides, barium and strontium chlorides. Rods of copper were heated in these mixtures to temperatures below the eutectic points (530° C. to 725° C.), and the changes in the density and electrical resistance of the metal measured.—R. Jouaust: The phenomena of propagation of radiotelegraphic waves. The phenomenon of the aurora has been explained as being due to ionisation at a great altitude (200 km. to 400 km.) caused by particles emanating from the sun. It is suggested that this same ionised layer is responsible for the reflexion downwards of the electromagnetic waves.—F. Bedeau and J. de Mare: The stabilisation of the oscillations of relaxation.—Maurice Lambrey: The absorption spectrum of nitric oxide. Completion of work discussed in an earlier communication.—Paul Soleillet: The polarisation of the resonance radiations of cadmium.—Jean Becquerel: The existence, for a uniaxial crystal, of two different magnetic rotatory powers, along the axis and along a normal to the axis.—Armand de Gramont and Georges Mabboux: Applications of ultra-microscopic illumination to the bubble of a spherical level.—Jean Thibaud: The refractive index of glass for X-rays of great wave-length.—L. Mallet: The spectral study of the luminescence of water and carbon disulphide submitted to the gamma radiation.—G. Allard: An allotropic state of silver. Ordinary silver has been shown by the X-ray method to be cubic. The silver obtained by the action of copper upon a solution of silver nitrate examined by the powder method gives a series of lines quite incompatible with a cubic structure and has proved to be orthorhombic.—René Delaplace: The gaseous contraction of hydrogen submitted to the electric discharge. Previous work on this subject has led to the suggestion that the abnormal contractions observed are due to a polymerisation of the hydrogen. In the experiments described the discharge tubes were made of Pyrex glass, without tap or ground joint, and cleaned by heating in a vacuum to 400° C. A contraction was observed, but the presence of methane and of carbon monoxide was proved.—André Léaute: Results of briquetting coal by means of hydrocarbons partially dehydrogenated by sulphur.—Arakel Tchakirian: The volumetric estimation of germanic acid: studies of some hydrated forms of this acid and its salts.—Adolphe Lepape: The separation of krypton and xenon from atmospheric air. In preparing krypton and xenon by the slow evaporation of liquid air, the yields are extremely small owing to the fact that as the liquid phase diminishes the proportion of the two gases escaping with the oxygen increases. A method of reducing these losses is given. A litre of xenon and several litres of krypton have been prepared.—R. Levaillant: A new method of preparing alkyl sulphates. The reaction proposed is

$$Cl . SO_2 . OR + NO . OR' = SO_2(OR)(OR') + NOCl,$$

in which R and R′ are alkyl groups.—A. Morel and P. Preceptis: The reciprocal actions of picric acid and cycloglycylglycine.—G. Delépine: The age of the grits of Naranco (Asturia). The fauna of these ferruginous grits clearly points to their age as middle Devonian.—R. Esnault-Pelterie: The law of the constitution of the atmosphere. A discussion of the formulæ proposed for giving the density of the air as a function of the altitude.—N. P. Péntcheff: The rare gases of thermal springs and the earthquakes of April 14 and 18, 1928, in Bulgaria. Although the amount of water issuing from the springs was changed by the earthquakes, the proportions of helium and argon remained the same.—V. Ghimpu: Contribution to the caryological study of the genus *Medicago*.—Maresquelle: The respiratory exchanges of plants attacked by the Uredineæ.—Laurent Rigotard: Alpine agronomy applied to the study of the formation of arable soils.—E. Miège: The presence of forms of the Inflatum type in *Triticum durum*.—V. Pertzoff: The lipase of the caterpillars of *Galleria mellonella*.—F. Rathery, R. Kourilsky, and Mlle. Yv. Laurent: Insulin, folliculin, and glycæmia in the normal dog.—Philippe Fabre: Electrocardiography by means of commercial oscillographs.—Edm. Sergent, A. Donatien, L. Parrot, F. Lestoquard: The transmission of bovine piroplasmosis to *Theileria dispar* of north Africa by the tick *Hyalomma mauritanicum*.—E. Marchoux: Man is less sensitive than *Macacus rhezus* to the virus of yellow fever.—J. Bridré, A. Donatien, and D. Hilbert: Stovarsol, a specific against contagious agalaxy of the sheep and goat.

LENINGRAD.

Academy of Sciences (*Comptes rendus*, No. 13).—B. I. Dolbeshkin: The occurrence of *Ædes escœnsis* Jam. in Orenburg.—B. I. Dolbeshkin: Fauna of mosquitoes of the Dnieper basin. A list of species with localities.—V. V. Gorickaja: The problem of infection of *Anopheles maculipenis* by malarial plasmodia under natural conditions. Dissections of mosquitoes collected in different habitats showed that the percentage of mosquitoes infected with malarial plasmodia is higher in houses than in stables; the presence of subjects suffering from malaria is reflected in a higher percentage of infected mosquitoes.—L. V. Burakova: Mosquito fever and mosquitoes of Crimea. A preliminary report of the expedition for the study of the papataci fever and the distribution of *Phlebotomus spp.* in Crimea.—N. I. Chodukin: Does *Anopheles algeriensis* (Theob.) exist in Turkestan? Turkestan mosquitoes recorded as *Anopheles algeriensis* var. *turkestanicus* belong to the species *A. bifurcatus* L.—N. I. Chodukin: Kala-azar in Tashkent and its relation to the epidemiology of the leishmaniasis of dogs. All the foci of kala-azar in Tashkent have been found to coincide with the foci of dog leishmaniasis, and it is suggested that the infection is transferred not by fleas, but probably by mosquitoes.—E. N. Pavlovsky, A. K. Stein, and P. P. Perfiliev: Experimental studies on the active principles of saliva of *Culex pipiens* on the skin of man. Saliva is more active than extracts from the œsophagal bladders.

Sydney.

Linnean Society of New South Wales, June 27.—**A. B. Walkom**: Fossil plants from the Upper Palæozoic rocks of New South Wales. Four species of fossil plants are described from the Kuttung Series, namely, *Ulodendron minus*, *Stigmaria ficoides*, a new species of *Pitys* (?), and a new species of *Lepidodendron* similar to *L. spitsbergense*. These plants indicate that the flora of the Kuttung Series is related to floras of Lower Carboniferous age in the northern hemisphere. A new species of *Dadoxylon* is described from the Ravensfield sandstone, in the Lower Marine Series.—**T. L. Bancroft**: On the life-history of *Ceratodus* (*Epiceratodus forsteri*). During a period of seventeen years many thousands of *Ceratodus* have been hatched, but the author only succeeded in rearing two past the critical three months' stage. The secret of successfully negotiating this stage has now been discovered, and a description of the technique is given. The great importance of this lies in the fact that conditions for favourable propagation of *Ceratodus* no longer exist in the Burnett River, and the fish must be gradually nearing extinction in that river.—**J. R. Malloch**: Notes on Australian Diptera. No. 14. This part deals with Asilidæ (subfamilies Laphrinæ and Dasypogoninæ), Chloropidæ (one subgenus and three species of *Parahippelates* are described as new, and a key is given to the species of that genus), Lonchæidæ (a key is given to the species of *Lonchœa*, one species is described as new, and notes are given on other species), Sepsidæ (one genus and one species are described as new) and Piophilidæ (one genus and one species are described as new).—**A. B. Walkom**: Lepidodendroid remains from Yalwal, N.S.W. Lepidodendroid stems from Yalwal are referred to two species (described as new) of *Protolepidodendron* and one species of (?) *Lepidodendron*. The former show resemblances to *P. primœvum* from the Upper Devonian of New York, and support the reference of the Yalwal rocks to the Devonian.—**C. P. Alexander**: The Australasian species of the genus *Nemopalpus* Macquart (Diptera, Psychodidæ). A second species of the genus is described from the Dorrigo Plateau in New South Wales. Keys are given for the recognition of the subfamilies of Psychodidæ, the genera of Bruchomyinæ and the species of *Nemopalpus*.—**H. J. Carter**: Revision of the Australian species of the genera *Curis*, *Neocuris*, and *Trachys*, together with notes and descriptions of new species of other Coleoptera. Amongst the Buprestidæ four species are described as new, many notes on synonymy are given, and the results of critical examination of recent work by Dr. Obenberger are recorded. One genus and six species of *Tenebrionidœ*, five species of *Cistelidœ* and one species of *Cerambycidœ* are also described as new.

Vienna.

Academy of Sciences, June 21.—**P. Gross** and **K. Schwarz**: The separating action of salts. An inquiry into the distribution of acetone and of hydrocyanic acid between benzol and aqueous solutions of electrolytes and some non-electrolytes.—**P. Gross**: The action of neutral salts.—**A. Müller** and **E. Rölz**: A new preparation of 1, 5-dioxy-*n*-pentane (pentamethyleneglycol) and 1, 5-diiod-*n*-pentane.—**R. Weiss**: Researches on the preparation of acridone derivatives.—**R. Weiss** and **E. Merksammer**: A new synthesis of cumarin derivatives.—**E. Blumenstock-Halward** and **E. Jusa**: The colour deepening action of the methyl-mercapto group in azo dyes (1).—**E. Blumenstock-Halward** and **E. Riess**: The colour deepening action of the methyl-mercapto group in azo dyes (2).—**G. Koller** and **E. Strang**: A synthesis of 2,4-dioxy-6,7-benzo-1,8-naphthydrin-3-carbonic acid-methylester.—**A. Tornquist**: The system of lead-zinc-pyrites mineralisation in the hills of Graz.—**A. Kieslinger**: Geology and petrography of the Kor Alps. (7) Eclogite and amphibolite. (8) Pararocks.—**A. Musger**: Etiology of Nicholas-Durand-Favre's disease. Apparently it is due to coryne bacteria.—**E. Haschek**: A contribution to the Young-Helmholtz theory. The hypothesis of three visual substances in the retina with separate photochemical sensitivities and regeneration constants.—**L. Holzer**: The determination of Lebesgue's measure of linear point manifolds the elements of which are given by systematic development.—**L. Hajek**: New recording apparatus of the Vienna phonogram archives.—**Z. Dische**: The nature of the albumen-fixed plasma sugar. The sugar was from horse blood and includes a non-dialysable blood-sugar partly an easily fermentable *d*-mannose and partly a non-fermentable sugar.—**A. Zinke, A. Dadieu, K. Funke,** and **A. Pongratz**: Researches on perylene and its derivatives (17).—**A. Pongratz**: Researches on perylene and its derivatives (18).—**O. Dischendorfer**: A disintegration acid of α-naphthol.—**K. Przibram**: Contributions to the coloration of salts. Crystals from molten rocksalt show blue coloration under sufficient pressure.—**C. Doelter** and **H. Hueber**: The colouring substance in blue rock-salt. Chemical inquiries as to alkalinity with phenolphthalein.—**O. Grube**: On numbers prime to each other and the sums of their powers.

Official Publications Received.

British.

The Tea Research Institute of Ceylon. Bulletin No. 2: Annual Report for the Year 1927. Pp. 43. (Kandy, Ceylon.)

The Quarterly Journal of the Geological Society. Vol. 84, Part 2, No. 334. Pp. xlix-cv+179-381+13 plates. (London: Longmans, Green and Co., Ltd.) 7s. 6d.

Apia Observatory, Samoa. Report for 1924. Pp. 84. (Wellington, N.Z.: W. A. G. Skeinner.)

British Association for the Advancement of Science, Glasgow Meeting, 1928. Daily Time-Table: Preliminary Issue. Pp. 23+xix. Excursion Arrangements: List of Excursion Fares and Trains available during the Period from 6th to 12th September 1928. Pp. 35. Visits to Works. Pp. 20. (London.)

Foreign.

Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 20, Part 5: Chemical Studies on the Ripening of Rice-seed and Chemical Properties of Rice of the Early Ripening Sub-varieties, by Tetsutaro Tadokoro; On the Differences in Physico-Chemical Properties of various Proteins in Plant Seeds. Third Report: On the Differences in the Physico-Chemical Properties of the different Kinds of Soy-bean Proteins. By Tetsutaro Tadokoro and Katsuji Yoshimura. Pp. 333-362. (Tokyo: Maruzen Co. Ltd.)

Proceedings of the Imperial Academy. Vol. 4, No. 6, June. Pp. xxi-xxiv+255-318. (Tokyo.)

U.S. Department of Agriculture: Bureau of Biological Survey. North American Fauna. No. 51: A Taxonomic Review of the American Long-tailed Shrews (Genera Sorex and Microsorex). By Hartley H. T. Jackson. Pp. vi+238+13 plates. (Washington, D.C.: Government Printing Office.) 50 cents.

Diary of Societies.

FRIDAY, September 7.

Philological Society (at University College), at 5.30.—Sir W. A. Craigie: Lexicography.

SATURDAY, September 8.

Institution of Municipal and County Engineers (Eastern District Meeting) (at Town Hall, Great Yarmouth), at 11.

Institution of Municipal and County Engineers (North-Eastern District Meeting) (at Town Hall, Morpeth), at 2.

THURSDAY, September 13.

Ceramic Society (Refractory Materials Section) (at Royal Technical College, Glasgow), at 10.30 a.m.—P. Cooper: Refractory Formers for Electric Heating Elements: some Problems in the Manufacture and Use.—W. Emery: Notes on Refractories for Salt Glaze Kilns.—A. T. Green: The Functions of Regenerators in Relation to the Properties of the Refractories of Construction.

FRIDAY, SEPTEMBER 14.

CERAMIC SOCIETY (Refractory Materials Section) (at Royal Technical College, Glasgow), at 10 A.M.—C. Edwards: Jointing Cement.—W. J. Rees: A Comparison of the Properties and Industrial Durability of Lime-bonded and Clay-bonded Silica Bricks.—W. J. Rees and D. W. Hubbard: The Dissociation of Carbon Monoxide in Contact with Fireclays and Silica.—C. E. Moore: Drying Cracks.—A. J. Dale: Aluminous Refractories and their Industrial Significance.

SATURDAY, SEPTEMBER 15.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South-Western District Meeting) (at Town Hall, Swanage), at 11.30.

CONGRESSES.

SEPTEMBER 5–12.

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

Friday, Sept. 7.

At 10 A.M.—

Dr. R. A. Sampson, and others: Discussion on the Photographic Measurement of Radiation.

Dr. J. Vargas Eyre, and others: Discussion on Fermentation.

Sir William Ellis: The Influence of Engineering on Civilisation (Presidential Address to Section G).

Dr. H. E. Magee, Prof. E. P. Cathcart, Capt. J. Golding, and Dr. N. C. Wright: Joint Discussion on Lactation and Nutritional Factors allied thereto.

Dr. Cyril Norwood: Education: the Next Steps (Presidential Address to Section L).

At 11 A.M.—

Prof. T. H. Pear: The Nature of Skill (Presidential Address to Section J).

Saturday, Sept. 8.

At 8.30 P.M.—

(In Royal Technical College Hall, George Street.) Prof. E. A. Westermarck: The Study of Popular Sayings (Frazer Lecture in Social Anthropology).

Sunday, Sept. 9.

At 11 A.M.—

Official Service in the Cathedral Church of St. Mungo. Preacher: Rev. Dr. Lachlan Maclean Watt.

Monday, Sept. 10.

At 10 A.M.—

Prof. A. W. Porter: The Volta Effect: Old and New Evidence (Presidential Address to Section A).

E. B. Bailey: The Palæozoic Mountain Systems of Europe and America (Presidential Address to Section C).

Prof. Allyn Young: Increasing Returns and Economic Progress (Presidential Address to Section F).

Sir George Macdonald: The Archæology of Scotland (Presidential Address to Section H).

At 11 A.M.—

Prof. C. Lovatt Evans: The Relation of Physiology to other Sciences (Presidential Address to Section I).

Prof. F. O. Bower, and others: Discussion on the Size Factor in Plant Morphology.

At 11.15 A.M.—

Dr. H. H. Read, Dr. Gertrude Elles, and others: Discussion on Problems of Highland Geology.

At 11.30 A.M.—

Prof. T. H. Pear, Prof. H. Clay, and C. G. Renold: Joint Discussion on the Nature and Present Position of Skill in Industry.

Tuesday, Sept. 11.

At 10 A.M.—

Dr. C. J. Davisson, and others: Discussion on the Scattering of Electrons by Crystals.

Sir William Pope, and others: Discussion on Recent Advances in Stereo-chemistry

Prof. F. E. Suess, and others: Discussion on the Tectonics of Asia.

J. A. Venn, Dr. J. S. King, and others: Joint Discussion on the Incidence of Taxation in Agriculture.

G. E. Briggs, Dr. F. G. Gregory, and others: Discussion on the Interpretation of Growth Curves.

Aims of, and Developments in, Broadcasting. Papers:—(*a*) Sir John Reith: Wireless in the Service of Education. (*b*) Salter Davis: An Experiment in Educational Broadcasting.—Sir Oliver Lodge, W. A. Brockington: Discussion.

At 12 NOON.—

Prof. T. H. Mortensen, Dr. F. A. Bather, and others: Discussion on Bothriocidaris and the Ancestry of Echinoids.

At 2 P.M.—

Conference of Delegates of Corresponding Societies.

At 2.15 P.M.—

Prof. F. E. Fritsch, R. Gurney, and others: Joint Discussion—A Biological Investigation of British Fresh Waters.

Dr. G. S. Carter: The Conditions of Life in a Tropical Swamp: an Investigation of the Swamps of the Paraguayan Chaco (Lantern Lecture).

At 2.30 P.M.—

Prof. E. Taylor-Jones: Spark Ignition (Lecture).

Dr. J. D. Sutherland, and others: Joint Discussion on the Economic Balance of Agriculture and Forestry.

At 2.45 P.M.—

Discussion on the Position of Geography in Scottish Schools.

At 5 P.M.—

Sir John Stirling-Maxwell, Bart.: Forestry in Scotland: Past, Present, and Future (Lecture).

At 8.30 P.M.—

(In Royal Technical College Hall, George Street.) Prof. F. G. Donnan: The Mystery of Life (Evening Discourse).

Wednesday, Sept. 12.

At 12 NOON.—

(In Fore Hall, University.) Concluding General Meeting.

SEPTEMBER 10–13.

INTERNATIONAL CONFERENCE ON LIGHT (at Lausanne and Leysin).—Among the subjects to be discussed are the Methods of Measuring the Energy and Biological Activity of Light Rays; Irradiated Foods and Sterols; the Climatic and Light Therapy of Various Forms of Tuberculosis.

SEPTEMBER 12–15.

CONGRESS OF THE GERMAN PHARMACOLOGICAL SOCIETY (at Hamburg).

Sept. 13.

Discussions on the Work of the Heart and Vessels in Honour of William Harvey, with papers by Liljestrand, Jarisch, Straub, Anrep, and Mansfeld.

Sept. 14.

Papers by Flury and Zangger on Modern Industrial Intoxications.

Sept. 15.

Paper by Barger on Ergot Bases.

SEPTEMBER 14–17.

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX (Fifth Annual Conference) (at New College, Oxford).

Friday, Sept. 14.

At 7.15 P.M.—

Address by the President of the Conference.

At 8.30-9 P.M.—

Dr. R. S. Hutton: The Work of Aslib.

At 9-10 P.M.—

Dr. A. P. Thurston: Patent Law Reform, with Special Reference to the Search for Novelty.

Saturday, Sept. 15.

At 9.30-12 NOON.—

N. Parley: The Direct Reproduction of Books and Manuscripts.

Dr. E. H. Tripp: Certain Aspects of Agricultural Research.

J. Forbes Marsden: The Literature of Scientific Management.

At 12-12.45 P.M.—

H. H. Johnson: Existing Types of Indexes to Technical Periodicals.

V. Garrett: An Index to Business Data.

J. N. L. Baker: Cartography and the Research Worker.

At 5.30-6.30 P.M.—

Annual General Meeting.

At 8.30-10 P.M.—

H. Jenkinson: The Librarian as Archivist.

F. M. Earle: Vocational Selection and Guidance.

A. Esdaile: Unification of the Library Resources of London.

Sunday, Sept. 16.

At 9.30-11.45 A.M.—

Dr. W. Rosenhain: Scientific Abstracts.

At 11.45-12.45 P.M.—

A. Farquharson: Civic and Regional Surveys: their Relation to Information Bureaux.

At 5-6 P.M.—

C. R. Griffin: A Book-Review Digest.

Capt. J. S. Allan and N. Parley: The Durability of Paper.

Lieut.-Col. J. A. A. Pickard and C. G. Ingall: Information on Accident Prevention.

At 8.30-9.15 P.M.—

Dr. S. C. Bradford: The Necessity for the Standardisation of Bibliographical Methods.

At 9.15-10 P.M.

Lieut.-Col. J. M. Mitchell: The Aslib Directory.

SEPTEMBER 15–22.

GERMAN SOCIETY OF NATURALISTS AND PHYSICIANS (at Hamburg).

SEPTEMBER 19–22.

NATIONAL GLASS CONVENTION (at Bournemouth).—Discussions on the Organisation of the Glass Industry and a Conference on the Legislation Concerned.

SEPTEMBER 24–27.

INTERNATIONALE TAGUNG FÜR BRÜCKEN- UND HOCHBAU (at Vienna).

SEPTEMBER 24–27.

INTERNATIONALE TUBERKULOSEKONFERENZ (at Rome).

SEPTEMBER 24–28.

DIE TAGUNG DER BALTISCHEN GEODÄTISCHEN KOMMISSION (at Berlin).

SEPTEMBER 26–29.

PALÄONTOLOGISCHE GESELLSCHAFT (at Budapest).