SATURDAY, AUGUST 9, 1924.

CONTENTS.

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

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

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

Science and Life.[1]

THERE has been no niggardliness in the intellectual menu provided for the Toronto visit of the British Association. There is plenty to masticate, and there are also delicacies. But the metaphor is dangerous, and we let it drop. The president, Sir David Bruce, strikes the humane note, " Science for Life," in his fine address. In the long run, man wins against microbe ; thus Malta, once the most deadly of foreign stations, becomes a health resort ; Malta fever is beaten in the first round. Anti-typhoid inoculation was one of the outstanding victories of the war, and the anti-toxin treatment of tetanus was another. The prevention of tuberculosis depends fundamentally on improved environment and on the education of the people in the art of health. The protozoal infectious diseases, like the bacterial, are being mastered—witness sleeping sickness and malaria. Successful attacks are being made on the undetermined group of infectious diseases, probably due to " filter-passer " germs, such as trench fever and typhus fever. Here the zoologists have to be thanked for their discovery and tracking of the insect and mite carriers ; and what shall we say of the attacks on deficiency diseases, whether the standard of victory bears the legend " vitamins," " balanced nutrition," or " endocrine glands " ? " Man has come into his heritage."

Prof. J. W. Gregory, addressing the Geography Section, brings us back to the idea of " Control." He seeks to show that, if due care be taken, the white man is not physiologically disqualified from manual labour in the tropics. This simplifies inter-racial problems, as it provides an additional outlet and a spacious home for the European race. The world has reached its present position by help of each of the three great races, and it still needs the special qualities of each of them—the contemplative Asiatic, who founded religions ; the artistic Negro, who probably gave the world the gift of iron, and the administrative European, who has organised the brain power of the world. But " the affectionate, emotional Negro, the docile, diligent Asiatic, and the inventive, enterprising European do not work at their best when associated in mass." Individual association there must be, but co-residence *in mass*—that way lies trouble. But will the clock stand the implied turning back of its hands, and will our hygienically resolute swarming into the tropics stop short of being massive ?

In his careful address to the Anthropology Section, on health and physique through the centuries, Dr. F. C. Shrubaill showed that Britain is *not* going to the dogs. " A pessimistic view of the physical or mental condition of the people of England is unnecessary and unfounded." Stature and weight are not less than in the days of Agincourt ; the general health of the nation is better and the expectation of life longer than ever before ; the real increase of the unfit is much less than has been assumed on a priori arguments ; the dysgenic tendencies of industrialism are being successfully opposed. Not that Dr. Shrubsall is satisfied with things as they are. His thesis, well documented, is

[1] The Advancement of Science, 1924 : Addresses delivered at the Annual Meeting of the British Association for the Advancement of Science (94th Year), Toronto, August 1924. Pp. iv+33+19+36+20+16+24+30+12+21+15+7+14+9+14. (London : British Association, 1924.) 6*s*.

that they are not nearly so bad as some Cassandras make out.

An inspiring address to the Physiology Section by Dr. H. H. Dale dealt with the progress and prospects of chemotherapy. "Science for Life" again! Chemotherapy in general is the specific treatment of infections by artificial remedies, but Dr. Dale was picturing the systematic chemotherapy which the genius of Ehrlich revealed, "the production by syntheses of substances with a powerful specific affinity for, and a consequent toxic action on, the protoplasm of the parasites, and none for that of the host." What Ehrlich was in search of were introduceable substances, which, as he said, should be maximally parasitotropic and minimally organotropic. What makes the difference is a biochemical problem still unsolved, but contributions to the reading of the riddle are rising above the horizon.

"As the biological complexity of the problem is realised, it becomes increasingly a matter for wonder and admiration that so much of practical value has already been achieved—the treatment of the spirochætal infections, syphilis, yaws, and relapsing fever, revolutionised; Leishmania infections, kala-azar and Baghdad boil, and Bilharzia infections, which crippled the health of whole populations in countries such as Egypt, now made definitely curable; trypanosome infections, such as the deadly African sleeping-sickness, after years of alternating promise and disappointment, brought now at last within the range of effective treatment."

Such achievements, we must remember, have rewarded experiment during a period—does it ever end?—when practice outran theory. What victories may be looked for when a fuller understanding affords not only tactics, but also strategy. This address will appeal to many very strongly with its Pisgah view of a Promised Land with no unconquered infectious diseases.

To the Botanical Section Prof. V. H. Blackman gave an address which does not sound like botany at all, it is so interesting. There is nothing in it about a "hortus siccus," and it is impossible not to be thrilled by the account of the unending attacks which the parasites make on the capitalists.

One of the peculiarities of parasitic diseases in plants, as contrasted with those of animals, is that the plant seems to give the same answer back to quite different invaders. Among animals, if certain symptoms appear, one can, in most cases, infer the presence of a certain parasite, but in plants a large number of infectious diseases display the same symptoms. This makes the practice of medicine among plants much more difficult than among animals. Another difference is that the acquired immunity due to one attack of a disease which is so common in animals is quite unknown in plants. Again, owing in part to the absence of a circulating blood-stream, the plant makes a local rather than a general reaction to the infectious disease.

Immunity and resistance to diseases are, of course, well known among plants, but they illustrate *natural*, not acquired immunity. There may be some physical barrier which resists the entry of the parasite, or the entry may call forth a wound reaction leading to the production of cork which checks further advance. This natural resistance may be increased by good cultivation, or Mendelian breeding may build up a plant synthetically which is resistant to various intruders, but there seems to be no hope of finding a way of endowing plants with artificial disease-resistance.

As Lord Kelvin was born a hundred years ago and as Faraday discovered the principle of the electromotor in 1821, it was very appropriate that Prof. G. W. O. Howe should address the Engineering Section on "A Hundred Years of Electrical Engineering." He tells a story of fascinating interest—a story that mankind may well be proud of. It is a record of "the mastery of man over the resources of nature, and in the use of these resources to the amelioration of the conditions of life." Every one knows part of the story, but a general review is very eloquent.

"By the aid of electricity the energy of the coal or of the lake or river a hundred or even two hundred miles away is transmitted noiselessly and invisibly to the city, to supply light and warmth, to cook the food, to drive the machinery, to operate the street-cars and railways." We flash intelligence to the most distant parts of the globe; we talk to our friends hundreds or even thousands of miles away; at small cost we can equip ourselves with what may almost be regarded as a new sense. "Whereas thirty years ago a ship at sea was completely isolated from the life and thought of the world, it is now in continuous communication with the land and with every other ship within a wide range."

In no branch of electrical engineering is there any suggestion of having reached a limit; rapid development is taking place in every direction.

Prof. William McDougall spoke of "Purposive Striving as a Fundamental Category of Psychology." The life of man from birth to death is one long series of purposive strivings. Even in his dreams the striving goes on. This must be recognised as an all-important aspect, corrective to the picture of man as "a bundle of mechanical reflexes, a superior penny-in-the-slot machine, whose workings are mysteriously accompanied by various 'elements of consciousness.'" The address may be described as a plea for more courage in psychology, which is spoken of as "the most concrete of the sciences."

Three of the addresses of presidents of Sections will not be delivered until Monday, August 11, so we cannot deal with them this week: they are by Sir William Bragg on the analysis of crystal structure by X-rays, by Prof. F. W. Gamble on construction and control in animal life, and by Sir John Russell on present-day problems in crop production. We are reluctantly forced to pass over here the other presidential addresses, —by Sir Robert Robertson on chemistry and the State, by Prof. W. W. Watts on geology in the service of man, by Sir W. Ashley on Free Trade doctrine, and by Principal E. Barker on academic freedom in universities, but summaries of them will be found in the Supplement to this week's issue. They are as interesting and as important as those of which we have given glimpses, and Toronto cannot complain of having been offered "second best" material. There is a very high standard throughout. There is also an interesting unity, for most of the addresses come round to this, that man conquers by understanding. The people perish for lack of knowledge; but science is for life, even for the life that is more than meat.

Where Philosophy joins Forces with Mathematics.

Substance and Function and Einstein's Theory of Relativity. By Ernst Cassirer. Authorised translation by Dr. William Curtis Swabey and Dr. Marie Collins Swabey. Pp. xii+465. (Chicago and London: The Open Court Publishing Co., 1923.) 3.75 dollars.

THE translators of Prof. Ernst Cassirer's most important contributions to mathematico-logical theory have done well to issue his "Substanzbegriff und Fonktionsbegriff" and his "Zur Einsteinschen Relativitätstheorie" together in one volume, although a considerable time interval separates the two works. The first appeared in 1910, the second in 1921, and the interval covers the formulation by Einstein of the new theory of gravitation. By presenting the two together, the philosophical significance of the principle of relativity and the intimate connexion of its mathematico-physical form with the logico-epistemological form of the philosophical problem are clearly brought out. The translation has succeeded in reproducing the clear scientific expression of the German and reads like an original English work. For an American publication there are singularly few Americanisms in the text. It is very unfortunate, however, that the word "Begriff" is not retained in the English title. The book is not about substance and function but about the concept; substance and function are meant to be adjectival, not substantival terms.

Prof. James Ward, in his recent most illuminating work, "A Study of Kant," has shown very clearly how Kant's interest in natural science and desire to discover its metaphysical basis were the original motive and directing force of his philosophy. Prof. Cassirer enables us to see the real significance of the Kantian doctrine in its relation to physical theory. The transcendental æsthetic was not, as often represented, a subjective idealism in regard to the concepts of space and time; on the contrary, it was a justification of the objective use of those concepts and intended to rationalise the Newtonian doctrine and provide a philosophical basis for the Newtonian physics. The attempt of Kant in the transcendental analytic to provide the necessary scientific categories is still more striking. It is curious to follow the complete transformation which has overtaken the chief doctrines of formal logic since he took it as the type of the perfect science, the science which since Aristotle had not had to advance or retrace a single step. This is Prof. Cassirer's starting-point. He shows how the Aristotelian logic depends on the Aristotelian metaphysics, how this accepts the substantival aspect of the world as given fact and the work of thought as discovery, and he traces the steps and stages by which in modern mathematical and logical theory, since Kant (and even before Kant, for the essential change of direction is found in Descartes and Leibniz), the whole position has been reversed.

The fundamental thought of logical idealism is most strikingly exhibited in mathematical theory. "More and more the tendency of modern mathematics is to subordinate the 'given' elements as such and to allow them no influence on the general form of proof." The concept of magnitude gives place to the concept of function; quality, not quantity, is the real foundation of mathematics. In place of the analysis of parts there appears the resolution into concepts.

How do we form concepts, and what purpose do they serve? The two questions are really one, the fundamental problem of the nature of the physical world which is the basis of physical science. Two principles seem equally insistent. One holds us firmly to concrete experience. The concept seems empty and meaningless which does not deepen and enrich our intuition. Yet when we turn to the mathematical concepts, and especially to the meaning of number, we seem to grasp this meaning completely only when thought has freed itself from seeking in concrete experience a correlative for its constructions. We are left to choose between two views of the world: either the empirical view that the only existent is what we can point to as an individual in a real presentation, or the idealist view that what really exist are intellectual structures which can never themselves be presented. Mathematics will not solve the riddle. All it can do is to lay bare the ultimate intellectual roots of our analysis of experience.

What then is the relation of mathematics to physics? The advance of theoretical physics has completely superseded the old view that measurements inhere in physical things and are just read off. The intellectual work of understanding a bare fact presented in sense-experience as an entity or empirical object only begins when the fact is replaced by a mathematical symbol. For the physicist the individual thing is a system of physical concepts. To distinguish one object from another, he must subsume it under a conceptual class. He analyses the object into the totality of its numerical constants; he does not break it up into the group of its sensuous properties. The thing changes from a sum of properties into a mathematical system of values established with reference to a scale of comparison. The constitutive parts of the perception are left completely out of account, and the mathematical symbol which constitutes the object a member of a system is taken as the real kernel of empirical reality. It is only when we bring the given under some norm of measurement that it gains fixed shape and form and has clearly defined properties. The metaphysical concept of substance, which natural science always clung to, has been displaced in the progress of science itself.

It is not possible to give more than an indication of the important contemporary work on methodology and philosophy of science which is surveyed and systematised in this book. Most students will probably turn first to what is described as a supplement, the essay on "Einstein's Theory of Relativity from the Epistemological Standpoint." The value of this essay is enhanced by the fact that Einstein himself read it in manuscript and gave the author the benefit of his criticisms. It is, Prof. Cassirer tells us, at first sight somewhat strange and paradoxical that such diverse epistemological points of view as those of radical empiricism, positivism, and critical idealism should all have appealed to the theory of relativity in support of their fundamental views. The reason is that they all appeal to experience and they all teach that every exact measurement presupposes universal empirical laws. The real problem is how we reach those laws and what sort of validity we grant them. For positivism they are grounded in sensation and never go beyond its domain; for idealism all equations are results of measurement. We neither measure mere sensations nor do we measure with mere sensations; relations of measurements transcend the given and replace perception with a conceptual symbol. The typical example is the development of modern physics in the theory of relativity.

A quotation better than any description will give an insight into the author's own philosophical point of view:

"Only the idealistic concept of truth overcomes finally the conception which makes knowledge a copying, whether of absolute things or of immediately given 'impressions.' The 'truth' of knowledge changes from a mere pictorial to a pure functional expression. In the history of modern philosophy and logic, this change is first represented in complete clarity by Leibniz, although in his case the new thought appears in the setting of a metaphysical system, in the language of the monadological scheme of the world. Each monad is, with all its contents, a completely enclosed world, which copies or mirrors no outer being but merely includes and governs by its own law the whole of its presentations; but these different individual worlds express, nevertheless, a common universe and a common truth."

H. WILDON CARR.

The Cheyenne Indians.

The Cheyenne Indians: their History and Ways of Life. By G. B. Grinnell. Vol. 1. Pp. ix+358+23 plates. Vol. 2. Pp. vii+430+25 plates. (New Haven: Yale University Press; London: Oxford University Press, 1923.) 45*s*. net.

MR. GRINNELL has spent some time each year with the Cheyenne Indians ever since 1890, and in this way he has come to know them as few others can have done. As he says himself:

"I have never been able to regard the Indian as a mere object for study—a museum specimen. A half-century spent in rubbing shoulders with them, during which I have had a share in almost every phase of their old-time life, forbids me to think of them except as acquaintances, comrades, and friends." Yet he can say, "I am constantly impressed by the number of things about the Indians that I do not know."

He has embodied the results of his study in two large and interesting volumes, which deal with all aspects of the life of this tribe, and it may come as a surprise to many to realise how much of the old life still exists. Mrs. Grinnell and Mrs. J. E. Tuell have enriched the book with numerous photographs of the people, their ceremonies and games, their everyday implements and utensils.

The Cheyenne are one of the tribes of the Algonquian family; to-day they are divided into the Northern Cheyenne in Montana and the Southern in Oklahoma, and in 1921 they numbered about 3281. They call themselves Tsistsistas, which probably means "our people," "those related to us," though the Rev. R. Petter has suggested that it means "cut" or "gashed" people, from the sign by which they used to designate themselves. Their movements can be traced back for about 200 years, but the tales of their origin are, as G. A. Dorsey also says, rather tales of early migration than of origin. They seem to have come from the north-east or east, but from how far north it is impossible to discover, possibly from a region north of the great lakes and toward Hudson Bay, as their legends tell of crossing a great lake much in the manner of the Israelites under Moses.

The old-time lodges were made of willow shoots plastered over with clay for the winter, but in summer their lodges were woven of peeled and unpeeled willow stems arranged to make a pattern, and unplastered. Their present lodges are made of skins, probably developed from the wind-breaks of undressed hides on a framework of poles which they used to set up.

Among methods of self-torture described in the chapter on camp customs is one which seems to bear certain resemblances to the hook-swinging formerly practised in some parts of India. Dorsey mentions the same form of torture as having been performed in 1903 in connexion with the Sun Dance, but Grinnell says that though it might be done at the time of the Medicine Lodge, it might be done at any time in fulfilment of a vow. Strips of skin were often removed as a sacrifice well-pleasing to the Great Medicine, or Great Spirit, thus leaving scars all over the body.

The Cheyenne are organised into ten groups or divisions, and from the testimony of several of the most aged men, Mr. Grinnell has gathered much evidence of exogamy. Descent was matrilineal, and on marriage a man went to live with his wife's group. If a man deserted his wife, she and her children were cared for by her own group. Each group had its own special ceremonies and taboos, but these old practices have now long passed out of use and cannot easily be reconstructed. So difficult is it that the author says that present-day investigation would lead to the conclusion that tribal descent is in the male line, while up to twenty or twenty-five years ago the old men all agreed that the children belonged to the mother's group. Detailed inquiry into more than fifty marriages of old people, however, resulted in establishing the fact that the man and woman had in all cases belonged to different groups.

The author draws a delightful picture of the home life of the Cheyenne, giving an account of the natural daily round from childhood to death.

The second volume is mainly concerned with the war customs and great ceremonies and dances of the Cheyenne. There are seven soldier bands, mostly named after some animal; but not every strong and able-bodied man is necessarily a member of one of these bands. These bands form a kind of standing army and enforce the commands of the chiefs. To each band belonged four young women, chosen from the best families in the camp. Their duty was to be present at the meetings of the band, to take part in the singing and dancing, and sometimes to do the cooking. It was an honourable position; but though it was looked on as a kind of profession, no girl was obliged to remain in the band against her will; she generally resigned on marriage, though sometimes a married woman was chosen. There was also a curious institution called Contraries, usually two or three Contraries in each tribe, who acted and spoke in the reverse or opposite way to that of common usage. They had serious duties to perform, and might not mix on equal or familiar terms with the rest of the tribe; each had to "walk by himself," lest those treading in his tracks should meet with evil results. One of the chief duties of a Contrary seems to have been to protect his tribe from thunder, and to do this he carried a peculiar form of bow called a thunder-bow. He could only be relieved of office if some one asked for his bow, or if he lost it by any accidental means.

There is also a Contrary Society, the members of which, though they seem to have no connexion with the Contrary warrior with the thunder-bow, also act by contraries and are in some way connected with thunder. The members are mostly old men and women, and appear to be buffoons, but at the same time they are believed to be able to help the sick. In the Massaum Ceremony (Crazy or Animal Dance), which is fully described, the Contrary Society plays the part of the hunters who pretend to kill the animals represented by other actors in the ceremony. This Massaum Ceremony is an ancient rite and seems originally to have been performed in order to increase the supply of food in the camps. It takes place when any man makes a vow to perform it in order to obtain some benefit for himself, but at the same time it benefits all the community. It lasts for five days.

A detailed account is also given of the Medicine Lodge, the midsummer or summer ceremony of many Plains Indians, which was fully described by G. A. Dorsey in 1905 in the Field Columbian Museum Publication 99, as a part of his studies on the Sun Dance of the various tribes. This term, however, comes from the Sioux, and refers to one part only of the Cheyenne ceremony, which now lasts three, but formerly eight, days. This ceremony, too, is offered as a sacrifice by one or more members of the community. It was at this ceremony that the self-torture often took place.

Though the Indians are repeatedly said to be very religious, there seems to be no official priesthood; but for these great ceremonies there are special "instructors," who take the part of priests or masters of ceremonies.

As may be seen from this résumé of some of the contents, the book is full of interest, and it is written in a simple straightforward style which makes the reader feel all the time that the subject is dealt with by one who is intimately acquainted with the matter in hand. It is a most valuable and sympathetic study of a people whose old customs are still in a measure retained, though obviously breaking down under modern conditions, and thus it is well to have these things recorded before more is forgotten. As it is, the author is frequently obliged to confess that in some cases the meaning of certain ceremonies appears to have been lost.

A. C. HADDON.

Our Bookshelf.

Wood-fibres of some Australian Timbers: Investigated in reference to their Prospective Value for Paper-pulp Production. By Richard T. Baker and Henry G. Smith. Pp. 159. (Sydney: Alfred J. Kent, 1924.) n.p.

DURING the War the Australian people suffered much inconvenience from the deficient supply and high price of paper and paper-making materials, which could be procured only by importation from Europe and North America. This directed attention to the possibilities of the manufacture of wood-pulp at a cheap rate in the Australian forests; and during recent years some investigations have been carried out by the different governments of the Commonwealth. A short account of the nature and results of these inquiries is given in the introductory part of this book; and it is apparent that there is no lack of suitable kinds of timber. Sites for pulp mills can be found in certain forest districts where an abundance of pure water is available, an essential requirement for commercial success.

The main part of the work is devoted to a detailed study of sixty species of trees, as regards both the microscopic structure of the wood-fibres and the bleaching and felting properties of the separated fibrous material. Each description is accompanied by a photomicrographic illustration. Most of the species of Eucalyptus are of little value for paper-making owing to the shortness of their fibres; but the so-called "ashes," which constitute one section of this large genus, have long and flexible fibres, and are considered to be very promising for the production of "chemical" wood-pulp. The only conifer studied, *Araucaria Cunninghamii*, is suitable for the same purpose, and "sulphate" pulp is manufactured from it on a commercial scale at Yarraman Creek in Queensland.

The Control of the Speed and Power Factor of Induction Motors. By Dr. Miles Walker. Pp. 151. (London: Ernest Benn, Ltd., 1924.) 18*s*. 6*d*. net.

IN recent years the use of the three-phase system of distributing electric power has been rapidly extending. The great advances made in the methods of controlling economically the speed of induction motors are not known to many engineers. It is necessary, in order that they may choose the best kinds of motor for their every-day work both from the points of view of ease of control and of economy, that they should be able to study for themselves their relative advantages and disadvantages. We therefore welcome this book by one of the leading authorities on the subject.

In Chapter i. the author gives a sketch of the fundamental theory. He lays stress on the importance of the mathematical method of inversion as this leads to a simple method of proving the "circle" diagram. We are sorry that no proof is given of the geometrical theorems of inversion, as students may have difficulty in proving these for themselves.

A very full description is given of the methods of controlling the speed of an induction motor. In battleships two speeds are desired, one for cruising and one for "fighting." In the latter case the highest attainable speed is wanted. The fighting speed is usually about 50 per cent. greater than the cruising speed and requires about 3·5 times as much power. In the United States, where many ships have been fitted for electric propulsion, the method of pole changing is the one generally adopted. In the later chapters of the book, brief descriptions are given of the cascade motor and the frequency converter. A good description is given of the phase advancer designed by Gisbert Kapp.

Silent Highways of the Jungle: being the Adventures of an Explorer in the Andes and along the Upper Reaches of the Amazon. By G. M. Dyott. Second edition. Pp. 320+16 plates. (London: Chapman and Dodd, Ltd., 1924.) 7*s*. 6*d*. net.

THE interest of this book is more adventurous than scientific, but it is most readable and the pages are seldom dull. The author was commissioned by the Peruvian Government to investigate the possibility of aerial routes between the Pacific littoral and that isolated part of Peru which lies around the head streams of the Amazon. With this end in view, he made a journey overland from the port of Pacasmayo through the Andes by Cajamarca and Moyobamba to Yurimaguas and down the Huallaga and Marañon to Iquitos. This was a relatively easy task: the return by a more northern and partly unknown route was difficult. In the forests of the upper Marañon, Mr. Dyott was basely deserted by his carriers and left to his own resources in a trackless wilderness. At his last gasp he fell in with forest Indians, by whom he was held a virtual prisoner for some weeks before he got away and returned to the coast. The book describes vividly the conditions of travel in those remote regions, and has a good deal of information about rubber and agricultural possibilities, but its chief value lies in the account of the Aguavuna Indians. Existing maps were found to be faulty, but Mr. Dyott had no means of making new ones.

Physiotherapy Technic: a Manual of Applied Physics. By Dr. C. M. Sampson. Pp. 443. (London: H. Kimpton, 1923.) 30*s*. net.

MAJOR SAMPSON defines physiotherapy as "the use of physical remedies in the treatment of disease or disability," and classifies these remedies as thermal, chemical, mechanical, and electronic. Of the value of such methods of treatment there can be no doubt, but the author of "Physiotherapy Technic" has certainly not justified his claim that physiotherapy is destined to be the salvation of therapy. The main defect in this book is the very loose style of thinking and construction which it indicates. For the description of one technique we are referred to "Treatment of Optic Neuritis," but have failed to find the reference. The statement that "things not equal to the same thing are not equal to each other" is absurd, but its appearance as an argument in a scientific text-book is worse than absurd.

Major Sampson's experience entitles him to speak with authority on the methods of application of physical remedies, but the scientific reader will probably tire of the effort to discover what these methods are.

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.*]

Sex Change and Breeding in the Native Oyster, *O. edulis.*

IN NATURE in 1922 (vol. 110, p. 212) it was shown that when an oyster spawns as a female it changes immediately into a male. In a later number of NATURE (vol. 110, p. 420) Spärck, who had been working on similar lines to the present writer, was able to confirm this observation. I have since continued similar observations on a large number of oysters with the same result, so that it can now be definitely stated as a fact that the female-functioning oyster normally changes into a male at about the period of the extrusion of ova; and further that the rapidity of the change strongly suggests the existence of a substance—which causes this change—in a fluid circulating in the body.

In the same number of NATURE I stated that experiments had been started to investigate the conditions of the reverse sex-change, that is, from male to female in both young and old oysters. The occurrence of this change has been suspected to occur on general grounds, but, so far as is known, has not been demonstrated. A brief summary of the results can now be given. In the summer of 1922, 115 oysters, which were proved to be male on a certain date by microscopic examination after boring a hole in the shell, were isolated in a cage in the sea along with 78 identified females. This experiment was a failure owing to an accumulation of mud in the experimental cage, and was repeated in July 1923 with 101 freshly determined males, and 28 fresh females, along with the remainder of the oysters the sex of which was known in 1922. By October 1923 nearly all the oysters had recovered, and most of them had put on good growth, but a sample of 18 oysters, which were male in July, were proved after a thorough examination to be either mostly feebly male or neuter sex. None of the oysters were in spawn at this time.

In June and July this year the oysters were again examined, with the following result at the instant of examination: of the 6 remaining individuals which were male in 1922, 50 per cent. had changed to females, and two of these were carrying recently extruded embryos; of the 69 remaining individuals proved to be male in 1923, only two extruded embryos at the time of examination; the rest are being kept intact in the sea to permit periodical examination for later spawning females.

Besides these proved male oysters, others which have spawned as females—which, as has now been established, would have changed immediately afterwards into males—have been also kept isolated in compartments of a cage in the sea. Of 16 remaining individuals female in 1922—and therefore by inference afterwards immediately male — 5 were female in July 1924, and 1 was carrying embryos at the time of examination; similarly, of 20 oysters female in 1923, and immediately afterwards male, 6 had changed into females in July 1924, and of these 2 were carrying embryos at the instant of examination.

The experiments described above were carried out at West Mersea on the East Coast, but similar results have also been obtained on the River Yealm on the South Coast. In the Yealm experiment some interesting cases occurred; for example, an oyster male in July 1922 was examined on July 9, 1923, and found to be still male, but nearly seven weeks later, on August 31, this same oyster was carrying an enormous number of fully developed shelled larvæ, and a few days later, on September 4, was rapidly developing sperm. This is an extremely interesting and important result, both theoretically and economically. In the same cage were 18 oysters, which were obtained from different parts of England; these had spawned as females in 1923, and afterwards changed immediately to males; of this group, 3 extruded numerous embryos in June to July this year, and were found by microscopic examination to have changed back again to males at once. It is expected that some of the remainder will have embryos during the next few months. Thus already 11 per cent. of these oysters have had at least *four experiences of sex in about a year*, reckoning from July to July, and this is believed to be the normal sequence of events in the European oyster for a good proportion of individuals which assume female characters in spring or early summer. It is, however, still an unsolved problem what proportion of individuals which are male in the spring change during the summer into females. So far I have only obtained one such case, but the reason would appear to be found in the difficulties of the work. It has been shown elsewhere that too much handling of oysters in summer causes "bleeding," and a loss of condition (Orton, "Fishery Investigations," vi. 3, 1923 (1924)), so that it is necessary to work continuously on or in close proximity to good oyster beds to obtain good results. Efforts are now being made to fulfil these conditions in further work.

In all the observations recorded above, it is to be noted that sex-conditions are only determined at the instant of examination, and as it is clear that sex-change does occur very rapidly, some sex-changes may have been missed. It is believed that in many cases changes of sex have been missed.

In the breeding of the oyster there are phenomena of a confusing nature which can only be referred to briefly here. It has been found that the mere dredging of oysters in the breeding season will cause those females which are ripe to spawn. I have called this phenomenon "forced spawning," and it has some peculiar results. The spawning female may extrude the whole or indeed any proportion of its ova. Now there are good reasons for believing that the act of spawning initiates the internal changes which result in changing the sex to male, and undoubtedly the sex-change does occur in females which have undergone forced spawning without expelling all their eggs. As a result the gonad in such cases would appear to the uninitiated to be hermaphrodite. Such individuals are, however, physiological males, and it has been shown elsewhere (*loc. cit.*) that the "residual" ova, as they have been termed, are absorbed, or dealt with in other ways. There is nevertheless a small proportion of hermaphrodite oysters which cannot be explained satisfactorily as physiological males, and since the act of spawning as a female may cause or is closely associated with the causes of the change to maleness, it is possible that stimuli, other than spawning, may produce a like result in a ripening female, and so produce a true hermaphrodite gonad.

Other explanations are, of course, possible; but the *proximal* cause of the change from male to female is still to be found. The change to female occurs commonly in the winter or early afterwards, but we have seen that it does also occur in the summer, though to an unknown extent; it is therefore apparently independent of seasonal conditions. An explanation which would satisfy those conditions would appear to be as follows : at the birth of an oyster the conditions which determine sex result at first in the establishment of a functional male gonad (this statement is apparently true, but must not yet be regarded as having been definitely proved) ; at some time later, generally at the end of the winter or even during the summer, the predominance of internal male-determining conditions is lost, and female characters are assumed. At this stage the position is clear, for immediately the female character is lost, namely at spawning, the sex potentiality swings back to predominant maleness. It has been seen that the male condition can occur twice in one summer, but we have no evidence yet of the occurrence of femaleness twice in one summer.

Even if we assume that specific hormones are responsible in predominance for the condition of maleness and femaleness respectively, yet it would appear that some factor connected with external conditions is the cause for the assumption of femaleness. Can this be merely the accumulation of reserve products in a quantity sufficient to produce a crop of ova reacting on the general system of the organism after the male-determining mechanism, so to say, has run down ? This condition might be an excess of glycogen in the body over that amount which can be stored, for example. A fact which lends some support to this view is that starved oysters are either feebly male or of neither sex. It is at this point that the study of sex-change appears to touch the all-important problem—for oyster-culture—of the "fishing-up" or natural fattening of oysters, on which subject there is still a great deal of work to be done. The investigations have been made partly by means of a grant from the Royal Society, and will be described in full on completion of the work in the Journal of the Marine Biological Association.

J. H. ORTON.

Marine Biological Laboratory,
Plymouth, July 23.

Relation between Pressure Shift, Temperature Class, and Spectral Terms.

IN a letter to NATURE of June 21, p. 889, I have shown the existence of a numerical relation between the pressure displacements of the lines of the iron spectrum, the temperature class of the lines, and the magnitude of the spectral terms which originate those lines by combination. It now seems probable that this relation is not only valid for iron, but may be a more general relation. Unfortunately, the available measures of temperature and pressure effects are neither very numerous nor very extensive, so that the general validity of the relation cannot at present be fully demonstrated. In a few cases, however, the available measures suffice to show that the relation holds very accurately.

The most complete data at present available are those for titanium. King (*Astroph. J.*, 39, 145, 1914, and 59, 1924) has studied the temperature effect ; different authors have investigated the displacements by pressure, the results of Gale and Adams being the most extensive (*Astroph. J.*, 35, 1, 1912) ; C. C. Kiess and H. K. Kiess (Journ. Opt. Soc. Amer., 8, 607, 1924) have studied the structure of the spectrum of the neutral atom, and given the absolute values of the terms which form a great number of multiplets (quintets and triplets). Following the plan adopted for iron, the mean values of pressure shifts (taken from Gale and Adams) for multiplets of titanium have been plotted in Fig. 1 against the mean values of the sum of the terms forming each multiplet. The curve thus obtained is quite regular, and similar to that for iron, so that the two may be approximately superposed by a simple translation. Unfortunately, it is only possible to follow the curve for titanium up to displacement 0·20 cm.$^{-1}$; those lines which have appropriate terms to give displacements between 0·20 and 0·50 cm.$^{-1}$ are out of the range observed. In the tables of Gale and Adams there are some lines which show displacements greater than 0·50 cm.$^{-1}$, but they are not classified in multiplets.

Very recently, Laporte (*Zeit. für Phys.*, 23, 135, 1924) has made an estimate of the absolute values of the iron terms, giving 48,000 cm.$^{-1}$ for the term A, to which, in my first letter, the arbitrary value 60,000 cm.$^{-1}$ was assigned. In a future communication it will be shown that this value is a little too small. If the value 50,000 cm.$^{-1}$ be adopted, all the values of the remaining iron terms must be lowered by 10,000 cm.$^{-1}$, and the sum of two terms by 20,000 cm.$^{-1}$. When this correction is applied, the titanium curve superposes on the iron curve very closely, thus indicating that the relation for iron is not only of the same form for titanium, but also of the same order of magnitude.

The curves for iron and titanium show that the classification of lines in Classes I, II, . . ., may be

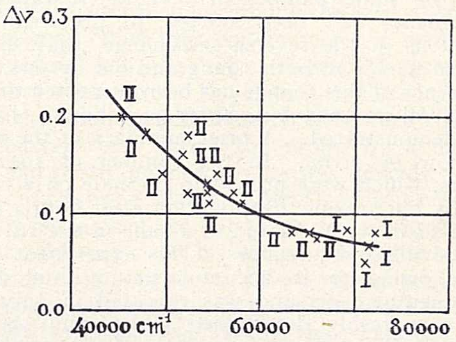

FIG. 1.

only a first approximation ; the effect of temperature, like that of pressure, may be a continuous function of the sum of the terms. King remarks (*Astroph. J.*, 37, 264, 1913) : "An examination of Table I. (referring to the classification of iron lines) shows a considerable variety as to the rate of growth among lines placed in the same class." In order to prove that the effect of temperature is as indicated by the curves for titanium and iron, I have examined in some detail all the spectra which have been investigated for multiplets and for temperature effects. In all cases the assumption has been quite confirmed. The details will be given elsewhere, but meanwhile the following examples will illustrate this point.

In the neutral iron spectrum there are several multiplets of Class I. If we arrange them in a list beginning with the multiplet for which the sum of its terms has the greatest value, and ending with that for which the sum has the smallest value, it will be noticed that we have at the same time arranged the multiplets beginning with the most sensitive at low temperature, and ending with the less sensitive. The greatest value for the sum of the terms is given in iron by the intercombination multiplet AE, or $n^5_3 - n^7_3$ (incompletely given by Walters, but now completed) in Paschen's notation, formed by the most sensitive lines of the iron temperature classification λλ5110, 5166, 5169, 5204, 5225, 5247, 5250, 5255 ; these lines, however, do not appear in King's furnace at 1400° because the sensitiveness of the film used was very poor beyond the blue. The relation of intensity of this multiplet AE in the arc and in the furnace at low temperature is 1/1·2; multiplet AH, which is situated in the middle part of the list of Class I multiplets, gives 1/1 for this relation, and multiplet AJ, which is near the end of the list, gives 1/0·2. So the sensitiveness of the multiplets at low temperature decreases gradually when the sum of the terms decreases.

It is interesting finally to remark that the iron intercombination multiplets AE, AZ, AX do not appear reversed in spite of their being the most sensitive groups of this spectrum and combinations of the ground level A. I think that it is not a particularity of the iron spectrum, but a general feature of all intercombination lines. The resonance lines of magnesium, calcium, strontium, barium, and manganese, which are also intercombinations, are not found reversed. The titanium resonance lines, which may be those of the intercombination multiplet $n^3{}_4 - n^5{}_3$ (λλ5397, 5409, 5426, 5447, 5461), because they give the greatest value for the sum of the terms in this spectrum, are also found to be very sensitive, but not reversed.

M. A. CATALÁN.

Laboratorio de Investigaciones Físicas, Madrid, July 1.

The Use of Naphthalene as a Fumigant in the Control of Red Spider and other Pests in Cucumber Houses.

A LETTER on "The Effect of Naphthalene Vapour on Red Spider Mite," signed by Mr. O. Owen and myself, appeared on pp. 280 and 281 (No. 2849, vol. 113) of NATURE on June 7.

Since that letter appeared, experiments have been carried out in distributing naphthalene in various states of division over the beds in cucumber houses. The state of division was determined simply by passing pure commercial white flake naphthalene through a graded series of sieves, ranging from 4 to 20 meshes to the inch; "milled" naphthalene has also been used.

With naphthalene which has been passed through a sieve of 16 meshes to the inch (=256 meshes to the square inch) all stages of the red spider mite (*Tetranychus telarius* L.), including the eggs, were killed in cucumber houses within a period of 24 hours, when the soil surface was at or above a temperature of 24° C. The amount of naphthalene used was 3 lb. to every 100 feet of bed. Similar results could only be obtained with naphthalene passed through a sieve of 8 meshes to the inch by using double the weight of naphthalene, while powdered or milled naphthalene did not kill all the spider, and tended to produce scorching of the plants.

Experiments have shown that very finely divided naphthalene volatilises too quickly, and that the large concentration of vapour resulting does not remain long enough in the atmosphere to kill all the mites. With milled naphthalene, on the other hand, the particles adhere so closely together that neither suitable distribution nor an adequate concentration of the vapours are obtainable.

When pure commercial white flake naphthalene was passed through a sieve of 16 meshes to the inch, and broadcasted by hand at the rate of 3 lb. to every 100 feet of border, no scorching of leaves or damage to plants resulted, provided that the plants were well watered before, and the atmosphere kept moist during fumigation. Plants lacking water, however, were often considerably scorched though not permanently injured.

During fumigation the fruit is liable to taste slightly of naphthalene, so that it is inadvisable to cut fruit until the odour of naphthalene has disappeared from houses treated. If exposed to fresh air, the taste soon leaves the cucumbers.

Other pests liable to destruction by naphthalene fumigation in cucumber houses are wood-lice (species of Porcellio, and Armadillidium) and crickets. The fumigation has now been carried out on the commercial scale for cucumbers, and has proved effective in houses and blocks of houses ranging from 50 to 200 feet in length, and from 8 to 20 feet in height. It was found unnecessary to increase the amount of naphthalene in the higher houses.

In all cases the red spider mite has been killed without damage to the plants, by one fumigation, and a large proportion of the wood-lice have at any rate been destroyed.

EDWARD R. SPEYER.

Nursery and Market Garden Industries' Development Society, Ltd.,
Experimental and Research Station,
Cheshunt, Herts, July 22.

Oscillations in Vacuum Tube Discharges.

A LETTER from Profs. Karl T. Compton and Carl H. Eckhart appears in NATURE of July 12, in which reference is made to experiments on oscillations occurring in vacuum tube discharges functioning with the aid of a hot cathode.

I should like to be allowed to point out that, so far as I am aware, the first published notice of this effect was a paper of mine in the *Radio Review* (now the *Wireless World and Radio Review*) of November 1919.

The general explanation there offered of the phenomenon requires some modification, but it was clearly shown that in the particular case of mercury vapour, ionic oscillations of easily regulated frequency could be produced by merely altering the potential conditions of the tube.

May I add that during the past year I have been following up these results in the particular case of vacuum tube discharges both with hot and cold cathodes with interesting results? When the discharge obtained from a battery of accumulators is viewed in a rotating mirror, cases are found when the appearance presented by the photograph (Fig. 1) is the rule. (See Aston and Kikuchi, Proc. Roy. Soc., 1921.)

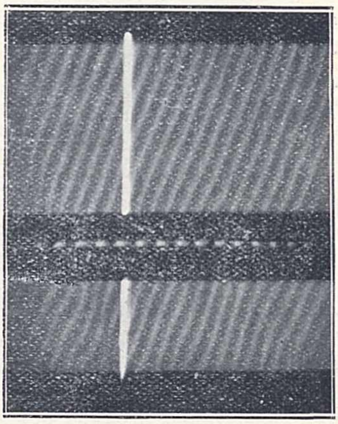

FIG. 1.

The inclined lines represent flashes of luminosity proceeding at a constant velocity away from the cathode, apparently moving at a rate which depends both on the gas pressure and on the applied potential.

The spectrum when examined by the Fabry and Perot étalon method does not exhibit, however, the Doppler effect.

These and other results will be presented and discussed in a paper now in course of preparation.

R. WHIDDINGTON.

Physics Laboratories,
The University, Leeds,
July 16.

Absorption Spectra of Some Metallic Vapours.

In the course of our experiments on the absorption of light by vapours of different metals, we have recently photographed the absorption spectra of lead, bismuth, antimony, thallium, and magnesium with the following results:

(1) The absorption spectrum of lead shows at 1100° C., besides the fundamental line 2833 and some other lines, a faint banded spectrum which has not been described previously. These bands extend from λ3000 to λ3320 Å.U. The interval between the various bands is nearly constant and is equal to 32 Å.U.

(2) The absorption spectrum of bismuth shows besides the "raie ultime" 3067, a typical banded spectrum containing about twenty bands. The absorption at each of these bands is very diffuse and complex, consisting of a number of fine bands. With increase of vapour density all the bands gradually fuse together (beginning from the short wave-length side) to form a region of continuous absorption.

(3) The absorption spectrum of antimony shows a fine line and a banded spectrum on the short wave-length side of this line, which has not been described previously. The fine line is at λ2310, and the bands extend from λ2304 to λ2200, with a constant interval of 15 Å.U. nearly. Eight of these bands have been photographed.

(4) A long column of non-luminous vapour of magnesium is found to absorb, besides the line 2852, λ4571, the single line spectrum of the element.

(5) The absorption spectrum of the non-luminous vapour of thallium shows at high temperatures, besides the lines of sharp and diffuse series, some prominent bands and lines due probably to Tl_2 molecules. A study of anomalous dispersion of the vapour by the method of Kundt's crossed prisms showed that at λ3775 there is anomalous dispersion and that at 5350·6 the phenomenon is much weaker.

A detailed account of these experiments together with the photographs of the absorption spectra will be published shortly.

A. L. Narayan.
G. Subrahmaniam.
D. Gunnaiya.
K. Rangadhamarao.

Research Laboratories,
H.H. The Maharajah's College,
Vizianagaram.

The Theory of Hearing.

To the letters of Sir R. A. S. Paget and Mr. Wilkinson in Nature of July 19 I will reply in regard to the piano experiment by saying that what a person hears is chiefly what he expects to hear. A conspicuous example is that of hearing the tones in whispered vowels. Every observer hears a different system. In the piano experiment I can hear fairly good vowels for *ah* and *oo* when sung; otherwise the result is vague. Yet in speech I hear every minute shading. I am quite in agreement with these gentlemen and most other writers in believing that the vowels are characterised by tones of definite pitch, but that is a matter that cannot be established by any such method.

The portamento piano experiment, however, furnishes a definite proof that the ear is not a resonating organ. When a tone is sung into the piano portamento *all* the strings vibrate more or less, and the result is a complete jangle. Exactly the same result would occur if the ear were a resonating organ. Much singing and *all* speech is portamento. If the basilar membrane acted by resonance, the voice of the singer would usually be a jangle with no pitch, and for the melody of speech we would have only a confused noise. This is exactly what I pointed out in my original letter to Nature, April 22, 1922. The piano as a resonating organ responds to portamento singing by a perfect jangle. That the ear responds by a sensation of a clear rising or falling tone is a quite adequate proof that it does not possess a resonating organ. This ought to settle the matter for good from the physical point of view. To those of us who are accustomed to work with delicate human tissues the Helmholtz resonance theory is simply unthinkable.

The resonance theory is dead and there is no use in wasting time in trying to put life into it again. The deformation theory, as explained in Nature for April 26, rests on distinct theses in strict accordance with anatomical and physiological facts, not one of which has been called in question.

E. W. Scripture.
University of Vienna.

Germanium and its Derivatives.

Until recently, germanium was regarded as one of the rarest of metals, but recent discoveries of larger sources of its minerals lend interest to any possible applications of this element. Germanium dioxide is appreciably soluble in water and an aqueous solution of a concentration of one in 5000 has a marked inhibitory action on the growth of *Bacillus coli communis*.

So far little is known concerning the organic derivatives of germanium which we are now investigating (Chem. Soc. Trans., 1924, 125, 1261). With the aid of the Grignard reaction, germanium halides have furnished germanium tetraphenyl, germanium triphenyl bromide and oxide, and hexaphenyldigermane. Water-soluble organic derivatives of germanium have also been obtained which are now under examination in this laboratory.

G. T. Morgan.
H. D. K. Drew.

The University,
Edgbaston, Birmingham, July 18.

Mathematics at British Universities.

A little time ago I turned light-heartedly to the study of relativity. I had no doubt of the sufficiency of my equipment for such study because two British universities had found me worthy of a degree in mathematics. You can imagine my surprise when I found how little connexion the mathematics of relativity had with my university studies, and what a serious study of new subjects I must undertake. Chief among the new subjects is vector analysis or tensor calculus, and I am puzzled that so many continental writers (as well as a few in this country) show a command of vector analysis, while my two universities knew nothing of it.

It is, however, some years since I left these universities, and it may be that vector analysis has now attained an appropriate position there. It is on this point that I hope your readers may help me by telling me which universities include vector analysis in their courses, and by indicating how far they go in this and other subjects preparatory to relativity. In this inquiry I am not actuated by mere curiosity. I am anxious to know, and I am sure many of your readers also wish to know, whether the teaching of mathematics in our universities is abreast of the times. I hope, therefore, that some one at Cambridge will say what is being done there, or if Cambridge is doing nothing, I hope some one elsewhere will be able to show that his university is making good the omission of Cambridge.

A Beginner in Relativity.

Surveys from the Air: the Present Position.[1]

THE issue by the War Office of the first Report of the Air Survey Committee affords an opportunity of reviewing the progress made in this method of making maps; more especially because the excellent Report in question puts together, in a comparatively small book, a mass of information not easily accessible elsewhere, and is written by the authority of the War Office, the Air Ministry, and the Ordnance Survey.

In discussing the matter it is very desirable to bear in mind that the object in view is the construction of an *accurate* map. It is this factor of accuracy which creates most of the difficulties found in practice. Indeed, if we are content with a pictorial representation of the ground, or with a sketch of uncertain trustworthiness, there is no problem—the thing is already done. It is when we try to produce, by this method, a map of the same high degree of correctness that we expect from a modern ground survey that we find that there are many obstacles to be overcome.

Owing to the special conditions that obtained on the Western Front during the War, the difficulties of the method were very commonly underrated. In this area there were available the old cadastral plans of France, discontinuous and some eighty years out-of-date, but still showing correctly the features which survived. The problem in this case was to correct an out-of-date map of which there existed a trigonometrical frame work. Moreover, along the British portion of the line the ground was generally flat, or only gently undulating, a circumstance which made the conversion of an air-photograph into a plan much easier than it would otherwise have been. The Committee reports that "an undue optimism as to the ease, cost, and suitability of air photo-topography was common at the close of the War."

Broadly speaking, we may tackle the problem in two ways. Either we may take the photograph of the ground without any special precautions as to the axis of the camera being vertical, and without attempting to ascertain its height above the ground. We must then, in the ordinary case, rely upon a fairly close network of measured points on the ground, and from the positions of their representations on the photograph we can, in several ways, determine the tilt, and direction of tilt, of the camera, and its height at the moment of exposure; or we may take precautions to fly level and straight at a known height.

The latter system has been carefully studied at Cambridge by Prof. Melvill Jones; and it is to him and to Major J. C. Griffiths that we owe its present development. It appears that "when the pilot is flying in fair weather at a height sufficient to escape surface air pockets, the probable errors of tilt and difference of flying height have been reduced to 1° and 40 ft. respectively." Truly remarkable results. When it is considered that during the War the average tilt was of the order of 10°, it will be seen what excellent progress has been accomplished in this direction. But still, straight and level flying only solves the difficulties in special cases. When there are considerable differences of level in the terrain photographed, large errors will appear on the resulting map. Where any approach to accuracy is desired, the system of making a map from an uncorrected "mosaic" of photographs taken in this way can be applied only to level areas. But probably it can be effectively applied to the surveys of estuaries and deltas and perhaps to the mapping of large native towns, which in most cases are scarcely worth accurate large-scale ground surveys. Sometimes in war the use of uncorrected mosaics may be inevitable; but that is scarcely the question before us.

In the general case, what is required is the means of mapping hilly and undulating country at a cost which will compare favourably with that of modern ground surveys. It may be as well to state at once that this state of affairs has not nearly been reached. It looks, in fact, as if it would be a long time yet before it is reached. Much patient work is still necessary, though it is only fair to say that much has been done. Experimenters are feeling their way, and are as yet unable to decide which of many promising paths is most likely to lead to the desired goal.

Apart from the use of uncorrected "mosaics" there are two principal problems to be solved. The first is to map, by means of air-photographs, a hilly district which has been so well provided with a framework of fixed points that, in general, four of these, well distributed, will be found on each photograph. The second problem is how to survey with accuracy, from air-photographs, a limited region or gap between two surveyed areas, the region in question not being provided with any fixed points. It is not to be assumed in either problem that it is possible to arrange for the axis of the camera to be vertical; and in each problem we must take account of the hilly character of the ground, and attempt to contour it.

It may be taken for granted that the focal length of the lens is known and also the position of the optical centre of the plate. Now if, in addition, we could find the amount of the tilt and the direction of the tilt, the problem would be much simplified. The Committee, therefore, turned its attention to the determination of the tilt by means of a gyroscopic apparatus, and it is reported that during approximately straight flight the apparatus worked well and that an accuracy of one-quarter of a degree might be expected.

An alternative method of finding the tilt is to make use of a "tilt-finder," a machine devised by Major MacLeod, which reproduces, in miniature, the conditions which obtained in the field (Fig. 1). To use this machine it is necessary to know the focal length and optical centre, and to have available the positions of three ground points, which in the latest model need not be of the same height. Three planes are dealt with: namely, the ground plane P′, which need not be horizontal; the map-plane M, which must be horizontal; and the photo-plane P, of which it is desired to ascertain the tilt. By a succession of approximations it is possible to determine the tilt with a satisfactory degree of accuracy.

If the terrain to be surveyed is flat, or nearly so, and if four points of which the co-ordinates are known are shown on the photograph, then it is possible to cover the map with a rectilinear grid, and by a graphic construction to draw the representation of this grid on

[1] Report of the Air Survey Committee. No. 1, 1923. Pp. 131. (London: H.M. Stationery Office, n.d.) 4s. 6d. net.

the photograph (Figs. 2 and 3). The photo-grid will be composed of two sets of straight but converging lines. If the grid is close enough, the detail can be drawn in on the map without difficulty.

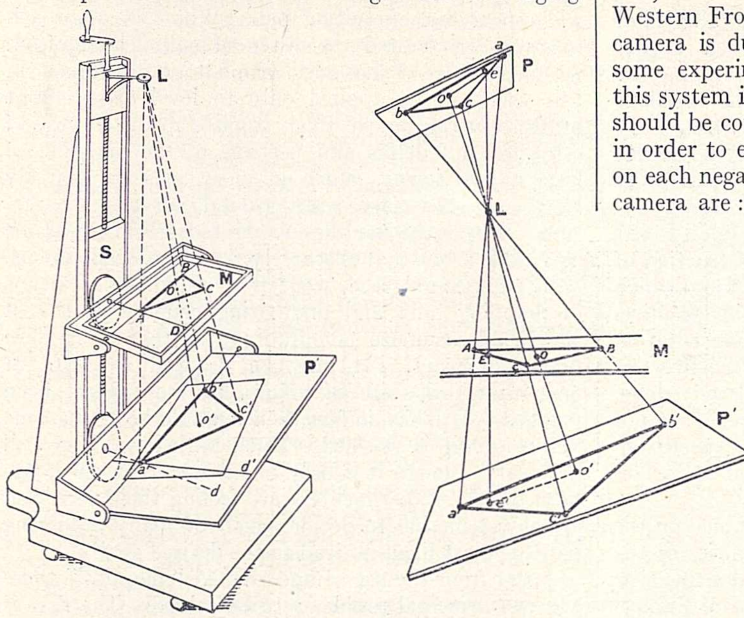

FIG. 1.—The tilt-finder (Mark I). Reproduced by permission of the Controller of H.M. Stationery Office, from the Report of the Air Survey Committee, No. 1, 1923.

The problem is, of course, capable of mathematical treatment. If there are given the focal length [and at least three known points, it is possible to determine the position of the camera in the air and the constants of the plate. Where the ground is approximately level the mathematical treatment is easy; but in hilly country it becomes cumbrous — and expensive.

In hilly country, for the purpose of plotting the relief, it is useful to employ oblique photographs, in addition to those taken with the plates horizontal. If the "obliques" are taken at lower altitudes than the horizontal plates, they can be at high tilts and are then most valuable. This may involve, however, the uneconomical procedure of double flights. Generally, the more the plate is tilted the more valuable it is for determining the relief and the less valuable for planimetry.

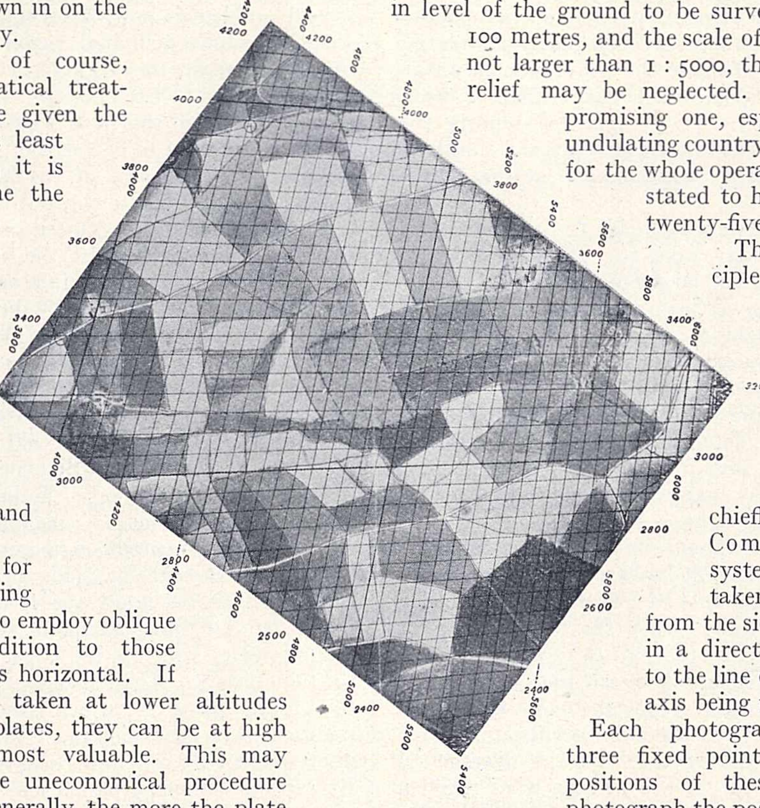

FIG. 2.—The photo-grid. Reproduced, by permission of the Controller of H.M. Stationery Office, from the Report of the Air Survey Committee, No. 1, 1923.

The rectification of the air-photograph can also be accomplished photographically. This method was, in fact, in use by the British and French armies on the Western Front. An up-to-date form of the rectifying camera is due to M. Roussilhe, who has undertaken some experiments for speed, cost, and accuracy. In this system it is necessary that the area to be surveyed should be covered with a close network of fixed points in order to ensure that three fixed points shall appear on each negative. The essential parts of the rectifying camera are: a projecting lantern, a negative-carrier, a lens-carrier, and a screen-carrier. The carriers are all capable of horizontal movement and of rotation. A tracing or diagram of the three control points, plotted to scale, is fixed to the screen-carrier, and the apparatus is manipulated until the projected images of the three control points in the negative correspond with the three points on the screen-carrier. If the three points are not all in the plane of reference a second adjustment will be necessary. The adjustment having been made, the tilt can be found to within ½ degree, the position of the map plumb-point to within 10 metres, and the height to within 10 metres; the rectified print is the required map, to scale. M. Roussilhe has shown that, provided that the differences in level of the ground to be surveyed do not exceed 100 metres, and the scale of the photograph is not larger than 1 : 5000, the distortion due to relief may be neglected. The method is a promising one, especially for flat or undulating country. The time required for the whole operation for one plate is stated to have been reduced to twenty-five minutes.

The stereoscopic principle has also been applied to air photo-surveying, and may be exemplified by the system evolved by Prof. Hugershoff, which is that chiefly dealt with by the Committee. In this system, photographs are taken in pairs, by hand, from the side of the aeroplane, in a direction at right angles to the line of flight, the optical axis being tilted to about 60°. Each photograph must include three fixed points; and from the positions of these points on the photograph the position of the camera in space is measured, and the direction of the optical axis. Each pair of photographs is then placed in the autocartograph, which is, in principle, much the same as the stereoautograph of Von Orel. By means of the autocartograph the map can be plotted mechanically; and by clamping the height lever at a particular height, and keeping the stereoscopic pointer (in appearance) just in contact with the ground, a contour can be traced. The whole apparatus is elaborate and expensive, and it would need many pages to describe it at all adequately. It has possibly come to stay, though it has not yet been subjected to exhaustive tests. The stereoscopic method has the great advantage that it is possible by its means to draw the contours of a bare hillside, an impossibility with any point-by-point system; and this requirement of drawing contours must be met if air photo-surveying is to have any general application to topography. A topographical map of the normal type shows the ground features by approximate contours, which are controlled by a trigonometrical framework. At present, apart from the stereoscopic methods above mentioned, air photo-surveying is incapable of supplying the contours in open country. It is therefore, at present, only fitted for the survey of flat countries. It would be waste of time and money to prepare a ground plan by air methods and then go over the same ground again for the survey of the contours.

The position that has been reached is briefly this: Air photo-surveying is indispensable in war. In peace-time it has a unique field of usefulness for archæological purposes; for it has been shown by Colonel Beazeley, Mr. O. G. S. Crawford, and others, that air photographs may show ancient features that are invisible except from the air. For surveying purposes air photographs are probably, even now, of value for the mapping of estuaries and deltas, and possibly for the mapping of native towns on medium scales. It also appears likely that in flat or very gently undulating country the method can be used for the construction of cadastral plans without contours, with satisfactory speed and accuracy; and that in such circumstances the cost may be brought down to a practicable figure.

But at present, for the construction of contoured topographical maps, air photographs cannot be economically employed; and the same remark applies to the construction of maps and plans, on all scales, for all purposes, in hilly country. The future use of air photographs, so far as concerns the general peace-time application of the method to the construction of accurate topographical maps, would appear to lie in the development of stereoscopic methods.

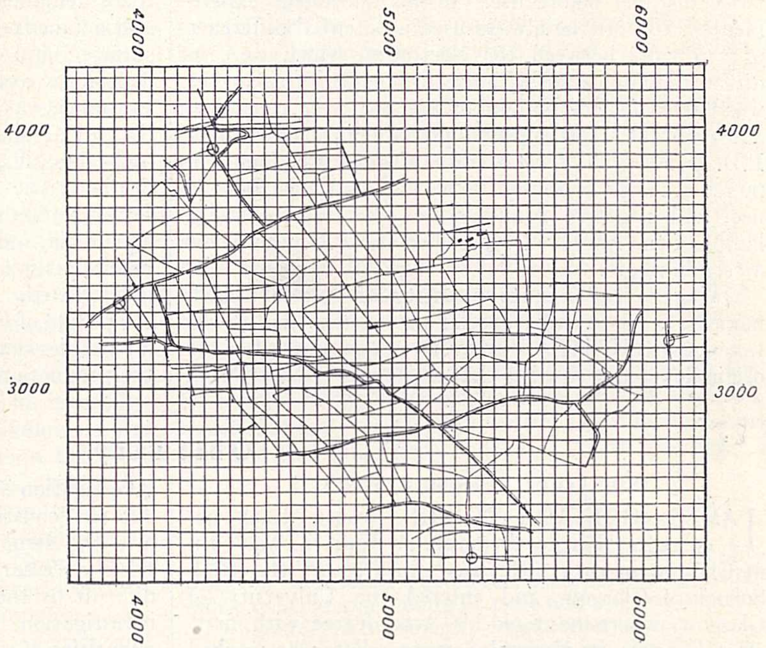

FIG. 3.—The map-grid. Reproduced, by permission of the Controller of H.M. Stationery Office, from the Report of the Air Survey Committee, No. 1, 1923.

Any one interested in the subject may be advised to purchase the Report of the Air Survey Committee, which is clearly written, well illustrated, and contains much useful information, including a short bibliography. C. F. CLOSE.

The Reported Transmutation of Mercury into Gold.

IN NATURE of March 29 last (pp. 459-460) we printed a communication by H. Nagaoka, Y. Sugiura, and T. Mishima "on the isotopes of mercury and bismuth revealed in the satellites of their spectral lines," at the end of which the authors stated that "if the above assumption as to the mercury nucleus is valid, we can perhaps realise the dream of alchemists by striking out a hydrogen-proton from the nucleus by α-rays, or by some other powerful methods of disruption." Following this statement, on July 21 the *Morning Post* reported from Berlin that Dr. A. Miethe, professor of photochemistry and astronomy in the Technical High School at Charlottenburg, had obtained gold from mercury by the prolonged action of a high-tension electric current upon it. In the absence of details, such a report could only be received with great reserve, for in the light of existing knowledge it seemed highly improbable that the amount of energy indicated to have been used would be sufficient to disrupt the mercury atom. An account of Prof. Miethe's work containing some definite experimental details is given in the issue of *Die Naturwissenschaften* for July 18, and we reproduce these in order that the claim advanced may be justly assessed.

Some thirteen months ago, Prof. Miethe adopted an improved type of mercury-vapour lamp, made by A. Jaenicke, for his experiments on the coloration of transparent minerals and glasses induced by ultraviolet rays. Early this year, he and his assistant, Dr. H. Stammreich, observed that when the current employed was too strong, the character of the emitted rays soon changed, and that a black deposit formed inside the lamp. (It is not stated if the lamp was of quartz or of glass.) This observation was confirmed by Jaenicke, who stated that on distilling the mercury recovered from old lamps of the improved type, he had found residues which he could not identify. He supplied Prof. Miethe with about 0·5 gram of the residues (which had been obtained from 5 kg. of mercury), and the latter after careful investigation discovered that they contained gold, in addition to other substances which were undoubtedly present as impurities in the original mercury. According to Jaenicke, all the mercury used in the lamps had been twice distilled before use. In his successful experiments, Prof. Miethe always used a potential difference of 170 volts between the electrodes, which were in direct communication with the air outside; the current was passed for 20-200 hours; and the lamp consumed 400-2000 watts. It appeared probable that a minimum P.D. is essential, for no trace of gold was found in mercury lamps of the old type that had been long in use, and negative results were also obtained with lamps of the improved type when the P.D. was below a certain figure.

Owing to the minute quantity of gold obtained, namely, 0·1–0·01 mg., special precautions had to be taken in identifying it. In every test an amount of the original mercury equal to that which was removed from the lamp was analysed and found to be free from gold both by Prof. Miethe himself and independently by K. A. Hofmann; and it was proved that no gold was present in the electrical connexions. Further, the very delicate analytical methods elaborated by Haber failed to show with certainty the pre-existence of gold. When the residue left, after distilling off *in vacuo* the mercury from the black deposit, was treated with nitric acid, there remained yellow well-formed crystals, cubical and octahedral in form, and with a highly reflecting surface; and when the mercury was removed from the deposit by volatilising it at a red heat, the resulting substance was bright gold in colour and of reniform or botryoidal shape. The substance was found to be malleable, it gave the streak of fine gold and the characteristic colour when the polished film was observed by doubly reflected light. It was easily soluble in aqua regia, and on evaporation the solution gave crystals precisely similar to those obtained when ordinary gold is so treated. Identical results were also obtained by the purple-of-Cassius test. It was not possible to make an atomic-weight determination or to attempt to prove the production of helium, hydrogen, α- or β-rays.

Obituary.

SIR JAMES J. DOBBIE, F.R.S.

JAMES JOHNSTON DOBBIE, whose death occurred at Fairlie, Ayrshire, on June 19, was born at Glasgow in 1852. He was educated at the High School of Glasgow, and entered the University of Glasgow, where he took his Arts degree with first-class honours in Natural Science. Later he worked at Leipzig in the laboratory of Wislicenus. There being no science degree at Glasgow in those days, he went to Edinburgh, and graduated as B.Sc., proceeding later to the Doctor's degree. He was elected to a Clark Fellowship at Glasgow University, and returned there and taught the class of mineralogy.

Sometime before this Dobbie had made the acquaintance of Ramsay, then a young assistant in the chemistry department of the university. Ramsay first introduced him to organic chemistry, and they read together Schorlemmer's well-known "Chemistry of the Carbon Compounds." Ramsay invited him to join in an investigation on the constitution of quinine, scarcely anything being known of the constitution of the alkaloids at that time. By oxidation with alkaline permanganate they obtained pyridine tri-carboxylic acids, which they identified, thus establishing for the first time the connexion between the alkaloids and the pyridine bases.

Soon after this Ramsay was elected to the chair of chemistry at Bristol, and Dobbie succeeded him at Glasgow. Here he continued his work on alkaloids, and also took an active share in establishing the Glasgow and West of Scotland Section of the Society of Chemical Industry, of which he was the first secretary.

In 1884 Dobbie was elected to the chair of chemistry in the newly founded University College of North Wales at Bangor. His first work was to get laboratories built and equipped, and to organise the teaching of his department. He resumed his research work on alkaloids, and made, in particular, a very complete investigation of the alkaloids of *Corydalis cava*, working out the constitution of corydaline and investigating also the structure of the associated alkaloids. This work, necessarily complicated, was rendered still more difficult by the high cost of the alkaloids, so that the investigation had to be carried out with very small quantities of material: the results were communicated in a series of papers to the Chemical Society from 1892 to 1904. A little later he took up the study of the relation between the ultra-violet absorption spectra and the constitution of organic compounds, working at first with the late Sir W. N. Hartley, and later with other workers. In particular, they showed how the method could be applied to determine the constitution of tautomeric bodies.

Dobbie's work at Bangor, however, was by no means limited to that of his own department. He felt that, in an agricultural country such as North Wales, one of the proper functions of the college was to do everything possible to promote its chief local industry. He spent several vacations on the Continent studying methods of agricultural education, and started a campaign for the founding of an agricultural department at Bangor. Funds had to be collected and the interest of the land-owning classes and the farmers, as well as that of the Board of Agriculture, aroused. After several years of strenuous work the agricultural department was at length inaugurated in 1894. Courses were provided leading to a diploma and later to a degree in agriculture, while a comprehensive scheme of extension lectures and experiments was devised. This was the first agricultural department to be founded in connexion with a University College, and it is impossible to overrate the importance of Dobbie's pioneer work at Bangor in the development of agricultural education. He took a leading part in the work of the foundation of the University of Wales, and the college and the university owed much in these early days to his sane judgment and great administrative skill.

In 1903 Dobbie was offered and accepted the post of director of the Royal Scottish Museum in Edinburgh, but gave up his work at Bangor with considerable reluctance. His wide interests and scholarship combined with his administrative ability made him an excellent director. He threw himself into the work of the Museum with characteristic energy, and greatly extended the collection of Egyptian antiquities, a subject in which he was much interested. He also collected funds to acquire for the Museum the valuable Noel Paton collection of armour and antiquities, and greatly developed the technical collections. He did not, however, relinquish his connexion with chemistry, but continued his research work, a regular series of papers being contributed to the Chemical Society on absorption spectra and alkaloid work.

In 1909 Dobbie was appointed principal of the Government Laboratory in succession to Sir T. E. Thorpe, and was at once required to undertake the reorganisation of the laboratory. This was made a separate Crown Department in 1911, dealing with chemical matters arising from all Departments of State, and Dobbie was the first to hold the position of Government Chemist. Here he continued his investigations in absorption spectra and on the alkaloids. His tenure of office covered the difficult years of the War, when the strain on his department was great. He served on various commissions and committees, and in particular his services on the Royal Commission on Rewards to Inventors, the Universities Grants Committee, and the Nitrogen Products Committee may be specially mentioned. He also acted for fourteen years as adviser on the research schemes in physics and chemistry to the Carnegie Trust for the Universities of Scotland.

Dobbie was elected a fellow of the Royal Society in 1904, and in 1915 his services to science, both as an investigator and as administrator, were recognised by the King, who conferred the honour of knighthood upon him. He received the degree of LL.D. from the University of Glasgow in 1908, and that of D.Sc. from the University of Wales in 1920. He was elected president of the Institute of Chemistry in 1915, and of the Chemical Society in 1919.

The foregoing is a bare outline of a life of varied and fruitful activity. In an unusual degree Dobbie combined the patience and lucidity of the born teacher, the fertility of ideas and resourcefulness of the research worker, and the clear common sense, critical yet always constructive, of the wise administrator. In addition to all these he had much of the scholar's temperament. Reading widely, but never without fine discrimination, he was indeed the "full man" of Bacon's aphorism, and his mind was a storehouse of information over a wide range of literature and history. To the end of his days the classics were his constant solace and relaxation, and he was a living negation of the supposed antipathy between science and the humanities.

Beloved by his students and fellow-workers, in the lives of his intimate friends he leaves a blank that can never be filled. He is survived by Lady Dobbie, one son, and two daughters. ALEX. LAUDER.

WE regret to announce the following deaths:

Sir George Beilby, F.R.S., distinguished by his work in industrial chemistry, fuel technology, and many other departments of pure and applied science, on August 1, in his seventy-fourth year of age.

Dr. R. S. Woodward, president of the Carnegie Institution from 1905 to 1920, and formerly professor of physics in Columbia University, on June 29, at seventy-five years of age.

Current Topics and Events.

THE Toronto meeting of the British Association opened on Wednesday evening with the delivery by Sir David Bruce of his presidential address on the prevention of disease, which is printed in full in this week's Supplement to NATURE, together with abstracts of most of the addresses of presidents of Sections. The provisional programmes of the Sections were described in our issue of July 26, and articles upon the main subjects discussed will appear in our columns later. At the inaugural meeting, the following congratulatory message from H.R.H. the Prince of Wales was read: "Dear Mr. President, Will you be good enough to convey to the members of the British Association at their inaugural meeting in Toronto my cordial good wishes for a very successful session? My knowledge of Canada assures me that your visit will be warmly welcomed, and that nothing but good can come of such a gathering, where the representatives of the most advanced thought from the Old Country will meet in discussion the equally keen and active intellects of the Younger Land. My interest has been particularly arrested by one item that is to come up for discussion, namely, the educational training of boys and girls in this country for life overseas. The call of the Empire for a wider distribution of the home population, for men and women to open up the vast uncultivated areas in the great Overseas Dominions, is more imperative to-day than at any time in its history. I congratulate the Association on thus showing in its deliberations such a broad interest in these problems, and I trust, and indeed am confident, that the influence thus exercised may result in great and extended benefits to the Empire."

A STRIKING illustration of the attitude of Parliament and the heads of State departments towards scientific workers is afforded by an examination of the personnel of the committee appointed by the President of the Board of Trade "to inquire into and report upon the conditions and prospects of British industry and commerce, with special reference to the export trade, and to make recommendations with regard thereto." The appointment of this committee is the outcome of representations made by Sir A. Shirley Benn on May 21 in the House of Commons. On that occasion Major A. G. Church directed attention to the fact that the proposal not to include on the committee a representative scientific worker—other than economists—suggested that the House did not realise that the greater part of the export trade of Great Britain was based upon the application of scientific discoveries. The function of the highly qualified scientific worker or technician engaged in industry is to improve industrial processes, to develop new processes, and, most important of all, to create new industries. Any national inquiry into trade must, therefore, necessarily consider the methods by which practical applications of science may be profitably encouraged. In the memorandum furnished to the Committee of Inquiry, upon which workers in science and technology are not represented, Mr. Sidney Webb states that it is their duty to make "an inquiry into British productive capacity and organisation . . . the present and future adequacy of raw materials and possible improvements in their utilisation, and the part played by the United Kingdom in new developments of industry, particularly those which are the outcome of scientific research." How such an inquiry is to be made on satisfactory lines without the assistance of those who possess a knowledge of science and its possibilities is difficult to understand. It is not enough to call scientific workers to give expert evidence; they should be given representation on the committee and share to the full responsibility for the report to be produced.

The appointment of the Rev. Canon E. W. Barnes, F.R.S., Canon of Westminster, to the Bishopric of Birmingham, is a noteworthy sign of the times. Canon Barnes is a distinguished mathematician with wide scientific knowledge as well as a leader in theological thought, so that he represents the progressive spirit of both science and religion and combines the principles of truth and righteousness for which each should stand. In the early fifties of the last century, Robert Braithwaite Batty, second wrangler and first Smith's prizeman, gave up his promising career in England to preach the gospel, as then understood by the "evangelical" school of theology, to the natives of India. His humble missionary effort, contrary to medical advice, was closed by his death in a year's time. Canon Barnes, also second wrangler and first Smith's prizeman, is now nominate Bishop of Birmingham. The contrast is indeed strange and marks a new stage in the evolution of spiritual thought.

Sir Max Muspratt, Bart., in addressing the eighth annual general meeting of the Association of British Chemical Manufacturers on July 17, said that great strides have been made recently in effecting co-operation among manufacturers and others associated with chemical industry, notably in the organisation of the chemical exhibits at the British Empire Exhibition. These exhibits have not only been instructive to students, but they have also been the means of bringing home to politicians and the public the importance of chemistry to the nation. There is considerable conflict of opinion within the Association concerning our dyestuffs policy: the council is trying to keep a balance between the opposing interests, and is advocating what it considers best for the Association as a whole. In supporting the principle of the Consolidated Factories Bill, the council approves of any measures that will make employment in factories easier and more pleasant, but it disapproves of hard and fast regulations that are unnecessary, or costly, or Utopian. Sir Max Muspratt is not hopeful that much can come out of the Rating of Machinery Bill, yet he hopes that the inquiries now being made into the general principles of rating will result ultimately in equitable treatment for chemical undertakings: the projected Census of Production will, if properly carried out, aid greatly in solving problems of unemployment, health, taxation, and rating. Sir John Brunner, Bart., referred to the Chemical Engineering Department of University College, London, and said that, although many hold that such education can produce only half-baked engineers and half-baked chemists, he thinks that there are many places in our Empire where large staffs cannot be afforded and where men trained in a chemical-engineering department could take control, if not of chemical works proper, of works in which chemistry plays a very prominent part, for example, in sugar factories.

With reference to our paragraph of July 19, p. 96, on the subject of trichlorophenylmethyliodosalicylic acid, it appears that this substance is to be classed among those actively germicidal owing to their inherent properties, rather than amongst those which owe their antiseptic powers to their ability to set free chlorine. The compound is very stable and its solution in water can be boiled without undergoing decomposition: it retains a great part of its germicidal action in serum. Used as an antiseptic in a 1 per cent. solution or less, it appears to owe its power to two distinct modes of action; on the one hand it stimulates the leucocytes, and thus aids the body's own defensive processes: on the other, it combines with the proteins of the bacteria by virtue of its chlorine groups; this combination is presumably with the amino-groups of the protein molecules. In this way it is attached to the micro-organisms and hinders or abolishes their activity; the phenyl and iodine radicles as well as the salicylic acid are themselves antiseptic of varying potency, and it is probable that with the attachment of the compound to the bacterial protoplasm by means of the chlorine group, the other groups are enabled to exert their action under more favourable conditions. Analgesic properties are also ascribed to it, owing to the fact that the chlorine groups are attached to the benzene nucleus. Finally, it is claimed by Dr. Callimachi that it shows little affinity for the protein molecules of human tissues, while reacting selectively with those of bacteria.

The International Congress of Architects concluded a week's programme in London on August 2. Organised by the Royal Institute of British Architects, the meeting had for its object the discussion of architectural education, which is controlled in Britain and the Dominions by the examinations of the Royal Institute's education board. To reach the status necessary for the successful design and supervision of modern buildings requires a course of study not less lengthy or exacting than that required for other professions, and the requisite training is provided in architectural schools, which usually give a four years' course, during which design, construction, and the technical and legal aspects of an architect's work are the subject of study. Discussions on three successive days were centred around architectural education of the past, present, and future, under the respective chairmanships of Lord Crawford, Sir Reginald Blomfield, and Mr. Cass Gilbert (U.S.A.). In addition to a display of rare architectural books, a unique collection of students' drawings from all countries, large enough to require both Grosvenor House and Devonshire House for its accommodation, was exhibited. This is the first international meeting of architects held, and in addition to Britain and the Dominions, thirteen other countries were represented. While British schools are to be congratulated on their work, it must be confessed that the drawings of foreign countries, especially those of the United States, must be given the first place for boldness in conception and possibly also for skill in composition.

THE meetings of the British Pharmaceutical Conference were held at Bath on July 22-24. At the opening session the Mayor of Bath welcomed the conference to the city, and the chairman, Mr. Edmund White, delivered an address entitled "Pharmacy: Present and Future." He first directed attention to the changes which are gradually taking place in the practice of pharmacy as the result of changes in medical practice. The *materia medica* has been enriched by the addition of a large number of synthetic substances and animal products such as gland extracts, sera, and vaccines. Pharmacists should be trained to deal with these new developments and also to undertake the newer methods of laboratory diagnosis for the assistance of the medical practitioner. Mr. White then reviewed the work of the Consultative Council on Medical and Allied Services set up by the Ministry of Health, and, from consideration of the report of that body, concluded that much of the work of the clinical laboratories, which it is proposed to set up, could be done by pharmacists. As to the Therapeutic Substances Bill, he thought that the Pharmaceutical Society should take an active part in the examination and standardisation of remedies by physiological and biological methods. The twenty-three papers read at the science meetings included: a number of communications on bismuth compounds from the Research Laboratories of the Pharmaceutical Society; a study of Benedict's method for the estimation of glucose; the preservation of anæsthetic ether; carbon tetrachloride for medicinal purposes; assay of mercurials in ointments; and papers dealing with the following drugs: tragacanth, acetannin, valerian, erythrophleum, artemisia, nux vomica, *Strychnos cinnamomifolia*, and tannin-containing drugs. The delegates from branches of the Pharmaceutical Society met under the presidency of Mr. F. Pilkington Sargeant and discussed the control of pharmaceutical specialities; also articles of pupilage, and pharmaceutical service in the Army. The programme of social events included the Civic Reception, a banquet, concerts, and motor excursions in the beautiful country surrounding the city of Bath.

THE Council of the Royal Meteorological Society has awarded the Howard prize for 1924 to Cadet J. M. Goode of H.M.S. *Worcester* for the best essay on "Monsoons." The prize was competed for by cadets from the following institutions: H.M.S. *Worcester*, H.M.S. *Conway*, and the Nautical College, Pangbourne. The prize was presented to the successful cadet at the annual prize-giving on the *Worcester* on July 31.

PROF. J. C. FIELDS informs us that the following conferences are to be held at the International Mathematical Congress at Toronto on August 11-16: "Some of the Characteristic Features of Twentieth Century Pure Mathematical Research," Prof. W. H. Young; "Science and Engineering," Sir Charles Parsons; "Modern Norwegian Researches on the Aurora Borealis," Prof. Carl Stormer; "Solved and Unsolved Problems in Dynamical Meteorology," Prof. V. Bjerknes; "Sur l'intégration des équations aux dérivées partielles par des intégrals définis," Prof. J. Le Roux; "Sur la déformation projective des surfaces," "Sur les relations entre la théorie des groupes et la géométrie," Prof. E. Cartan; "Sur les nouveaux appareils multiplex de télégraphie," J. B. Pomey; "Principe de réciprocité dans les sciences appliquées," Prof. G. Puppini; "Géométrie algébrique," Prof. F. Severi; "Sur le calcul des variations," Prof. L. Tonelli; and "On Ballistics," General Charbonnier.

A CONFERENCE, under the auspices of the British Non-Ferrous Metals Research Association, will be held at High Leigh, Hoddesdon, Herts, during the week-end September 5-8, to which are invited all who need to utilise information systematically, or are interested in the conduct or operation of information bureaux, intelligence services, and special libraries. The programme will include papers and discussions on the functions, future developments, and the methods and equipment of intelligence bureaux, and on their relations with other institutions, including national and public libraries. It is hoped to obtain representatives of such varied fields of activity as government and municipal departments, technical and research institutions, industrial concerns, financial houses, insurance offices, newspapers, and civic and social organisations, all of which have a common interest in the collection, treatment, and dissemination of facts and information relevant to their particular activities. Further information may be obtained from Mr. A. F. Ridley, Athenæum Chambers, 71 Temple Row, Birmingham.

THE fifth Entomological Meeting was held at Pusa on Feb. 5-10, 1923, under the chairmanship of Mr. T. Bainbrigge Fletcher, Imperial Entomologist. The Report of its proceedings has recently come to hand, and, although it is less bulky than some of its predecessors, some sixty-one papers are included. These represent almost every branch of applied entomology and afford ample testimony of the importance the subject has attained in India. The institution of meetings of this description brings together workers who are often isolated at great distances apart with little or no opportunities of direct intercourse. The means thus afforded for the ready interchange of information and ideas also attains a more lasting value by the publication of these very fully illustrated Reports. Among the various papers included in the present volume, one of the most important is that by Mr. T. Bainbrigge Fletcher on the possible introduction of the American cotton boll-weevil into India. It appears that the risk of this pest securing a footing in that country is very real, and, after considerable discussion, the Conference passed a resolution that the Indian Central Cotton Committee should consider the advisability of recommending the total prohibition of cotton from America. As an alternative, it is suggested that all bales containing such cotton should be confined to Bombay. The subject of the teaching of entomology in the Indian universities also came up for discussion. The meeting recommended and passed a resolution to the effect that entomology be taught as of equal rank with other branches of biological science in the courses of study for the examinations for degrees in science, including agriculture.

A FISHERY expert is required by the New Zealand Government for co-operation with the chief inspector of fisheries. Particulars of the appointment and form of application may be had from the High Commissioner for New Zealand, 415 Strand, W.C.2. The completed form must be returned by, at latest, August 23.

SOME appointments are about to be made in connexion with the Fuel Research Station, East Greenwich. Candidates must be honours graduates in chemistry (or have equivalent qualifications) with experience in the technology of fuels; or be honours graduates in engineering (or have equivalent qualifications) with similar experience. Research experience is essential for a higher post in chemistry, and industrial experience for a higher post in engineering. Applications must be made on a form obtainable from the Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1, returnable not later than August 20.

THE American Oil Chemists' Society has established a new quarterly journal which will be the official journal of the oil and fat industry in the United States. The new publication will deal with the chemical considerations of oils, fats, and related materials such as oil meal feeds and fertilisers, paints, soaps, foods, and packing-house products. H. S. Bailey, chief chemist of the Southern Cotton Oil Company, heads the board of editors, composed of the leading American chemists in this field. The first number is to appear this month from the press of the publishers of the American Chemical Society publications. Correspondence regarding subscriptions should be sent to Fred H. Smith, Managing Editor, Experiment, Georgia, U.S.A.

THE Wisconsin Survey Bulletins Nos. LII. and LIV. include a general soil survey of the south part of North Central Wisconsin, and a detailed survey by counties of the southern and older portions. Each section is preceded by a general description of the area concerned, with a summary of the various series of soils found in the district. These groups are then treated in detail, special attention being directed to the economic aspects, such as topography and drainage, native vegetation, and the present state of agricultural development. Each survey is illustrated by an excellent soil map to which a legend is appended in which the soils are grouped according to their surface features and drainage, and are further classified in accordance with their uses and adaptation, fertility, and methods of improvement.

A NEW and much more convenient *format* has been adopted by the Ministry of Agriculture and Fisheries for its fishery publications: it is understood that this is a very great reform, accomplished with difficulty. Three papers are noticed here: Vol. 6, No. 1, a study by Dr. E. S. Russell of the seasonal variations in the chemical composition of the oyster. The paper is based on a large series of analyses made by the staff of the Government Chemist. Vol. 6, No. 5, by J. N. Carruthers, deals with the "intensive" plaice investigations of 1921, particularly the marking and transplantation experiments. Vol. 7, No. 1, is an account of the development of the cod by Prof. A. Meek. The author has been able successfully to make sections of developing cod eggs—a result of considerable value—and has evidently made a contribution of importance to the study of teleostean embryology. This embryological detail has, however, been omitted from the paper "as unsuitable in a fisheries publication," and the figures and results actually included are mainly such as have long been familiar in fisheries reports—pictures of fish embryos as seen through the outer membranes and useful only for the purpose of identification of the eggs.

THE Leicester Museum, Art Gallery, and Library Bulletin, of which the first number was issued in June, is in itself a token of progress. It announces another advance in the experimental appointment of Miss F. A. Rogers as guide demonstrator to all three institutions; the extension of this service to the libraries of the town is, we believe, a novelty. The main object of the Bulletin is to direct attention to recent accessions. Those mentioned in the present number comprise an ancient Egyptian funeral boat of the XII. Dynasty, a single-handed turret clock of about A.D. 1700 from Aylestone Church, a bronze, "The Mourning Woman," by Epstein, and a number of books on hosiery manufacture and the related textile industries. The Bulletin is intended, for the present, to be distributed gratis at quarterly intervals.

A BEAUTIFUL album of views in the Canton of Graubünden or Grisons has reached us from the Grisons Tourist Information Office, Coire (Chur), Switzerland. The album includes striking illustrations of Klosters and the Canardhorn, Arosa, Flims-Waldhaus with its lakes and pine-woods, St. Moritz, Silvaplana, Maloja, the Morteratsch glacier, the fine Bernina Pass to Alp Grun with the valley and the lake of Poschiava below, the National Park, Pontresina, and many other places in the Upper and

Lower Engadine. Few areas in Switzerland can offer such a variety of interest and charm as the Engadine. There are mountain peaks, glaciers, well-shaded walks, and lakes, while the remarkable railway, going to a height of 7400 feet, from St. Moritz to Tirano, with conveniently placed stations, make most of the beauty spots in the district easily accessible to visitors who are not mountaineers or cannot undertake long excursions in the high Alps. In the Engadine the mountains are wooded to a greater height than anywhere else in the Alps, and as the general level is about six thousand feet, the district has advantages over most of the places visited by tourists. Pontresina is one of the best centres, and a holiday spent there cannot fail to be of benefit to both body and mind.

MESSRS. DULAU AND CO., LTD., have just circulated a catalogue (No. 114) of books and papers on conchology, mollusca, and minor classes—recent and fossil. Upwards of 1300 titles are given in the list, which will doubtless interest many readers.

READERS of NATURE on the look-out for bargains in books should obtain Catalogue No. 237 from Messrs. W. Heffer and Sons, Ltd., Cambridge, in which are given the titles of many books of science now offered for sale in new condition at greatly reduced prices—the books being "remainders."

WE have received from the British Dyestuffs Corporation, Ltd., a price list of fine organic chemicals for research work, indicators, microscopic stains, and medicinal and photographic chemicals. A very extensive range of products at reasonable prices is available, and it is evident that great progress has been made in the fine chemical industry.

MESSRS. H. K. LEWIS AND CO., LTD., 136 Gower Street, W.C.1, have just issued, at 1s. net, a supplement (1921–1923) to the catalogue of their Medical and Scientific Circulating Library. It should be very useful, not only to users of the library, but also to students in general of scientific literature, being practically a list of the science books published during the period named, consisting of a classified index to subjects in addition to the catalogue itself, which is arranged alphabetically under the names of the authors. It gives the date of publication of the volumes included.

MESSRS. W. H. HARLING, of 117 Moorgate, London, have just issued a new illustrated catalogue of drawing instruments, mostly of their own design and manufacture. These include, besides the usual group of engineers' drawing materials such as scales, parallel rules, T-squares, set squares, drawing boards, etc., a few more elaborate instruments, such as pantographs and eidographs, which should appeal to the increasing number of people who frequently resort to graphical methods. There is a cheap new pantograph which enables drawings and plans to be reduced by sixteen different ratios and enlarged to four times. A more expensive but much more accurate instrument is the eidograph, designed to provide the accuracy required for fine details of map construction. The instrument will enlarge with this accuracy up to a ratio of 1 in 4.

ERRATUM.—Dr. H. O. Forbes writes: "By a very regrettable oversight in correcting the proofs of my communication in NATURE for August 2, 'Pre-Columbian Representations of the Elephant in America,' Dr. Maudslay's name was misspelt Maudsley."

Our Astronomical Column.

ENCKE'S COMET.—This comet was detected on its return by Prof. G. van Biesbroeck at the Yerkes Observatory on July 31. Its position at $20^h\ 45 \cdot 6^m$ G.M.T. on July 31 was R.A. $3^h\ 24^m\ 53 \cdot 4^s$, N. Decl. $28^\circ\ 6'\ 27''$, Magnitude 16·0. The position is within 1′ of Matkiewicz's prediction, according to which perihelion will be reached on Oct. 31·42 G.M.T. The comet should become visible to ordinary telescopes in the last week of August.

THE TOTAL LUNAR ECLIPSE OF AUGUST 14.—We are passing through a period of eighteen years (1920–1938), during which no total lunar eclipses are visible in England under really good conditions. That on August 14 will, however, give some opportunities for observation, especially towards the close of totality. Sunset is at 8.25 P.M. (summer time), the middle of eclipse at 9·20, the end of totality 10.9, last contact with umbra 11.9. The eclipse is nearly central, its magnitude being 1.66 in terms of the moon's diameter. The degree of illumination, and colour, of different portions of the eclipsed moon should be studied, since they give interesting information as to the transparency of the terrestrial atmosphere. Total eclipses can also be used for obtaining improved values of the moon's diameter, by observing the occultations (both disappearance and reappearance) of faint stars. This requires co-operation between a large number of observers; the moon will be too low for observations of this kind in Europe, but some lists have been prepared for southern observers.

A NEW FORM OF ORRERY.—The *Times* of July 31 describes a very interesting method of demonstrating celestial phenomena which is being installed in the Deutsches Museum at Munich. It was constructed by the well-known optical firm, Messrs. Zeiss, of Jena, and consists of about forty optical projectors which throw images of the various heavenly bodies on the white inner surface of a spacious dome. Their relative movements and changes of aspect can be exhibited in an instructive manner.

The ordinary cinematograph can be usefully employed as an aid to astronomical education. It will be remembered that Mr. Maskelyne took a successful film of the total solar eclipse of May 1900 (exhibited at a meeting of the Royal Astronomical Society), and the attempt was repeated in Australia in 1922; but no one seems yet to have realised the possibilities of the method in explaining elliptical or parabolic motion, or various other points in which a moving picture would give far more convincing demonstration than the ordinary diagrams of the text-books.

THE PREPARATION OF THE "GESCHICHTE DES FIXSTERNHIMMELS."—Prof. R. Schorr writes to say that the preparation of this work is being continued at Berlin, Prof. Paetsch having been appointed by the Prussian Academy of Sciences to superintend it. Prof. Schorr is making an independent study of the proper motions of the stars contained in the published volumes (R.A. 0^h to 2^h). The note in this column on July 12 gave the erroneous impression that he was taking a part in the Geschichte itself.

Research Items.

The Antiquity of Man in California.—In *Science* for July 4, Dr. John C. Merriam, in surveying the results of the investigations into the question of the antiquity of man in California carried out by the University of California during the last twenty-five years, points out that the Californian coast region has been in almost constant movement throughout the later geological periods and thus affords a continuous record of the processes of erosion and deposition and of the life of the region during these times. Four lines of investigation have been followed:—(1) the shell-mounds have been examined from the deposits of known culture to those of the earliest times; (2) cave deposits have been explored; (3) pleistocene and recent land, stream, lake and marine deposits in which human remains are likely to be found have been studied; and (4) the evidence relating to the occurrence of human remains or implements in gold-bearing gravels or other ancient deposits has been reviewed. Up to the present, all human remains discovered belong to the type which has been recognised as "modern" and none belong to a geological formation older than the recent period. In the same issue of *Science*, Dr. Chester Stock follows with an account of the geological conditions in which the skeletal remains of six individuals were found in the course of the construction of a sewer at Los Angeles in March last at depths of 18 ft. and 23 ft. The skulls, so far as they have been compared, are of modern type. Some of the remains are considerably mineralised. They present the appearance of having been mired in under bog or marsh conditions rather than washed in. No pleistocene or recent mammals were associated with the human remains, but a comparison with similar deposits in the immediate vicinity suggests the probability of a date later than pleistocene, though of considerable antiquity.

New Species of Shipworms in Bermuda.—As part of the inquiry taking place in the United States on the activities of shipworms, Dr. E. L. Mark, Director of the Bermuda Biological Station, installed test-boards at four stations in Bermudan waters. The specimens of shipworms which attacked these blocks have been examined by W. F. Clapp (Proc. Amer. Acad., Arts and Sci., vol. 59, 1924). He reports that the attacks were not so severe as those caused by shipworms at Key West, Florida, and in the West Indies, but the ravages by Limnoria were so extensive that the posterior ends of many of the shipworm tubes were soon exposed to the action of the water, resulting in the premature death of many of the shipworms, so that specimens of large size were rare. The destruction caused by Limnoria was found to be about an inch in twelve months. Of the six species of shipworms received in the test blocks three are new; descriptions of two of these are given, but the author desires further material for the study of the third species before giving an account of it. The genus Bankia (Xylotria) is not represented either in the present collections or in any previous records from Bermuda.

Additions to the Brackish Water Fauna of Spain.—There is still much to be done in the investigation of brackish water faunas throughout the world, and if the curious discoveries of Enrique Rioja, in the Rio de San Nicolás at Gandía on the west of Spain, are to be taken as typical the investigations will yield some startling results in geographical distribution. He found, in the first place, in the streams debouching in the harbour of Gandía, colonies of a small serpulid worm which spread over stones, grew on the submerged keels of old boats and such like. The serpulid he identifies as *Mercierella enigmatica*, a species described by Fauvel, in December 1922, as occurring in the brackish water of the canal at Caen, the only place where it has been found until now. Rioja gives a good description and some excellent figures of the species. (Bol. Real Soc. Espag. Hist. Nat., tome xxiv., 1924, p. 160-169.) But growing amongst the tubes of Mercierella was a more remarkable form, a minute hydroid which the author identifies with *Annulella gemmata*, a new genus and species minutely described by Ritchie from collections made at Port Canning, Bengal. The characters of the two forms agree; in Bengal, as in Spain, the species frequented brackish water; and in Spain Rioja has been able, as Annandale was in India, to keep examples alive in the laboratory in a mixture of sea and fresh water. This occurrence of Annulella, so far distant from its original place of discovery, indicates either a very widespread distribution of brackish water species, or possibly an environmental effect of this particular medium, inducing close convergence of structure, in forms not necessarily directly related.

The Symbiotic Organ in Aphids.—In his studies on the development of Aphids, L. B. Uichanco (*Philippine Journ. Sci.* vol. 24, No. 2, 1924) deals especially with the history of the symbiotic organ or mycetom. The follicular epithelium of the ovary apparently becomes infected with the symbionts, which remain in a dormant condition until stimulated to multiplication by the development of the egg. The symbionts break through the follicular epithelium and invade the embryo and especially the vitellophags—which the author calls mycetoblasts. The relation of these to the inflowing granular mass—suggestive of phagocytosis—lends support to the view that the symbionts are extraneous organisms and not by-products of the insect's own metabolism. The mycetoblasts form a globular mass in which definite cellular differentiation takes place shortly before segmentation of the germ-band, some thirty to seventy mycetocytes being produced. After birth of the aphid, the mycetocytes, which lie in the abdominal cavity, do not further divide, but they increase in size and the symbionts multiply. In the adult aphid, the mycetocytes begin to degenerate one by one until at the end of life very few remain. The mycetom is present in every aphid whether male, female, or parthenogenetic. In its development, the aphid egg differs from that of related groups in that the periplasm and afterwards the blastoderm leave an opening at the posterior pole so that there is direct communication between the follicular epithelium and the egg cavity. The author regards this as a special adaptation by which the symbionts are enabled readily to enter the egg cavity.

Estimation of Wind above Fog.—Mr. L. F. Richardson has devised a method for use in estimating the wind above fog or low cloud which he describes in Meteorological Office Professional Notes, Vol. 3, No. 34. The procedure is relatively simple. In the middle of a large uninhabited field a steel roof is supported on posts. The observer shelters under this roof, through a hole in which is projected a smooth-bore gun. The gun is mounted on a special mounting which enables the observer to vary its tilt. The aim of the observer is to vary the tilt in such a way that the ball which is fired from the gun falls on the roof.

The tilt which attains this object is called the balancing tilt, β, and it is read in two components, the components which Mr. Richardson designates by β being the cosines of the angles between the axis of the gun and the east-west line and the north-south line respectively. The gun is first loaded with a steel ball and sufficient powder to carry the ball up to a moderate height, say 100 m. By trial and error, and the use of a table giving corrections to β necessary to correct certain errors in point of fall of the ball, the tilt necessary to bring the ball back down on the roof of the shelter is evaluated. The charge of powder is then increased so that a greater height is attained, and so on by successive stages. The limit of height attained by Mr. Richardson appears to have been about 750 m. The height attained by the ball is evaluated by noting the time of absence of the ball, *i.e.* the time from firing until the return impact on the roof. The raw material of observation thus consists of certain times of absence with the corresponding values of β in two directions. The computation of winds at different levels is carried out by the use of certain formulæ given by Mr. Richardson in a paper in Phil. Trans. R. Soc. A. Vol. 223, "Theory of the Measurement of Wind by shooting Spheres Upward." The process is quite straightforward and simple. The paper before us does not indicate the degree of accuracy which may be expected from such observations.

THE RADIOACTIVE CONSTANT OF RADON.—In the *Comptes rendus* of the Paris Academy of Sciences, May 26, Mlle. I. Curie and Mlle. C. Chamié describe a new method of determining the above constant. Suppose two bulbs could be obtained, containing exactly equal quantities of the gas, in equilibrium with the rapidly evolved active deposit; one of them is placed in an ionisation chamber and produces a current i, which decreases with the time. The instant t when i passes through a certain value a is observed, and then the two bulbs are placed together in the chamber, and the instant t' observed when the ionisation current again passes through the value a; then $T = t' - t$ is the half life period of radon. In practice, it is not possible to obtain two bulbs with exactly equal quantities of the gas; but it is shown that if the quantities q_1 and q_2 at time 0 are nearly equal ($q_1 < q_2$), and the times t_1 when one bulb produces the ionisation current a, t_2 when the other bulb produces the same current, and t', when the two bulbs together give a, are determined; then $T = t' - \frac{1}{2}(t_1 + t_2)$. Details of the experimental method employed are given, and the results of four determinations agree to 0·1 per cent., giving T = 3·823 days with an accuracy equal at least to 1 in 2000, and probably higher than this. Mme. Curie found T = 3·85 in 1910, Sir E. Rutherford confirmed her value in 1913, and Bothe and Lechner determined T = 3·810 in 1921.

DISTRIBUTION OF ENERGY IN THE SPECTRUM OF A MERCURY ARC.—M. G. Athanasiu describes in the *Comptes rendus*, Paris Acad. Sci., June 16, measurements of the energy of a number of lines in the spectrum of the mercury arc, with different electrical inputs. The observations were made by means of a thermopile and galvanometer. The lines of the first triplet of the sharp series, the three groups of lines forming the first triplet of the diffuse series, and the three groups forming the second triplet of that series were investigated. The group of yellow lines 5769-90 was also measured. Inputs from 100 up to 300 watts were employed. The energy curves of lines belonging to the same series have the same general appearance, and the ratio between the intensities of two lines of the same series remains nearly constant when the watts are varied. The deviations in the case of the first triplet of the sharp series are not larger than the experimental error (3 per cent.). In the case of the diffuse series the deviations are somewhat larger; this might be expected, since each of these groups contains a line belonging to a different series, the combination series $1p - Dm$ (Fowler). For two lines belonging to different series the ratio of the intensities varies with the watts between large limits, and may be inverted, the energy curves cutting one another. The ratio of the intensity of the yellow group to that of the green line, λ5460 (the first line of the first triplet of the sharp series), changes in the lamp studied from 0·5 for 100 watts to 1·25 for 300 watts.

THE NUMBER OF α-PARTICLES EMITTED BY RADIUM.—In the *Zeitschrift für Physik*, June 12, V. F. Hess and R. W. Lawson criticise a recent paper by Geiger and Werner, who have obtained for the above number $3·4 \times 10^{10}$, agreeing with the value originally found by Rutherford and Geiger, but differing from Rutherford's later value, $3·57 \times 10^{10}$, and from that found by the authors in 1918, $3·72 \times 10^{10}$. It is suggested that the platinum used in the construction of the container employed for the emanation, which had to be heated in the course of filling, occluded emanation when cooled; this might easily produce an error of 10 per cent. It is doubtful whether Geiger and Werner are correct in thinking that their scintillation screen, in which powdered zinc sulphide was mixed with castor oil or turpentine oil, gave scintillations corresponding to almost 100 per cent. of the total α-particles, as was the case with the zinc sulphide alone (99·6 per cent.). The method adopted for obtaining the true number of scintillations from the counts is criticised, and the authors conclude that their own previous result is more trustworthy. It agrees much better with estimates derived from the amount of heat produced by the disintegration of radium, the difference being perhaps due, as suggested by Geiger and Werner, to energy liberated in consequence of structural alterations in the nucleus. This energy is not likely to be so large as would be indicated by Geiger and Werner's number.

THE PRODUCTION OF SULPHURETTED HYDROGEN BY FERMENTATION IN THE BLACK SEA.—Six cubic centimetres of hydrogen sulphide per litre has been found at a depth of 2970 metres in the Black Sea, and it has been suggested that this is due to the decomposition of organisms which are brought in by currents from the Mediterranean and killed by the alteration in the salinity. Sulphates in the water would also be reduced, with the formation of hydrogen sulphide. Zelinsky and Brousselovsky ascribed the phenomenon to the action of a definite organism, *Bacterium hydrosulphureum ponticum*, on the sulphate; but Nadson considers this bacterium to be an ordinary putrefactive ferment, *Proteus vulgaris*. Mr. B. Issatchenko, who gives the above particulars in an article in the *Comptes rendus* of the Paris Acad. Sci., June 23, has recently taken part in a voyage of exploration in the Black Sea, and has found a small characteristic vibrion, with all the characteristics of *Microspira aestuarii*, and probably identical with this organism. It grows abundantly under anaerobic conditions, without the presence of any albuminoid substance, in a solution containing salts of organic acids and sulphates, producing 0·3 to 0·5 of hydrogen sulphide per litre. Issatchenko considers it probable that the hydrogen sulphide in the lower layers of the Black Sea is largely due to this organism.

The Scottish Cattle Breeding Conference.

THE student of agriculture now passing through the schools is receiving an introduction to the newer sciences that have their applications in agricultural practice, but from the older generation of stock-breeders the recent advances in these fields of inquiry are completely hidden and, before their conservative indifference towards science can be overcome, much work of an educational nature must be undertaken. It was for the purpose of displaying recent achievements in the field of agricultural physiology that the Scottish Cattle Breeding Conference, held at Edinburgh on July 7-12, was convened. It was intended also to show to the breeder part of the State schemes of research in relation to agriculture in operation.

The Conference was undoubtedly an event of outstanding interest in the history of livestock breeding in Great Britain and can be accounted a success, although, as was anticipated, British breeders did not attend in large numbers. It was not to be expected that the man who regards himself as a successful breeder could easily be attracted by a scheme that had for its object the systematic collection of information that would help to make breeding successful. As the days of the Conference passed it became increasingly clear that there exists a great gulf between the scientific worker and the breeder that cannot easily be bridged. Each speaks a tongue that is foreign to the other, and the outstanding need in British agriculture to-day is the scientifically trained agricultural journalist who shall interpret the work of the man of science to the breeder. The programme was so arranged that full opportunity was given to both to learn each other's language and to see each other's point of view and methods. A great deal of time had to be spent in discussing the very A B C of genetical science, and there can be no doubt that had these hours been available for more advanced matters the Conference would have been more profitable.

The speeches of the chairman of the Board of Agriculture for Scotland, the Lord Provost of Edinburgh, the Secretary of State for Scotland, the president of the Shorthorn Society and of Dr. Robert Wallace, emeritus professor of agriculture in the University of Edinburgh, at the opening session, created just the atmosphere in which the free interchange of experience flourishes, and the stage was set for the business of the five following days.

Early in the proceedings Major E. N. Wentworth, a geneticist of repute and the present head of Armour's (Chicago) Livestock Bureau, outlined the relations between the science of genetics and practical breeding. He explained the reasons why the spectacular advances in the pure science have not been quickly followed by parallel advances in the craft, and why genetical knowledge is not likely to affect, at all profoundly, breeding procedure. The reasons are financial in nature. Genetical knowledge can best be employed in the creation and development of new breeds, but this work is made quite prohibitive because of the expense and the length of time required. It is a matter of the greatest difficulty to displace the already established even with a more satisfactory breed, and almost impossible to overcome tradition.

Major Wentworth mentioned one matter of considerable interest. The American consumer is exhibiting an ever-increasing demand for baby-beef (yearling cattle), whilst the producer, disregarding this demand and certainly fighting a losing battle, is still intent on breeding for increased size. The problem of meeting the demands of the consumer is to be tackled by the geneticist and breeder working in collaboration.

Dr. Chr. Wriedt, of Kristiania, in a paper on the inheritance of abnormal conditions, opened up a subject of profound importance to the livestock industry. During the discussion that followed it was pointed out that any characterisation, detrimental to the individual, which behaves in a mendelian fashion in inheritance is a character in the mendelian sense, and can be eradicated from a stock only by the adoption of mendelian methods of breeding. Already a considerable number of such characters that render the possessor non-viable or more or less imperfect have been recognised. Monstrous calves, deformed lambs, still-births, certain forms of sterility, of blindness, and of deafness, white heifer disease, hermaphroditism, undescended testis, skin defects, and many other conditions, have been shown to be mendelian characterisations, and it can be expected that the list will be considerably augmented when the veterinarian and the breeder recognise that the present-day knowledge of the hereditary mechanism has been gained through the study of the inheritance of similar conditions in the usual laboratory animals. It is probable that a great proportion of the anatomical defects and physiological derangements that are found in cattle will be shown to be mendelian characters.

Prof. L. J. Cole, chief of the Animal Husbandry Division of the U.S. Bureau of Animal Industry, in one of his many papers dealt exhaustively with the vexed question of the effects of inbreeding, maintaining that the harmful effects depend entirely upon the hereditary constitution of the individuals concerned and not upon any pernicious attribute of inbreeding in itself. There is a great deal of evidence which supports this contention, but the unfortunate fact remains that it is not possible for the geneticist to be really helpful in this matter. It is unwise to advise the breeder to undertake inbreeding in order to achieve rapid improvement in his stock, when the records of so many domestic breeds show that the individuals are carrying factors for harmful recessive characters which would quickly be disclosed were inbreeding practised. It is true that by this method of breeding a stock could be purged of its undesirable characters, but it is equally true that during the process the stock might become extinct. In certain cases stockbreeding has become one sustained effort to retain heterozygosity in order that undesirable characters may not be expressed, and the homozygosis that follows inbreeding is the last thing that the breeder desires.

Two papers of great interest which roused great enthusiasm among the breeders were those on the reproductive functions and on the development of the udder in the cow, given by Mr. J. Hammond, of the Cambridge Institute of Research in Animal Nutrition, and these led the way to a discussion on milk-recording which was opened by a paper by Mr. B. A. Sanders, of Cambridge. The breeder was shown clearly how difficult the genetical interpretation of milk records is made by the efforts of the husbandman. Until all variations of extraneous origin are accounted for the genetical basis of milk-yield cannot be begun, and even then it is to be expected that this will prove to be a very complicated multi-factor affair.

There is no doubt that shortly some modified system of advanced registry will be adopted in Great Britain in the recording of milk cattle. Mr. Mackintosh, of the National Institute for Dairying, Reading, helped on this movement considerably by his plea for a uniform system of stating milk and butter-fat records. He pointed out that the present lack of uniformity renders comparative studies impossible, seriously embarrasses the breeding of dairy stock, and denies the overseas buyer those data to which he is entitled. He urged that the lactation period of a cow should be recorded in days; that the date of the next calving and details as to whether a full-time calf had been born should be stated; that the records of the milk-yield should be based on weighings at not more than weekly intervals and should be stated only in pounds; that the records of butter-fat should be based on a sufficient number of samples taken at fairly spaced intervals during the lactation period, and that the total weight of the butter-fat produced should be stated in pounds. The conference unanimously supported Mr. Mackintosh.

The fifth day of the meeting was given over to papers by the breeders, who were asked to define their problems. Most of the difficulties presented were such as are at the present time quite beyond genetical analysis, for they concerned highly improved expensive stock, and in many instances passed far into the realms of veterinary medicine. Nevertheless certain of the breeders' problems are problems no longer, and it was very satisfying to the geneticist to be able to explain away the lesser difficulties which still harass the breeder.

During the whole of the week the discussions were eager and the audience insatiable for information. It was shown quite conclusively that this was to be but the first of many such meetings. Before the next, however, it is to be hoped that the Journal of the Ministry and of the Board of Agriculture for Scotland, and also the series of monographs now being issued by the Ministry, will find their way into the hands of many more of the breeders of Great Britain, and that the geneticist will be co-opted on the councils of the various breed societies. F. A. E. CREW.

The Imperial Mycological Conference.

ON July 2, mycologists from all parts of the British Empire met in conference at the Imperial College of Science, South Kensington. It was the first gathering of its kind, and marks a distinct advance in organising the campaign against fungous diseases of agricultural and plantation crops. The conference was called by the Colonial Office to discuss the future arrangements for the Imperial Bureau of Mycology, but a large part of its time was taken up with interesting and useful discussions on various aspects of plant disease work throughout the Empire. Official delegates represented most of the Dominions, Colonies, and Protectorates, while the members of the Committee of the Bureau attended the meetings, as well as a number of mycologists from the British Isles who were invited to be present. On the afternoon of July 2 the delegates were entertained to tea at the Bureau, and on the evening of July 4 the British Mycological Society acted as hosts at a dinner given to the overseas mycologists in the Criterion Restaurant. The conference had been arranged to precede the Imperial Botanical Conference, which was held the following week, and the delegates had the opportunity of taking part in the meetings and excursions arranged by the latter conference.

Earl Buxton, chairman of the Committee of Management of the Bureau, received the delegates, and in his opening address spoke at length of the founding of the Bureau, the scope of its work, and the economic importance of plant diseases. The rest of this day, as well as the last part of the closing meeting, was spent on business matters.

On Thursday, July 3, under the presidency of Mr. W. Nowell, Assistant Director of Agriculture, Trinidad, Mr. Tattersfield (Rothamsted) opened a discussion on "The Co-ordination of Investigations of Fungicides," expressing the view that the explanations of fungicidal action are, in general, inadequate, and that research should attempt to correlate chemical constitution with toxic action. The subject gave rise to an animated discussion in which Dr. Brierley (Rothamsted), Mr. Dowson (Wisley), Dr. Wormald (East Malling), Mr. Briton-Jones (Long Ashton), Mr. Massey (Sudan), Mr. Nowell, Mr. Summers (Shirley Institute), and Dr. Butler (Bureau) took part, and finally the suggestion, made by Dr. Brierley, that a committee be appointed for the co-ordination of work on fungicides was referred to the Managing Committee of the Bureau for consideration. The second half of this session was occupied with the consideration of "Plant Disease Surveys in the British Empire." Dr. Butler, who introduced the subject, spoke of the many ways in which plant disease surveys are invaluable aids to the phytopathologist. Mr. A. D. Cotton (Kew) described the origin and development of the survey of England and Wales and emphasised the importance of a survey for the agricultural progress of any country. Dr. Shaw (India), Mr. Gadd (Ceylon), and Dr. Doidge (South Africa) reviewed the survey work being done in their respective countries.

In the afternoon, Dr. Pethybridge (Ministry of Agriculture) in the chair, Mr. Cunningham (New Zealand) spoke on "The Standardisation of Popular and Scientific Nomenclature in Plant Pathology." He illustrated the necessity of standardisation by a few well-chosen examples, and showed how the multiplication of common names, especially for those diseases of which the causal organisms are not known, must lead to confusion. The considerable divergence of the scientific names adopted by different workers, as well as their frequent change, is also liable to cause trouble. Mr. Cotton stated that the Phytopathological Committee of the British Mycological Society had undertaken the work of the standardisation of common names in England and enunciated the principles the committee had decided to adopt. Dr. Murphy (Irish Free State) suggested that some understanding with the United States should be reached on the subject. Various speakers mentioned the importance of the popular name in dealing with the farmer.

The next paper was one by Mr. Tunstall, of the Indian Tea Association, on "The Encouragement of Private Enterprise in the Investigation of Plant Diseases." After describing the development of the scientific department of the Association, which had more than satisfied the tea planters with the results obtained, the speaker expressed the view that continuity of the work was essential and the use of highly paid specialists for short periods unsatisfactory. The Government could encourage non-official enterprise by means of grants, and in return should have a call on the services of the enterprise. Dr. Butler spoke of the excellent work being done by private enterprise in various parts of the world, and considered that such enterprise need not clash with Government institutions. Mr. Gadd outlined the rubber research scheme established in Ceylon in conjunction with the Rubber Growers' Association. Col. French (Empire Cotton Growing Corporation) gave an account of the work of the Corporation, and Dr. Pethybridge mentioned the enterprise of the glass house industry near London in this respect.

The morning session on Friday, July 4, when Prof. J. B. Farmer (Imperial College) and later Mr. Stockdale (Ceylon) presided, was occupied wholly with diseases of tropical plantation crops. Dr. Doidge gave an account of the campaign to eradicate from South Africa the canker of citrus trees (*Pseudomonas citri*), which was probably introduced on some Japanese stocks. The cost of the campaign to date was 117,000*l.*, and though it was too early to be sure that the disease was completely stamped out, the results were promising. Various other citrus diseases were briefly reviewed. In the discussion which followed, Mr. Nowell expressed the opinion that the present campaign in South Africa, if successful, would no doubt have a considerable reaction throughout the world. Mr. Massey followed with a paper on "The Cotton Diseases occurring in the Sudan," dealing particularly with the outbreak of *Bacterium malvacearum* in that area. The disease is seed-borne, and the problem of control essentially one of seed disinfection, which is being carried out on a large scale with this year's seed. The discussion was largely concerned with this disease, but Mr. Briton-Jones (formerly mycologist in Egypt) spoke of the diseases occurring in Egypt, and Mr. Summers of the mildewing of cotton fabrics. Prof. S. F. Ashby (Trinidad) was responsible for leading the discussion on "The Panama Disease of Bananas." After an account of the disease and of the very heavy losses caused by it, especially in Central America, the speaker showed that the real solution of the problem of fighting it was the discovery of an immune variety; the work with this end in view, now in progress at the Imperial College of Tropical Agriculture, was described. Mr. Hansford described the position of affairs in Jamaica with regard to this disease. In the afternoon Mr. Bunting spoke on "The Diseases of Cacao in the Gold Coast," mentioning particularly the newly discovered cocoa parasites of that Colony.

A subject of fundamental importance was raised by Mr. Nowell, on Friday afternoon, in his paper on "The Influence of Soil Conditions on Plant Diseases." The speaker put forward the view that many diseases of plants are primarily due to soil conditions and that the fungi are only parasitic when these conditions render the hosts susceptible. Diseases of this nature could be classified as root diseases and debility diseases. Numerous examples were given, particularly root rot of sugar-cane, which has been ascribed to various fungi and which can be completely overcome by good manuring. In the vigorous discussion which followed, Mr. Tunstall strengthened the views advanced by citing additional examples from his experience of tea diseases, and Dr. Shaw spoke of the differences in the incidence of the wilt of pigeon pea on the permanent manurial plots at Pusa in India.

At the closing session of the conference on Saturday, July 5, Mr. Nowell presided, whilst Dr. Shaw and Dr. Murphy addressed the meeting on "The Application of the Results of Mycological Investigations," the former from the point of view of the tropical countries with a native population, and the latter from that of temperate countries with white farmers. Dr. Shaw described the organisation of the agricultural service in India to deal with plant diseases and the methods adopted for conveying information to the cultivator. A full discussion followed, in which Mr. Bunting, Miss Welsford (Zanzibar), Dr. Butler, Dr. Doidge, and Mr. Stockdale took part. The last part of the closing session was occupied with business matters, Sir David Prain being in the chair, and a number of resolutions were passed dealing chiefly with the establishment and finances of the Bureau, and recommending that similar conferences should be held every five years.

University and Educational Intelligence.

CAMBRIDGE.—The Research Studentship offered annually by Trinity College to a graduate of another university who intends to come to Cambridge with a view to the degree of Ph.D. has been awarded to Mr. Joseph Ratner, of Columbia University, and a teacher in the Department of Philosophy at the College of the City of New York, for research in ethics. The Dunning Scholarship, open on this occasion to prospective candidates for the degree of Ph.D., has been awarded to Mr. Lawrence St. Clair Broughall, of University College, London, for research in physics. A Dominion and Colonial Exhibition has been awarded to Mr. J. B. Williams, of McGill University, Montreal.

LEEDS.—Mr. J. R. R. Tolkien has been appointed professor of English Language. He has been Reader in English Language in the University since 1920, and has held several teaching and examining posts at Oxford and elsewhere. The institution, in the English Department of the University, of a separate Chair of English Language, is in accordance with the constitution of corresponding schools at Oxford, Cambridge, Liverpool, Manchester, and elsewhere; and indeed it restores the position which at one time obtained also at Leeds.

Dr. C. E. Gough has been appointed to the Chair of German at the University, which has been in abeyance since 1916.

Dr. S. Brodetsky has been elected the first occupant of the Chair of Applied Mathematics. He graduated as Senior Wrangler at Trinity College, Cambridge, in 1908, held the Isaac Newton Studentship for research in Mathematical Astronomy, and thereafter proceeded to the degree of Doctor of Philosophy at Leipzig. On returning to this country, he joined the mathematical staff of Bristol University in 1914, and came to Leeds in 1919 as Reader in Applied Mathematics. Prof. Brodetsky has produced a long series of papers on many branches of Applied Mathematics, and has devoted special attention to aerodynamics.

LONDON.—Dr. A. W. M. Ellis has been appointed as from October 1, 1924, to the University Chair of Medicine tenable at the London Hospital Medical College.

Dr. E. V. Appleton has been appointed as from August 1, 1924, to the Wheatstone Chair of Physics tenable at King's College. Since 1919 he has been supervisor in physics and mineralogy at St. John's College, Cambridge, of which he is a fellow, and demonstrator and lecturer in the Cavendish Laboratory.

The following doctorates have been awarded, the thesis in each case following the name of the candidate:—*Ph.D.* (*Science*): Mr. J. F. Congdon (King's College), "The Kinetic Energy of the Electrons emitted from a Hot Tungsten Filament in an Atmosphere of (*a*) Argon, (*b*) Hydrogen"; Mr. J. W. C. Crawford (Battersea Polytechnic), "Experiments on the Synthesis of Carnitine"; Mr. A. T. Fuller (Battersea Polytechnic), "Terpineol: its Resolution and Optical Properties, with a Description of some of its Derivatives"; Mr. V. G. Jolly (University College), "Platinocyanides"; Mr. M. A. Matthews (Sir John Cass Technical Institute), "Some Anthracene Derivatives"; Clara Agnes Pratt (Imperial College—Royal College of Science), "Growth Conditions of Fungi"; Mr. H. E. M. Priston (Battersea Polytechnic), "The Alcohols of the Hydroaromatic and Terpene Series: (*a*) Fenchone and the Fenchyl Alcohols, (*b*) The Esters of Borneol and Isoborneol"; Mr. E. J. Weeks (Sir John Cass Technical Institute), "Hydrogen Overpotentials in Alkaline and Neutral

Solutions" ; Mr. W. Clark, " On the Light Sensitivity of Photographic Emulsions" ; Adela Gwendolyn Erith (University College, Reading), " A Monograph on White Clover (*Trifolium repens*, L.)" ; Mr. P. Lewis-Dale, " An Investigation into the Nature of the Compounds occurring in the Liquid obtained when Oil Gas is submitted to Pressure, with Suggestions as to the possible Utilisation of the Liquid" ; Mr. J. N. Sugden (Imperial College—Royal College of Science), " Hydration of Electrolytes and Non-Electrolytes in Aqueous Solution."

MANCHESTER.—The Council has accepted an offer from the brothers and sisters of the late Mr. Philip Buckle, a former student of the University, for the endowment, in his memory, of a scholarship in some branch of Agriculture or Zoology.

The following appointments have been made: Associate professor of applied mathematics (for one year), Dr. T. M. Cherry; Assistant lecturer in engineering, Mr. J. B. M. Hay; Demonstrator in human physiology, Miss Hilda Linford; Demonstrator in experimental physiology, Mr. E. Nevill Willmer.

SHEFFIELD.—Lord Bearsted has made a gift of 10,000*l*. to the department of metallurgy for the encouragement of study and research.

APPLICATIONS are invited for the professorship of pathology in the University of Melbourne. They should reach the Agent-General for Victoria, Melbourne Place, Strand, W.C.2, by September 20 at latest. Particulars of the post may be obtained from the Agent-General.

IN the report for 1923 of the University of Adelaide, it is announced that the original University Act, which provides that a subsidy of 5 per cent. up to 10,000*l*. p.a. shall be paid by the Government on all endowments by private benefactors, has been amended by raising that limit to 20,000*l*. p.a., thus encouraging further donations. The Council has agreed to assist the Medical Sciences Club in meeting the expense of publishing a journal of experimental biology and medical science, which is to serve as a medium for making known the results of researches carried on in this and other universities. Work conducted in connexion with the University's Animal Products Research Foundation included a comparison of the growth of animals initially below the average weight with that of animals initially above the average. The jubilee of the University is to be celebrated in 1926.

COMPLETE reform of the preparatory school curriculum seems yet a long way off. The Board of Education exercises no control over any of these schools, and, with one or two exceptions, is not invited to express an opinion on their efficiency. Preparatory school headmasters form a close corporation influenced mainly by the requirements of the Common Entrance Examination, upon the results of which scholarships to the public schools are awarded. In most preparatory schools science is regarded as an expensive luxury which brings no adequate return in the way of " successes." There are, however, a few progressive headmasters who, greatly daring, put the cause of education first. It is interesting to note that Mr. Seymour Bryant, St. Piran's, Maidenhead, has recently added a new block containing an engineering shop and drawing office, two new well-equipped dark rooms, wireless room, technical library, and music rooms. The list savours of pleasure as well as business, but this is a characteristic of a school in which the tradition of Sanderson of Oundle is followed.

Early Science at the Royal Society.

August 10, 1664. The secretary presented the society from Mr. Beal with a box full of several stones, by which the latter conceived it might be seen what is the process of the plastic spirit in shaping perfect cockles, muscles, scollops, headless serpents, fishes, thunder-stones, etc. Then was begun to be read Mr. Beal's annexed discourse relating to these stones, the rest being referred to another meeting, because Mr. Birchinsha was without, expecting to be called in, for the prosecution of the experiments with the monochord.—

Ordered—That Dr Wilkins be desired to speak to the lord Berkley, that he would please, in the name of the Royal Society, to move the committee of the company for the East Indies, that, by their interest in these parts, they would procure such answers, as may satisfy the inquiries to be sent to them ; as also such particulars of the productions and curiosities of nature, as shall be specified unto them, and such others, as those parts do afford, and they by their industry can inquire for the use of the said society. Moreover, to write . . . to take special care of the transport of such things.

August 13, 1662. It was voted, That the president attended by the council, and as many of the society as can be obtained, should wait upon the King, after his coming from Hampton-Court to London, to give him humble thanks for his grace & favour: and that in the meantime the president should acquaint his majesty with their intention: and that afterwards the lord chancellor be thanked likewise, as also Sir Robert Moray, for his concern and care in promoting the constitution of the society into a corporation.

August 14, 1686. A letter was read describing the manner of transporting the great globes made for the cardinal d'Estrees by father Coronelli, designed to be presented to the French King ; which manner was, that the large carts, in which they were to be carried, were placed upon low wheels, with four axle-trees, that so the wheels might be changed, at the turning of a corner, without altering the position of the case.

August 15, 1666. A letter from Dr Wallis to Mr. Oldenburg, dated at Oxford, was read, importing that whereas he had used to observe in his baroscope, that the sun-shining made the quicksilver to rise, in which the observations of others had concurred ; he had this summer in the hot time of June, July and August observed the mercury constantly to rise in the night and to fall in the day. The President affirmed, that he had generally observed the contrary in his baroscope.—

The contrivance for the experiment appointed to shew, that the circular pendulum was made of two strait lines crossing one another, being fitted, as was suggested at the preceding meeting, it appeared, that the motion from the one end of the greater diameter of the circular pendulum to the same end again was equal to two vibrations of the strait line pendulum, equal in length to the former, and moving in the same plane.

August 16, 1686. A note from Mons. Justel was read, giving an account, that a french ship having lately been at the Cape of Good Hope, had been informed by the Dutch there of an expedition, which they had made towards the tropic of Capricorn ; and that they had there found a nation, which answered their violins with thirty instruments, and among the rest with one, that was a sort of flute, which was made with a slit instead of holes, and a ferrel case that runs up and down upon it, according to the tone intended by it.

Societies and Academies.

LONDON.

Royal Meteorological Society, July 18 (meeting at the Rothamsted Experimental Station, Harpenden).—Mr. C. J. P. Cave, president, in the chair.—R. A. **Fisher**: Adaptation of variety to climate. One of the main problems attacked by the statistical laboratory at Rothamsted in recent years has been to ascertain numerically the effect of weather on the yield of farm crops. The Rothamsted data give the yield of wheat on thirteen plots which have been under uniform manurial treatment since 1851, and rain records from a large gauge set up in 1853. From these series of values it has been possible to evaluate the actual gain or loss of each consequent upon an additional inch of rain at any time during the harvest year. The work has involved a detailed analysis of the distribution of rainfall through the year for each year since 1853, some of the results of which are of interest. The total rainfall fluctuates greatly from year to year, but there is some evidence that the fluctuations are not at haphazard, but that at two periods centred about 1879 and 1914 there has been a prolonged spell of significantly increased rainfall. On the other hand, one feature of the rainfall distribution has shown a steady and apparently uniform change throughout the 70 years. This involves increasingly wet Decembers, and perhaps drier weather in spring and autumn. Data on this point from other stations would be of great interest.—W. B. **Haines**: A comparison of three different types of radiation recorder. This paper deals with a comparison of the readings taken at Rothamsted with three types of radiation recorder. The first of these is a recorder of the Callendar pattern, depending upon the difference in temperature between a black and a bright resistance exposed to the sky. These readings are taken as standard. The second instrument (Wilson integrator) reads the amount of alcohol or other volatile liquid which distils from a bulb exposed to the radiation into a similar shielded bulb. The third set of data is the record of hours of bright sunshine from the widely-used Campbell-Stokes apparatus. Reference is also made to a fourth set of data, that given by an evaporimeter of the porous candle type, since the readings of this instrument are correlated to the amount of radiation. A diagram made by plotting the data to suitably adjusted units brings out the following points:—(1) The alcohol integrator gives readings much too low during the winter months. The readings could be correlated for the effect of temperature upon the vapour pressure of alcohol, but there is a large random error which makes it impracticable to advance a correction formula to deduce the true radiation. (2) The hours of bright sunshine should be corrected by a factor depending upon the time of day and year (*i.e.* upon the sun's altitude). A formula deduced by Ångström from the Stockholm data, for calculating total radiation from hours of bright sunshine, is examined and found fairly satisfactory for the Rothamsted data. It is concluded that such a formula, based upon the data at one station, could with due caution be adopted for another station.

PARIS.

Academy of Sciences, June 30.—M. Guillaume Bigourdan in the chair.—A. **Desgrez**, H. **Bierry**, and L. **Lescœur**: Relation between the variations of P_H of waters containing hydrogen sulphide and their transformations when exposed to the air. The changes observed are due to two phenomena, oxidation of the sulphur causing a reduction in the P_H, and loss of carbon dioxide producing a rise in P_H.—A. **Recoura**: The action of acetic acid on hydrated metallic salts. Acetylated salts. Powdered crystallised copper sulphate, $CuSO_4$, $5H_2O$, treated with a large excess of acetic anhydride loses rapidly four molecules of the water. The fifth molecule fixes one molecule of the anhydride, and it has been proved that acetic acid is not formed. The compound produced is $CuSO_4 . H_2O . [(C_2H_3O)_2O]$. The sulphates of nickel and magnesium form similar compounds.—Alfred **Rosenblatt**: Algebraic varieties of three dimensions, the species of which satisfy the inequality $P_g \leqq (p_g - p_a - 3)$.—R. H. **Germay**: The elimination of the parameters in Cauchy's method of characteristics for the integration of partial differential equations of the first order.—Georges **Giraud**: Two formulæ applicable to the numerical calculation of integrals.—Jacques **Chokhate**: The polynomials of Tchebycheff.—Armand **Cahen**: Classification of the new continued fractions dependent on an operation $R(z)$ to one unit in excess.—E. **Gau**: Conditions that a surface may be ruled by deformation.— —— **Gros**: Finite bending of a circular ring compressed diametrically.—Paul **Dumanois**: Experimental results on increase of compression in aviation motors. In an earlier communication, some results were theoretically deduced concerning the increased explosion pressures and thermal efficiencies of internal combustion motors when an anti-knocking compound, such as lead tetraethyl, was employed. In the present paper experiments are described which confirm the theoretical conclusions. Experiments were also made to determine whether the temperatures developed at the base of the pistons or at the escape valves were so high as to endanger the low melting material now employed.—Louis **Breguet**: The yield of the propulsion of birds by the motions of the wings.—Louis **Roy**: The fundamental equations of electrodynamics of continuous media in motion.—Maurice **Curie**: The photo-electric and phosphorogenic effect.—L. **Riéty**: The electromotive force of filtration.—Charles **Henry**: The calculation of heats of formation and the interpretation of some exceptions to the law of maximum work.—J. J. van **Laar**: The vapour pressure of solid carbon. In a recent communication Wertenstein and Jedrzejewski have given an expression for the vapour pressure of carbon, making use of Langmuir's method (evaporation in a vacuum) and the Knudsen-Langmuir formula. This leads to 5050° C. (absolute) as the boiling-point of carbon. By an independent method the author arrives at 5010° C. (abs.) for the same constant. The figure 4200° C. (abs.) deduced from the measurements of Lummer and of Mlle. Kohn with the positive crater of the arc is certainly too low.—Francis **Perrin**: The role of viscosity in fluorescence phenomena.— —— **Bogitch**: The oxidation of chromite and the preparation of chromates. Experiments on heating chromite with various mixtures of lime and sodium carbonate, calcium and sodium carbonates, lime and common salt, lime and sodium sulphate. The influence of temperature and duration of heating were also studied.—P. **Lebeau**: The thermal fractionation of the gaseous products of the pyrogenic decomposition of some definite compounds. The author has shown that by submitting coal to progressively increasing temperatures, the curve showing the relation between gas yield and temperature is definite and constant for a given fuel. The same method has now been applied to definite compounds (starch, sugar, glucose, casein). The results appear to indicate that the method may be of value in studying organic compounds of high molecular weight.—Ch. **Courtot** and R. **Geoffroy**: The sulphonation of fluorene.—MM. **Maurain, Eblé, Labrouste, Mouronval, and Escher-Desrivières**: The propagation of seismic waves in the neighbourhood of the origin. Experiments made with seismographs installed at La Courtine, Felletin, and Ussel, recording the four experimental explosions at La Courtine.—F. **Diénert**: Subterranean hydrology. Details of technique relating to the use of fluorescin and other dyes in tracing the path of underground waters.—Ladislas **Smolik**: The influence of heat on the total surface offered by the elements of the soil.—L. M. **Bétancès**: What is a hæmohistoblast?—A. **Rochon-Duvigneaud**: Visual lines of the central fovea (independent vision) and the lateral fovea (associated vision) in the kestrel.— —— **de Luna**: The presence of an accessory ovary in *Drosophila melanogaster*.—A. **Lecaillon**: The new races or varieties which can be obtained by the method of crossing in the silkworm.—(Mlle.) Lucienne **Dehorne**: Remarks on the ephippia of *Daphnis longispina*.—W. **Mestrezat** and M. **Janet**: The dispersion of the electrolytic colloids of the protoplasm in relation with the mineral nutrition of the cell.—Maurice **Piettre** and Clément **Roéland**: Trimyristine, the glyceride of milk.—S. **Mutermilch**: Normal and artificial hæmolysins.

July 7.—M. Guillaume Bigourdan in the chair.—H. **Deslandres**: The extension to some line spectra of a property already recognised in several band spectra.—Maurice **de Broglie** and A. **Dauvillier**: Complementary researches on the Compton effect.—L. **Lumière**, A. **Lumière**, and A. **Seyewetz**: Contribution to the study of the latent photographic image. In experiments on the latent photographic image after fixing, a developer consisting of paraphenylene diamine and silver sulphite acting for 48 hours showed a gradual production of particles, which, under a magnification of 2300 diameters, proved to be hexagonal crystals. These crystals were not obtained when the developer was silver sulphite dissolved in sodium sulphite with addition of formaldehyde, but if a plate after exposure, fixing, and washing were treated with an ordinary organic developer, such as diamidophenol, subsequent treatment with the formaldehyde-sulphite of silver both developed the crystals.—B. **Berloty** was elected a correspondent of the Academy for the section of geography and navigation in the place of the late Elie Colin.—Marcel **Légaut**: Systems of points and the theory of skew algebraical curves.—A. **Demoulin**: Surfaces of the Lie quadrics have only two characteristic points.—Paul **Mentré**: The projective deformation of certain congruences of straight lines.—Rolf **Nevanlinna**: The exceptional values of meromorph functions.—Pierre **Jolibois** and Georges **Normand**: The decomposition of lead tetra-ethyl and its application to internal combustion motors. Pure lead tetra-ethyl is decomposed at 400°, producing finely divided lead. In the cylinder of an internal combustion motor, lead tetra-ethyl would be decomposed at all locally heated points covering these with a layer of metallic lead, thus reducing the curvature of any sharp points tending to become centres of auto-explosion.—Pierre **Idrac**: Contributions to the study of the flight of the albatross. An automatic kinematographic apparatus was utilised in this work: it is concluded that, contrary to all hovering birds previously studied, the albatross does not utilise ascending air currents.—Alfred **Lartigue**: The co-ordination of the thermodynamical properties of water.—André **Marcelin**: Extension of the application of the gas law to superficial solutions.—L. **Vegard**: The luminous spectra of solid nitrogen and their application to the aurora borealis and to the diffused light of the sky at night. It is shown that the aurora is probably due to the action of the kathode rays acting upon small crystals of solid nitrogen.—G. **Reboul** and **Bodin**: A new method of production of radiations in the region between the ultra-violet rays and the X-rays. Pastilles of various metallic salts are placed between two electrodes connected to a battery of small secondary cells, the fall of potential across the pastille being variable from 90 to 2430 volts. The radiation emitted is easily absorbed, capable of ionising gases, and has a wave-length between the ultra-violet and the X-rays.—Louis **de Broglie**: The general definition of the correspondence between wave and motion.— —— **Lemarchand**: Equilibrium in saline double decompositions in aqueous solution.—L. **Chassevent**: The thermal phenomena which accompany the setting of plaster of Paris.—A. **Boutaric** and Mlle G. **Perreau**: A protection effect of suspensions realised by the addition of electrolytes in quantities too small to effect flocculation.—P. **Job**: The electrometric study of the hydrolysis of salts.—André **Job** and Guy **Emschwiller**: The photolysis of the organic iodides. The photochemical limit and the linkage energies. Pure ethyl iodide, in a closed system free from oxygen, on exposure to light gives free iodine and a mixture of ethylene (53 per cent.), ethane (36 per cent.), butane (6 per cent.), and hydrogen (5 per cent.). When a tube of ethyl iodide is exposed to the arc spectrum, the reaction commences only for wave-lengths shorter than $0 \cdot 41\ \mu$.—R. **Locquin** and L. **Leers**: Some new pinacolines.—Max and Michel **Polonovski**: Tautomerism of eserine.—Ph. **Négris**: The variation of composition of lavas and the temperature of the pyrosphere.—J. **Thoulet**: Local studies of the circulation of the water in the Atlantic Ocean.—L. **Petitjean**: The application of frontology to the Sahara depressions.—Filippo **Eredia**: The secondary depression of the Adriatic Sea.—Jules **Wolff**: New observations on the loss of the germinating power in the seeds of orchids.—A. **Sartory** and R. **Sartory**: The action of potassium bichromate and copper bichromate on the growth of *Phytophtora infestans*. The copper salt acts more powerfully than the potassium salt in retarding the growth of this organism.—A. **Goris**: The chemical composition of the green fruit of the vanilla and the mode of formation of the perfume of vanilla.—A. **Demolon** and Mlle V. **Dupont**: Some characters of the peat from the chalk valleys of the north of France.—Ch. **Brioux**: Saturation in the soil of sulphuric acid utilised for the destruction of weeds. After this treatment, soils originally acid or containing only small amounts of lime should be limed, or the soil will be left too acid for plant growth.—Louis **Lapicque**: The theory of latent addition.—Boris **Ephrussi**: The segmentation velocities of the egg of the sea-urchin.—F. **Vlès** and A. **de Coulon**: The relations between the state of the organism and the physico-chemical properties of muscular substances.—Jules **Auclair**: The probable cause of the natural immunity of birds towards human tuberculosis and its application to the digestion of the Koch bacillus in the organism of the guinea-pig. A substance has been extracted from the organism of the pigeon, chicken, duck, goose, and turkey which, as extracted, is without action on the Koch bacillus. Under well-defined conditions this substance can be converted into another capable of digesting the tubercle bacillus. No tuberculosis developed in guinea-pigs, if this substance and the Koch bacillus were injected together. No details of the method of extraction, nature of the substance or mode of after-treatment are given.—L. **Hugounenq** and J. **Loiseleur**: The catalytic action exercised by some colloids, more particularly by glycogen, in the hydrolysis of the albumens.

CAPE TOWN.

Royal Society of South Africa, May 21.—Dr. A. Ogg, president, in the chair.—R. F. **Lawrence**: South African spiders. Several genera of South African Thomisidæ illustrate imitations of the calyx, leaves and leaf-axils of flowers and the stems of reeds and grasses. Runciniopsis is much flattened and lies pressed against the stems of grasses, while the straw-coloured form Monoeses has the abdomen elongated into a long cylindrical caudiform process and escapes observation by remaining motionless amongst grass or thin reeds.—F. G. **Cawston**: The smaller South African shells that harbour Cercariæ.—F. E. **Fritsch** and Florence **Rich**: Contributions to our knowledge of the Freshwater Algæ of Africa, V. On a deposit of diatomaceous earth from Ermelo, Transvaal. This deposit occurs as a pan, about half a mile long and 440 yards wide, on the farm Bank-Plaats, and is still being formed. During the wet season, water percolates through the deposit, and living diatoms are found on its surface; in the dry season these mostly die off, and their siliceous valves form the deposit. Seventeen species of diatoms occur in it; one of these is new, and several new varieties are also described and figured.

MELBOURNE.

Royal Society of Victoria, March 13.—Prof. T. H. Laby in the chair.—A. M. **Lea**: On some new Australian Chrysomelidæ.—F. **Chapman** and F. A. **Singleton**: A revision of the Kainozoic species of Glycymeris in Southern Australia. Three new species are here described, namely, *G. gunyoungensis* (Balcombian and Janjukian), *G. ornithopetra* (Janjukian), and *G. planiuscula* (Kalimnan and Werrikooian). An example of the type referred by McCoy to "*Pectunculus*" *laticostatus* shows that two species were represented. The species described by Johnston as "*Pectunculus*" *maccoyi*, from Table Cape, is apparently confined to that locality, and all Victorian records under that name are here referred to other Victorian species. On broad lines the phylogeny of the group in two main series can be traced, linking the early Kainozoic with the living species.—H. **Ashton**: Notes on the Gippsland hairy cicada, *Tittigarcta crinita*, Dist. This insect, unlike the other Cicadidæ, is probably nocturnal, as it flew late in the evening and early in the morning, and was not seen during the day, hiding under bark. The species is not so uncommon as the small series in the various museums would suggest, as on the evidence of the nymphal cases very many must emerge during the season. The specimens were caught close around the Hotel Kosciusko, and are the first recorded from New South Wales.—G. F. **Hill**: Notes on Australian mosquitoes, with descriptions of their early stages.—H. W. **Wilson**: Studies on the transpiration of some Australian plants, with notes on the structure of their leaves. So long as the available water supply was adequate, the transpiration rate increased with the temperature to the limit of the transpiring power of the plant and increased very rapidly when the temperature rose above normal. The highest transpiration rates recorded in grams per sq. metre per hour for the two hottest days of observation were:—*Eucalyptus botryoides*, 750 gm. between 12 and 2 P.M.; *E. cladocalyx*, 640 gm. between 12 and 2 P.M.; *Casuarina Luehmanni*, 525 gm. between 2 and 3 P.M. Strong wind increased the transpiration of such plants as *E. cladocalyx* and *Casuarina Luehmanni*. The acacias were affected very little, while in other species the transpiration was quite disorganised. Stomata were studied in their relations to transpiration. The number per sq. mm. of transpiring surface varied: *Hakea gibbosa* with 70, and *Myoporum insulare* with 80 had the lowest record, while *Casuarina Luehmanni* with 500, *Eugenia Smithii* with 540, and *Veronica Dieffenbachii* with 610 had the highest average records. The highest records of stomata were 1030, 970, and 960 per. sq. mm. on some juvenile leaves of *Eucalyptus globulus* and 740 on some leaves of *E. cladocalyx*. The size of the stomata varied from 52×36 microns (outside measurements) in *Hakea gibbosa*, and 70×65 microns in the adult *E. alpina*, to 18×16 microns on the juvenile leaves of *E. maculata* var. *citridora*. The so-called xerophytic plants of Australia are provided with a high average number of stomata which enables their transpiration rate to respond quickly to changes of temperature and water supply, and they are well protected by their tough outer coverings, in some cases assisted by glands, from injurious loss of water.

SYDNEY.

Linnean Society of New South Wales, April 30.—Mr. R. H. Cambage, president, in the chair.—W. F. **Blakely**: The Loranthaceæ of Australia (Pt. v.). Six species were described as new.—G. H. **Cunningham**: A critical revision of the Australian and New Zealand species of the genus Secotium. Sixteen species are discussed, fourteen of them being confined to Australasia. Five species are described as new.—P. **Brough**: Studies in the Epacridaceæ. i. The life-history of *Styphelia longifolia* (R.Br.). An explanation of the structure and mechanism of dehiscence of the anther is given, and megasporogenesis is described; the micropylar megaspore functions, in place of the usual chalazal one. All three non-functional megaspores persist in an active state until endosperm formation is almost completed. This phenomenon has not previously been recorded in the life-history of the Angiosperm. The persistence of the non-functional megaspores evidently represents the retention of an ancestral condition, but the present-day function seems to be haustorial.—Marguerite **Henry**: A monograph of the freshwater Entomostraca of New South Wales. Pt. iv. Phyllopoda. Nineteen species are given, six of which are described as new, while three others are recorded for the first time from New South Wales and one from Australia.

Official Publications Received.

Uganda Protectorate. Annual Report of the Geological Survey Department for the Year ended 31st December 1923. Pp. 11. (Entebbe, Uganda: Government Printer.)

Canada: Department of Mines. The Mineral Industries of Canada. Compiled by A. H. A. Robinson. (British Empire Exhibition edition, 1924.) Pp. 138. (Ottawa: Government Printing Bureau.)

South African Museum. Guide Leaflet No. 1: Inscriptions left by Early European Navigators on their Way to the East. By L. Péringuey. Pp. 49. (Cape Town.)

New York Zoological Society. Report of the Director of the Aquarium for 1923. Pp. 16. (New York City.)

New York Academy of Sciences. Scientific Survey of Porto Rico and the Virgin Islands. Vol. 5, Part 3: Botany of Porto Rico and the Virgin Islands. Descriptive Flora—Spermatophyta (continued). By N. L. Britton and Percy Wilson. Pp. 317-474. (New York City.) 2 dollars.

Madras Fisheries Department. Administration Report for the Year 1922-23. By James Hornell. (Report No. 1 of 1924, Madras Fisheries Bulletin, Vol. 18.) Pp. 58. (Madras: Government Press.) 10 annas.

South Australia: Department of Mines. Mining Review for the Half-year ended December 31st, 1923. (No. 39.) Pp. 83. (Adelaide: R. E. E. Rogers.)

City and Guilds of London Institute. Report of the Council to the Members of the Institute, 1924. Pp. li+97. (London: Basinghal Street, E.C.2.)

Instituts scientifiques de Buitenzorg "'s Lands Plantentuin." Treubia: Recueil de travaux zoologiques, hydrobiologiques et océanographiques. Vol. 5, livraison 4, avril. Pp. 299-434. (Buitenzorg: Archipel Drukkerij.) 2.50 f.

The Journal of the Royal Anthropological Institute of Great Britain and Ireland. Vol. 54, January to June 1924. Pp. 209+32 plates. (London: 50 Great Russell Street, W.C.1.) 15s. net.

Supplement to NATURE

No. 2858 AUGUST 9, 1924

Prevention of Disease.[1]

By Major-General Sir DAVID BRUCE, K.C.B., F.R.S., A.M.S., President of the British Association.

THIS is the fourth time the British Association for the Advancement of Science has met in Canada—first in 1884 in Montreal, in this city in 1897, and in Winnipeg in 1909. The addresses given on these occasions dealt with the advancement of knowledge in archæology and physics. It is now my privilege, as a member of the medical profession, to address you on the advances made during the same period in our knowledge of disease and our means of coping with and preventing it.

An address on the prevention of disease at first sight does not promise to be a very pleasant subject, but, after all, it is a humane subject, and also a most important subject, as few things can conduce more to human happiness and human efficiency than the advancement of knowledge in the prevention of disease. Think for a moment of the enormous loss of power in a community through sickness. Some little time ago the English Minister of Health, when emphasising the importance of preventive work, said that upwards of 20,000,000 weeks of work were lost every year through sickness, among insured workers in England. In other words, the equivalent of the work of 375,000 people for the whole year had been lost to the State. When to that is added the corresponding figure for the non-insured population you get some idea of the importance of preventive work.

Another way of estimating the value of prevention is in terms of dollars, or pounds, shillings, and pence, and it has lately been calculated that the direct loss in England and Wales from sickness and disability amounts to at least 150,000,000*l*. a year. In the United States, with a much larger population, the loss is put down at 600,000,000*l*.

Another reason why this is an important subject is that medicine in the future must change its strategy, and instead of awaiting attack must assume the offensive. Instead of remaining quietly in the dressing stations and field hospitals waiting for the wounded to pour in, the scientific services must be well forward in the enemy's country, destroying lines of communication, aerodromes, munition factories, and poison-gas centres, so that the main body of the army may march forward in safety.

[1] Inaugural address delivered to the British Association at Toronto on August 6.

It must no longer be said that the man was so sick he had to send for the doctor. The medical practitioner of the future must frequently examine the man while he is apparently well, in order to detect any incipient departure from the normal, and to teach and urge modes of living conformable to the laws of personal health, and the Public Health authorities must see to it that the man's environment is in accordance with scientific teaching. It may be a long time before the change is widely accepted, but already enormous advances have been effected, and it only depends on the intelligence and education of the populations how rapid the future progress will be. Public opinion must be educated to recognise that most diseases are preventable and to say with King Edward VII., "If preventable, why not prevented?"

To our forefathers disease appeared as the work of evil spirits or magicians, or as a visitation of Providence to punish the individual or the community for their sins. It is not my purpose to give a detailed account of the first strivings after a better knowledge of the causes of disease, but it may be said the new era began some few hundred years ago, when it was recognised that certain diseases were contagious. For a long time it was held that this contagion or infection was due to some chemical substance passing from the sick to the healthy, and acting like a ferment; and then, about the middle of last century, the idea gradually grew that microscopic creatures might be the cause.

About this time it had been discovered that the fermentation of grape juice was caused by a living cell and that certain contagious skin-diseases were associated with living fungi. Things were in this position when there appeared on the scene a man whose genius was destined to change the whole aspect of medicine; a man destined to take medicine out of the region of vague speculation and empiricism, and set its feet firmly on new ground as an experimental biological science. I mean the Frenchman, Louis Pasteur. It is from him we date the beginning of the intelligent, purposive prevention of disease. It was he who established the germ theory, and later pointed the way to the immunisation of man and animals, which has since proved so fruitful in measures for the prevention or stamping out of infectious diseases. I need not discuss his life and work further. His name is a household word among all educated and civilised peoples. Every great city should put up a statue to him, to remind the rising generations of one of the greatest benefactors of the human race.

What the change in medicine has been is put into eloquent language by Sir Clifford Allbutt: "At this moment it is revealed that medicine has come to a new birth. What is, then, this new birth, this revolution in medicine? It is nothing less than its enlargement from an art of observation and empiricism to an applied science founded upon research; from a craft of tradition and sagacity to an applied science of analysis and law; from a descriptive code of surface phenomena to the discovery of deeper affinities; from a set of rules and axioms of quality to measurements of quantity."

With one notable exception, the medical profession were not quick to see that Pasteur's discoveries of the nature of fermentation and putrefaction had a message for them. This exception was Joseph Lister, who had been for some years endeavouring to comprehend the cause of sepsis and suppuration, which commonly followed every surgical operation and most serious injuries involving a breach of the skin. When, in 1865, Lister read Pasteur's communication upon fermentation, the bearing of the discovery on the problems which had so earnestly engaged his attention was apparent to him. He inferred that suppuration and hospital gangrene, the causes of which had so far baffled his imagination, were due to microbes introduced from the outside world, from the air, and by instruments and hands of the operator. Remember, this was years before the microbial causation of any disease was established.

To test the correctness of his inference, Lister proceeded to submit all instruments, ligatures, materials for dressings, and everything that was to come directly or indirectly into contact with the wound, the hands of the operator, and the skin of the patient, to treatment with chemical disinfectants. The satisfactory results which followed this practice astonished even Lister, and he spent the rest of his active life in improving and simplifying technical methods of preventing the ingress of microbes to wounds, and in convincing his professional brethren of the truth of the conclusions based on this work of Pasteur.

Infectious Diseases—(A) Bacterial.

As soon as it was recognised that infectious diseases are caused by living germs, a wave of enthusiasm swept through the medical world, and it was not long before the causation of many of the most important of them was discovered. I need not give a full list of these, but at or round about the time of the first meeting of the British Association in Canada the micro-organisms of tuberculosis, typhoid fever, Malta fever, cholera, malaria, diphtheria, tetanus, and others had been discovered and described.

But it must not be assumed from what has been said that all the most important diseases are caused by living germs. Many of the ills that afflict mankind are due to quite other causes—alcoholism, for example, or the deficiency diseases, due to the absence or deficiency in our diet of some substance essential to proper growth and development. Rickets, one of the greatest scourges of industrial communities, is mainly a deficiency disease. It is reported that as many as 50 per cent. of the children in the slums of some of our big cities suffer from the effects of this disease. Then, again, there is the whole series of diseases or conditions due to defective or excessive action of our own internal glands. Added to these, and perhaps the greatest scourge of all, there is the immense amount of chronic ill-health and actual disease caused or promoted by the unhealthy conditions found in our large cities, due to bad housing and overcrowding—the so-called diseases of environment.

Malta Fever.

To return to the infectious diseases. After the living germs or parasites causing them had been isolated, the process of prevention was soon begun. The methods employed were varied, and I may illustrate one of the simplest by relating briefly the history of the prevention of Malta fever, with which I was myself, to some extent, associated. Malta fever is really a widespread disease, although it is called by a local name. It is found all round the Mediterranean, throughout Africa as far south as the Cape Province, in India and China, and even in some parts of America. It was very prevalent in Malta in the old days, and rendered the island one of the most unhealthy of all our foreign military stations. When I arrived in Malta, in 1884, I found that every year, on an average, some 650 soldiers and sailors fell victims to it, and, as each man remained on an average 120 days in hospital, this gave the huge total of about 80,000 days of illness per annum from this fever alone.

The British had held Malta since the beginning of last century, and, although much attention had been given to the fever and its symptoms had been fully described, no advance was made towards its prevention until 1887, when the living germ, the *Micrococcus melitensis*, causing it was discovered. At this time a good deal of work was expended in studying the natural history of the fever and the micrococcus, but all to no purpose. Nothing was discovered to give a clue to any method of prevention. At the Naval Hospital especially everything in the way of prevention was done that could be thought of: the water supply and drainage were thoroughly tested, the walls were scraped and every corner rounded off where dust might lie, immaculate cleanliness reigned; but all these precautions proved useless. Almost every sailor who came into the hospital even for the most trivial complaint took Malta fever, and after a long illness had to be invalided to England.

Things remained in this very unsatisfactory state for seventeen years, until 1904, when the Admiralty and War Office, alarmed at the amount of sickness and invaliding in the Malta garrison, asked the Royal Society of London to undertake the investigation of the fever. This was agreed to, and a Commission was accordingly sent out in the same year and remained at work until 1906. During the first year every likely line of approach was tried. A careful study was made as to how the micrococcus entered the body, how it left the body, its behaviour outside the body, its pathogenic action on various animals; but still no indication of a method of prevention showed itself. Next year, however, in 1905, the problem of prevention was solved, and that by the merest of accidents.

In the previous year experiments had been made with the object of finding out if the goat, among other animals, was susceptible to the disease. The goats in Malta, which supply all the milk, are very much in evidence, as they are driven about in small herds and milked as required at the doors of customers. Several goats had been injected with cultures of the micrococcus, but, as they showed no rise of temperature or any signs whatever of ill-health, they were put aside as being immune or refractory to the disease and nothing more was thought about them.

In the spring of 1905, about six months after these experiments had been made, Dr. Zammit, a Maltese member of the Commission, who had kept one or two of these goats, happened for some reason or other to examine their blood, and found that it clumped or agglutinated the micrococcus. This was strange, and seemed to show that, although the micrococcus had not caused fever or any signs of illness in the goats, it must have lived and multiplied in the tissues of these animals in order to have brought about this change in the blood. This observation led to the re-examination of the immunity of the goat, when the extraordinary discovery was made that about 50 per cent. of the goats in the island were affected by this disease, and that 10 per cent. of them were actually excreting the micrococcus of Malta fever in their milk. Monkeys fed on milk from an affected goat, even for one day, almost invariably took the disease.

Thus the weak link in the chain of causation had been found. The military authorities struck Maltese milk out of the dietary, and replaced it by an imported variety, and from that day to this there has scarcely been a case of Malta fever in the garrison. Malta, from being the most unhealthy of foreign stations, became a health resort, and was in fact used as a sanatorium during the late War. The disease had been blotted out at a single blow. This, then, is one way of preventing an infectious disease; that is to say, by the discovery of the living germ, the study of its natural history, and so to a means of stopping it reaching its victim, man. This is the best way of prevention: shutting the stable door before the horse is stolen.

Typhoid Fever.

There are, however, other ways of preventing bacterial diseases. Let us take, for example, a method widely used in the prevention of typhoid fever. The fundamental and sound way of attacking this disease is by ordinary hygienic measures, especially a good water supply and good drainage. It is therefore one of the first duties of those in power to see that their people have, in addition to houses with plenty of light and air, a good water supply and a good drainage system, and money cannot be spent to better advantage than in the attainment of these three essentials to health.

When typhoid fever is rife in a community, it means that there is either a contaminated water supply or a faulty drainage system, and the municipal authorities ought to be called to account. In England, owing to improved sanitation, cases of typhoid fever are fifteen times less than they were fifty years ago.

It is not always possible to ensure good hygienic surroundings—for example, among troops on active service. It is therefore legitimate under certain conditions, and especially in time of war, to practise a less sound, a less fundamental, method of prevention, and this second method is known as inoculation or vaccination. In order to understand how this acts, let us consider, for a moment, what takes place in a man's body when he is attacked by the typhoid bacillus. Everybody knows that the bacillus gives rise to poisons or toxins which cause the fever and other symptoms. But the cells and tissues of the man are not passive under the attack. They at once begin to fight against the infection, by forming substances in the blood to neutralise these toxins, hence called antitoxins or antibodies, and their function is finally to destroy the invading germs. If the man recovers, he is immune from a further attack by the presence of these antibodies in his blood. He has become immune by passing through an attack of the disease.

This is the foundation of the second way of preventing infectious diseases. Speaking broadly, it means that you subject a man to a mild attack of the fever in order that his blood and tissues will respond to the stimulus by producing antibodies. This method takes its origin and name from that of vaccination against smallpox. Jenner solved that problem by the accidental discovery of vaccinia, a form of smallpox attenuated or weakened by passage through another species of animal. This weakening of the virulence of a micro-organism by passage through another kind of animal is by no means uncommon in Nature.

Pasteur, following on these lines, conceived the idea of weakening or attenuating the virulence of the living bacilli by artificial means, so as to give rise to a mild attack of the disease, and in this way to render animals immune. This he did with marked success in anthrax and chicken cholera.

The next forward step in this method of preventing disease was made by Haffkine, a pupil of Pasteur, who about the year 1894 produced a vaccine against cholera, and a few years later another against plague. In the course of this work it was discovered that it was not necessary to use living cultures of the bacilli, but that vaccines made up of dead bacilli had much the same effect. This substitution of the dead bacilli for the living was a great advance in the method, being much simpler and much safer.

The next disease to be attacked by this method was typhoid fever. This was initiated by Sir Almroth Wright at the British Army Medical School, and carried out with that investigator's characteristic ability and energy. The method was mainly directed in the first place to lessen the mortality from this disease among our soldiers serving in India. After several years' experience, the mode of inoculation which was finally settled on was to give two injections of dead typhoid bacilli, one of 500 millions, and a second, at an interval of ten days, of a thousand millions.

Now let us see what effect anti-typhoid inoculation has had on the prevention of typhoid fever among our soldiers in the field. In the South African War, at the beginning of the century, before the method had been developed, in an army the average strength of which was only 208,000, there were 58,000 cases of typhoid fever and 8000 deaths. In the Great War, on the Western Front, with an average British strength of one and a quarter millions, there were only 7500 cases and 266 deaths. In other words, there were fewer cases of the disease in this War than there were deaths in the South African.

It is also interesting to learn from French sources that at the beginning of the War the French soldiers were not inoculated, whereas the British were. The result for the first sixteen months was striking. During this time the French had some 96,000 cases, with nearly 12,000 deaths. The British had only 2689 cases and 170 deaths. Afterwards the French soldiers were very thoroughly vaccinated, with the result that their immunity eventually became as striking as our own.

What the number of cases and death-rate from typhoid fever might have been in the huge armies fighting on the different fronts had it not been for this preventive inoculation it is impossible to say, but undoubtedly the suffering and loss of life would have been enormous. I may therefore conclude this account of anti-typhoid inoculation by saying that it certainly constituted one of the greatest triumphs in the prevention of disease during the recent War.

Tetanus and Diphtheria.

I shall now pass on to consider a third method of preventing bacterial diseases which has also been evolved during the time under review; that is, by the injection of specially prepared blood sera. These are known as antitoxic sera, and the most familiar examples are anti-tetanic and anti-diphtheritic.

We have seen how the injection of living or dead bacilli or their toxins into animals gives rise to the production of antibodies or antitoxins. The blood serum of such animals in virtue of the antibodies contained in it can be used to combat disease. Let us take in the first place the case of tetanus, until recently considered to be one of the most fatal of maladies, at least 85 per cent. of the cases succumbing. As you are aware, anti-tetanic serum is prepared by injecting horses with large quantities of tetanus toxin. When the blood is as full as possible of antibodies, it is drawn off and the serum allowed to separate out.

The idea lying behind this third method of preventing disease is to pour in these ready-made antitoxins in order to assist the body in its first struggle with the invading disease, and give it, as it were, a breathing space to prepare its own defences. Naturally the immunity produced by these antitoxic sera is of a passive nature and of short duration, as compared with that produced by the disease itself, or even by the milder form brought about by vaccination or inoculation. Anti-typhoid inoculation will protect a soldier for, let us say, two years; anti-tetanic serum will protect for only a week or ten days. It is therefore impossible to inoculate a whole army against tetanus. It is necessary to wait until there is a danger of the disease occurring.

To illustrate this I shall describe briefly the history of the prevention of tetanus during the Great War. When the British Expeditionary Force went over to France in August 1914, only a small quantity of anti-tetanic serum was taken, and that for the purpose of treatment rather than prevention. But shortly after the outbreak of hostilities, the number of cases of tetanus among the wounded became so alarming that no time was lost in grappling with the danger. Large quantities of serum were hurried to the front, and some two months after the beginning of the War it was possible to make an order that every wounded man should receive an injection of anti-tetanic serum as soon after he was wounded as possible. Later on, after further experience had been gained, the single injection was increased to four, given at intervals of a week. This helped the wounded man over the dangerous time, and the results were very successful.

In August and September 1914, before the prophylactic injection was given, roughly speaking, nine or ten out of every thousand wounded were attacked by tetanus, and some 85 per cent. of these died. After the anti-tetanic injections had been introduced, the incidence fell to little more than one per thousand, and the mortality to less than half. To put the matter broadly: during the War there were 2500 cases of tetanus in the British Army, with 550 deaths. If there had been no prophylactic injection of anti-tetanic serum, there would probably have been 25,000 cases with 20,000 deaths—a very striking example of the recent development in the prevention of disease.

Another very important and widespread disease, somewhat resembling tetanus, is diphtheria, and there is no better example of the advance of science in methods of cure and prevention than is found in this disease. Thanks to the work of Klebs and Löffler in the early 'eighties and, some years later, to the brilliant researches of Roux and Yersin, the causation and natural history of this disease were very thoroughly elucidated. Anti-diphtheritic serum is prepared much in the same way as the anti-tetanic. By the repeated injections of gradually increasing doses of the bacilli or their toxins, a serum is produced which has a marked curative effect in cases of diphtheria. It is stated that the introduction of anti-diphtheritic serum in 1894 has reduced the death-rate from 40 to 10 per cent., and if used on the first day of the disease to almost *nil*.

The serum is essentially a curative agent and is useful only to a limited extent in prevention. But lately essentially preventive measures in diphtheria have come into vogue. The procedure employed is to bring about an active immunisation by a mixture of toxin and antitoxin in individuals who have been shown to be susceptible to the disease by what is known as the Schick test. In the United States, a campaign on these lines has been begun against this disease which promises brilliant results. It is confidently stated that by their new measures there is a possibility of robbing diphtheria of all its powers to kill or injure.

The mode of prevention of these diseases—Malta fever, typhoid fever, and tetanus—illustrates the three principal methods of preventing bacterial diseases: in Malta fever, by getting down to bed-rock and stopping the disease at its source; in typhoid fever, by giving, as it were, a mild attack of the disease, by vaccination or inoculation, so as to bring about a greater power of resistance; in tetanus, by pouring in antitoxins, already prepared in the serum of another animal, in order that they may neutralise the toxins of the invading bacilli as soon as they are formed.

Tuberculosis.

There are other important bacterial diseases, however, which cannot be attacked so simply. For example, there is tuberculosis, a disease distributed over the whole world and one of the greatest scourges of civilised communities. It is a disease which has been known from time immemorial, but it is only within our own time that the bacterial cause has been recognised. I can well remember a day in 1882 when I met a fellow student who had just returned to Edinburgh from Germany. He told me that it had been recently discovered that the disease was really caused by a living germ, the tubercle bacillus. It was difficult at first to believe such a revolutionary idea, but such was the interest and excitement raised that many workers at once took up the study of the subject, and in a short time the truth of Koch's great discovery was fully proved. This was a magnificent example of research work, most admirably, carefully, and completely carried out, and placed Koch at once in the front rank of scientific workers.

Before Koch's discovery a good deal had been done in the way of prevention. Before all things, this disease is a disease of environment. Its birthplace and home is the sunless, ill-ventilated, overcrowded room. The late Prof. Edmund Parkes, Professor of Hygiene at the Army Medical School, reduced to a great extent the incidence of tuberculosis in the British Army by procuring for the soldier more floor-space and more air-space in his barracks. It is related of General von Moltke that when he heard of the death of Parkes he said that every regiment in Europe should parade on the day of his funeral and present arms in honour of one of the greatest friends the soldier ever had.

The prevention of tuberculosis is thus seen to depend fundamentally on the provision of a better environment and the education of the people in physiological living. To attain this in the older civilisations will be a hard task, entailing enormous expenditure of money and energy. In the Report of the Royal Commission on the Housing of the Industrial Population of Scotland in 1917 is described the unsatisfactory sites of houses and villages, insufficient supplies of water, unsatisfactory provision for drainage, the gross overcrowding in the congested industrial towns, occupation of one-room houses by large families, groups of lightless and unventilated houses in the older burghs, clotted masses of slums in the great cities—a terrible picture, the heritage of the age of ignorance, internal strife, and walled towns.

The people of new countries should see to it, and doubtless will see to it, that these old evils are not perpetuated. As Sir Robert Philip, Professor of Tuberculosis in the University of Edinburgh, has eloquently said: "Were it possible to begin afresh the scheme of civilised life, were it possible to undertake anew the creation of cities and the homes of our people, were it possible to place within the recreated dwellings an understanding race, detuberculisation might be quickly attained. What a magnificent opportunity for the builders of the new cities, the moulders of fresh civilisations, with the grand purpose of 'No tuberculosis.' The architect, the sanitarian, and the citizen would agree in insisting that physiological laws should be paramount, that there should be effective obedience to the larger demands of hygiene in the home, the school, the workshop, the meeting-place and the cowshed. Mankind was born into air and sunlight: these are his natural heritage. They are more—they are the irreducible conditions of life."

In regard to the tubercle bacillus it is so widespread, so ubiquitous in civilised communities, passing from one infected host to infect another, that it would seem impossible under existing conditions to prevent its spread. At present it is taught, and on what seems good evidence, that the majority of the population of our crowded cities has at one time or another been attacked by this disease. But in every hundred men who die in England, only about ten die of tuberculosis, which shows that a large percentage of the population successfully resists the tubercle bacillus. When this occurs it means that the person attacked possessed powers of resistance which enabled him either to destroy the invading bacilli or deal with them so as to render them harmless.

A point of importance in this connexion is that it has recently been demonstrated that the disease is usually acquired in childhood. The fact is of capital significance, for if the disease is recognised sufficiently early, and the child is placed under good hygienic conditions, there is a very good chance of effective resistance and immunity against a second attack being set up. The present evidence goes to show that the presence of latent tubercle prevents a second invasion. If further outbreaks take place, they would seem to be due to a flaring up of the old latent tubercle rather than to a fresh infection. Metchnikoff studied the question in a remote part of Siberia where the tubercle bacillus was unknown. He states that very many of the young men and women who migrated from this clean country into the big cities died of acute and rapid tuberculosis, on account of not having been exposed to infection in their childhood.

The experience of Colonial troops in the late War is instructive. Thus, in France the Senegalese, who are almost without tuberculosis in their native condition, and were found to be free from tuberculosis on reaching France, developed in large numbers an acute and fatal form of tuberculosis in spite of the hygienic measures enforced by the Army authorities. This raises a curious point. If it were possible for any country to clear itself of the tubercle bacillus, it would appear to be incurring a great risk for an inhabitant to migrate into any neighbouring country. But, in spite of this, it is the duty of medical men to keep in check, as far as possible, the ravages of the disease.

The preventive measures against tuberculosis at the present time are, in the first place, improvement in the general hygienic conditions. Thereby individual resistance—and communal resistance—can be remarkably increased. In the second place, as every case of tuberculosis must arise from a previous case, either human or bovine, it is very necessary that methods of early diagnosis, preventive treatment, and segregation of the more infective types should be employed. This is done by the setting up of tuberculosis dispensaries, care committees, sanatoria, hospitals and colonies. These several elements are combined in the model Tuberculosis Scheme which is now universal throughout Great Britain. In the third place, much can be done to anticipate and limit the progress of infection by the use of tuberculin, but caution is required in assessing the claims, sometimes hasty and extravagant, advanced by adventurers in this field of research.

Many other points might be brought forward, but the subject is such a vast one that I must content myself with directing attention to the importance of a sound milk supply. The contamination of our home herds with tuberculosis is so great that no pains should be spared to secure a safe milk supply, and I understand that the city of Toronto is a model in this respect.

The result of these methods of prevention against tuberculosis may be given briefly. Sir Robert Philip writes that in Scotland ten years before Koch's discovery the death-rate from this disease was 404 per 100,000; in 1920 it had fallen to 124 per 100,000, a fall of 69·3 per cent. He also points out that the "recent acceleration of rate of reduction which is noticeable in England and Scotland is of arresting interest. In Scotland the acceleration of fall in the mortality rate likewise arrests attention. Thus, during twenty years up to 1890, the percentage fall in mortality from all forms of tuberculosis was 35, while during twenty years from 1900 to 1919 the percentage fall was 45."

This is very satisfactory, and has only been arrived at by hard work on the part of medical men, nurses, and voluntary workers. Any tuberculosis scheme, however perfect in theory, will require untiring energy, patience, and perseverance to bear fruit. On this side of the Atlantic, in the United States, these anti-tuberculosis schemes have been pursued with enthusiasm, with the result that Washington in 1920 had a death-rate, from all forms of tuberculosis for 100,000 of the population, of only 85, Chicago 97, and New York 126. London in the same year had a death-rate of 127, practically the same as New York. Other nations have not been so energetic in preventive measures, Vienna having in 1920 a death-rate of 405, and Paris 279 per 100,000 from the same cause.

It is evidently the duty of every nation to take up arms against a disease which exacts such a terrible toll of death, suffering, and inefficiency. If this were done with energy and enthusiasm it is not too much to hope that in a few generations the tubercle bacillus would be practically brought under control, and with it many other malign influences.

Infectious Diseases—(B) Protozoal.

I shall now pass on to the consideration of the second great group of infectious diseases, the Protozoal, and consider what methods of prevention have been found applicable to them.

The scientific study of the protozoal diseases of man may be said to have begun with the epoch-making discovery of the malaria parasites in 1880 by the illustrious Frenchman, Laveran; next, in 1893, the discovery by Theobald Smith and Kilborne of the cause of Texas fever and the part played in its dissemination by the cattle-tick; in 1894 the discovery of the trypanosome of nagana and its intermediate insect host the tsetse-fly; in 1898 the working out of the development of the malaria parasite of birds in the mosquito by Ronald Ross, greatly aided and abetted in the work by Patrick Manson, which led, through the work of Grassi and his fellow-workers in Italy, to the final solution of the malaria problem. A year later the important discovery of the mosquito carrier of yellow fever was made by the American Army Commission, under the directorship of Reed, and in 1903 Leishman announced his discovery of the protozoal cause of kala-azar.

These protozoal diseases are world-wide, like the bacterial, but it is in the warmer climates that their effect is most felt. The great plagues of the tropics, such as malaria, amœbic dysentery, kala-azar, and sleeping sickness among men, Texas fever, tsetse-fly disease, and others among domestic animals, are caused by minute microscopical animal parasites. Large tracts of country have been and are still rendered uninhabitable to white settlers by their presence. The opening up of Africa, for example, was rendered difficult by the tsetse-fly, before the advent of railways. No sooner had an expedition started for the interior than the fly attacked the cattle transport, and before long the expedition had to make its way back as best it could to its base on the coast. The only way to get into the country was on foot with native porters.

The protozoal diseases of domestic animals have also led to enormous loss in all parts of the world. Texas fever, or red-water, has swept whole countries of their cattle. After the Boer War, South Africa was devastated by the introduction of East Coast fever, another protozoal disease of cattle closely related to Texas fever. How is the prevention of these diseases to be brought about? We find that up to the present little can be done by way of vaccination or inoculation or by the use of anti-sera as in the bacterial diseases. On studying the natural history of these protozoal parasites, however, it is found that many of them depend on an intermediate insect host for their continued existence, and it is by taking advantage of this characteristic that methods of prevention can be devised. To illustrate this I might cite the classical examples of malaria and yellow fever, but, as these must be familiar to you all, I shall take instead the trypanosome diseases of Africa, the best known of which are sleeping sickness in man and nagana or tsetse-fly disease in the domestic animals.

Nagana or Tsetse-fly Disease.

In 1894, a year after Theobald Smith and Kilborne had published their famous monograph on Texas fever, a severe epidemic among native cattle in the north of Zululand was reported to the Natal Government. The disease was called nagana by the natives, and it is curious that there was no suspicion at the time that it had any connexion with the tsetse-fly. At this time a very enlightened administrator, the late Sir Walter Hely-Hutchinson, was Governor of Natal and Zululand, and it was due to him that the investigation of the cause of the Zululand outbreak was at once undertaken. As I happened to be stationed in Natal at this time I was chosen to undertake the work, and at once started on the long journey, mostly by ox-wagon, to the scene of the outbreak.

On examination of the blood of the nagana cattle, a minute active flagellated protozoal parasite, belonging to the genus Trypanosoma, was discovered, and after many experiments on dogs, horses, and cattle it was decided that in all probability it was the cause of the disease. Trypanosomes had previously been described in the blood of rats and horses in India by Timothy Lewis and Griffith Evans, but nothing was known as to the mode of their transmission from animal to animal.

It seemed as if the discovery of the nagana trypanosome would have ended the investigation in Zululand without any means of preventing the disease being discovered, but another observation made at this time threw more light on the subject. In the low country, between the high ground on which the nagana camp was situated and the sea, there happened to be a so-called "Fly belt." Every schoolboy had read about the tsetse-fly in books of travellers and hunters, especially in those by the most famous of them all, David Livingstone the missionary, and out of curiosity I decided to find out what happened when an animal was bitten by the fly, or, as it was termed, fly-struck. Natives were therefore sent with cattle and dogs into this "fly country," with orders to form a camp and expose the animals to the bites of the fly. This was done, and it was with great surprise that on their return to the hill the blood of these fly-struck animals was found to contain the same parasite as that found in the nagana cattle.

Nagana and tsetse-fly disease were finally proved to be identical. The tsetse-fly disease was shown to be caused, not, as had been believed, by the poisonous bite of the fly, but by the transference of a protozoal parasite from the fly to the animal in the act of sucking blood. Now the question arose as to where the fly found the parasite. As the tsetse-flies constantly lived among and fed on wild game, such as buffalo and antelope, these animals were suspected. Their blood was examined, and before long it became evident that the wild animals acted as the reservoir of the disease, the trypanosomes living in their blood as harmless parasites. When the tsetse-fly fed on blood containing the trypanosome it became infected, and was capable by its bite of giving rise to a fatal disease in cattle, horses, or dogs; whereas if it fed on a wild animal nothing happened, as the wild game are immune to the disease, much in the same way as the goat is immune to Malta fever.

Now that the natural history of the disease had been so far worked out it was evident that its prevention might be attempted. This can be done in any of three ways: by getting rid of the wild game, the reservoir; or by getting rid of the fly, the vector or carrier; or, lastly, by removing the cattle, horses, and dogs to a safe distance from the "fly country." This work on nagana led later, in 1903, to the discovery of the cause and mode of prevention of sleeping sickness.

Sleeping Sickness.

About the beginning of the century an epidemic of this disease raged round the shores of Lake Victoria in Central Africa. It had been introduced into Uganda from the West Coast, where it had been known for many years as a curious and unaccountable disease. It was observed that although the disease spread in a West African village from man to man apparently by contact, no such thing occurred among natives exiled from their homes. The disease never spread if introduced into native compounds in the West Indies or America, however closely the slaves might be herded together. The disease remained shrouded in mystery, and nothing had been done in the way of prevention, until the matter was taken up by the Royal Society of London in 1902 and a Commission sent out to investigate. It is not necessary to go into details; suffice it to say that after one or two false starts the Commission in 1903 came to the conclusion that the disease was caused, as in nagana, by a species of trypanosome.

The question of the distribution of sleeping sickness in Uganda was then taken up. This disclosed the remarkable fact that the disease was restricted to the numerous islands in the northern part of the lake and to a narrow belt of country skirting the shores of the lake. In no part of Uganda were cases found more than a few miles from the lake shore. The next important step in the working out of the etiology was made when it was shown that the distribution of the disease was identical with the distribution of the common tsetse-fly of the country, *Glossina palpalis.* Where there was no fly there was no sleeping sickness.

The problem was now solved. The epidemic could be stopped either by getting rid of the fly or by removing the natives out of the fly area. As the destruction of the fly was impracticable under the circumstances, the second method was decided on. The natives were moved from the islands and lake shore and placed on healthy inland sites, and the epidemic, which had cost the Protectorate some 200,000 lives, speedily came to an end.

This method of preventing disease, by removing man out of the zone of danger, is an extravagant one, and can only be done in exceptional circumstances. In Uganda the native population could be easily moved, but it meant that from about 1910 until the present day some of the most fertile land in Uganda has been lying derelict, has returned to the primitive jungle. The War delayed things, of course, but it is only now that the natives are being returned to their old homes on the islands and lake shore, in the hope that the fly by this time has lost its infectivity.

The other method, by the destruction of the tsetse-fly, has been carried out successfully in other places. For example, in the island of Principe, off the West Coast of Africa, by destroying the wild animals which supplied a large part of the food of the fly and by clearing the jungle, the tsetse-flies disappeared, and with them the disease. This is the method employed in malaria and yellow fever. It was by destroying the mosquito carrier that Gorgas drove yellow fever out of Havana and, later, both malaria and yellow fever from the Panama Canal zone. Thus through the work of Manson, Laveran, Ross, Reed, and others has it been made possible to deal with these two scourges of the tropics, malaria and yellow fever. I include yellow fever among the protozoal diseases, although Noguchi in 1919 brought forward strong evidence that it is caused by a spirochæte.

In regard to yellow fever the victory has been almost won. During the last century this disease, known as "yellow jack," devastated the West Indies and Central and South America. At the present time, thanks chiefly to the unremitting efforts of the late General Gorgas and the International Health Board of the Rockefeller Foundation, the disease has been driven out of the West Indies and Central America, and only retains a precarious foothold in Colombia and Brazil, whence it will doubtless be ejected during the next year or two.

One of the best examples of the prevention of disease is the attack made on yellow fever in Rio de Janeiro, the capital of Brazil, by the well-known man of science, Dr. Oswaldo Cruz, with the result that the annual deaths in the city from yellow fever fell from 984 in 1902 to 0 in 1909. This brilliant result was brought about by the destruction of the Stegomyia mosquito, the intermediate insect host in yellow fever.

So also in the case of malaria. A dozen years ago, based on the experience gained by Ross on the West Coast of Africa and Ismailia and by Watson in the Federated Malay States, the method of prevention by mosquito control and drainage has been so perfected that the practical blotting out of malaria from a given locality is now merely a matter of expense. A great deal of work has been done during the last few years in the way of experiment in the United States, and Vincent, the President of the Rockefeller Foundation, lately stated that there is evidence that "under normal conditions an average community can practically rid itself of malaria at a *per capita* cost of from 45 cents to $1 per year."

This is an altogether inadequate account of the methods of preventing these highly important protozoal diseases. From the few examples given it will be seen that they are most rampant in warm climates, that they are as a rule conveyed from the sick to the healthy by an insect intermediary, and that it is by an attack on this insect, be it mosquito, tsetse-fly, or tick, that the best chance of success in prevention lies.

Infectious Diseases—(C) Undetermined Group.

In addition to the bacterial and protozoal infectious diseases, there is a third and large class, known as the "undetermined group," in which the parasite is either unknown or doubtful. Many of these undetermined diseases are very common and familiar, such as influenza, measles, scarlet fever, smallpox, typhus fever, trench fever, dengue fever, and sand-fly fever; among animals, rabies, rinderpest, foot-and-mouth disease, and African horse-sickness. The theory generally held at present in regard to most diseases included in this group is that the living germs causing them are ultra-microscopical, in at least some part of their life history, and this is strengthened by the fact that many of them pass through porcelain filters, which keep back the smallest of the visible bacteria. Hence the name "filter-passers."

Many of these undetermined diseases are highly infectious and appear to infect at a distance through the air, as, for example, in influenza, scarlet fever, and smallpox. In some of them there is no attempt made at prevention, except that the sick are isolated and placed under quarantine for a longer or shorter period. But in others there are well-known methods of prevention even when the virus is quite unknown. The best example is smallpox, the ravages of which have been completely held in check since the memorable discovery of Jenner. As has already been argued, this method of prevention, by inducing a mild or attenuated form of the disease, is at best a clumsy one, and when the natural history of the smallpox virus is better known it may be hoped that a more fundamental method of preventing this disease may be discovered. In the meantime the best means at our disposal is by the use of vaccine lymph, and people should recognise their responsibility to the community if through ignorance or selfishness they refuse to have their children vaccinated.

Another well-known disease with an unknown virus, rabies or hydrophobia, has also, by the genius and intuition of Pasteur, been robbed of many of its terrors. The mortality following bites of rabid animals has fallen from 16 per cent. to less than 1 per cent. But in rabies, when the conditions are favourable, the radical method is to drive the disease altogether out of the country by the careful administration of muzzling and quarantine laws. This was carried out successfully in England at the beginning of the century.

Trench Fever.

There are among the diseases of undetermined origin a few which are slowly emerging from the unknown into the known. One of the most interesting of these is trench fever, which came into great prominence during the War. The history of the investigation of this fever is interesting, and well illustrates the method of studying a disease with a view to its prevention. Before the War trench fever was unknown, though there is some evidence that it had been recognised at an earlier date in Poland and called Wolhynia fever. Be that as it may, it is quite certain that, though it was unknown on the Western Front at the beginning of the War, it is no exaggeration to say that it became one of the most powerful factors in reducing our man-power, probably more than a million cases occurring among the Allies on the Western Front. In 1917 in the Second British Army alone, out of a total of 106,000 admissions to hospital at least 20,000 of the cases were trench fever.

Although this fever has well-marked characteristics of its own, such as a peculiar type of temperature curve, and other symptoms, yet for a long time it was unrecognised as a separate entity, and remained mixed up with other diseases, such as typhoid fever, malaria, and rheumatism. In 1916 MacNee, Renshaw, and Brunt in France made the first definite advance by showing that the blood of trench-fever cases was infective. They succeeded in transferring the disease to healthy men by the injection of the blood. The most careful microscopic examination of the blood corpuscles and lymph failed, however, to reveal any living germ. Nothing more was done until the following year, when the British War Office took the matter up seriously and formed a committee for the purpose of investigating the disease.

The United States of America, on coming into the War, at once recognised the importance of trench fever, and without delay also undertook its investigation. In October 1917, at the first meeting of the Medical Research Committee of the American Red Cross in Paris, Major R. P. Strong recommended that a research into trench fever should be undertaken. He stated that, after several months' study of the problems relating to the prevention of infectious diseases occurring in the Allied Armies on the Western Front, it became evident that the subject of the method of transmission of trench fever was one of the most important for investigation in connexion with the loss of man-power in the fighting forces.

At the next meeting, in November 1917, this was agreed to, and a Trench Fever Committee, under the chairmanship of Major Strong, was formed. The research was organised, and experiments begun on February 4, 1918. In less than six months the investigation was completed and the report in the hands of the printer. This is a striking example of research work which, if carried out at the beginning of the War instead of at the end, might have saved the Allied Armies hundreds of thousands of cases of disease, which, although never fatal, were often of long duration and led to much invaliding.

The most important result of the work of these two committees was that it was amply proved that the louse, and the louse alone, was responsible for the spreading of the disease. This discovery meant that in a short time trench fever would have disappeared from our armies on the Western Front. Just as the elimination of goat's milk blotted out Malta fever, the elimination of the mosquito malaria and yellow fever, so would the elimination of the louse have completely blotted out trench fever. This method of prevention, by the destruction of the louse, although doubtless requiring careful organisation and energy in carrying out, was shown before the end of the War to be a perfectly practicable proposition, and there can be little doubt that, if the War had lasted much longer, trench fever, like tetanus, would have practically disappeared.

Besides the main discovery from the preventive point of view that the louse is the carrier, there are many other points of interest in the natural history of trench fever. The living germ causing it has never been recognised in the human blood or tissues, probably on account of its extreme minuteness, and its consequent liability to confusion with other small granules. But when the louse sucks blood from a trench-fever case there is apparently a great multiplication and development of the supposed micro-organism. In five to nine days the louse becomes infective, and there is seen in the stomach and intestines enormous numbers of very minute bodies. What the exact nature of these bodies is, is unknown, but there can be little doubt that they are the infecting agents by which the louse passes on the disease. They pass out in countless numbers in the droppings or excreta of the louse, and it is to these bodies in the excreta that infection is due. The louse seldom if ever gives rise to the disease in the act of biting. It is the infective excreta thrown out on the skin which causes the infection. The micro-organisms or so-called Rickettsia bodies contained in the excreta find their way into the blood through abrasions or scratches, and so give rise to the fever.

From what has been said it will be seen that trench fever is an interesting disease. It also explains why it disappears in times of peace. As soon as the War was ended, and our men could leave the trenches and resume their normal habits, the disease disappeared. The louse was eliminated and the trench fever with it.

Typhus Fever.

Another disease of the undetermined group closely related to trench fever and also carried by the louse is typhus fever, one more of the furies following on the heels of war. The French and British Armies escaped this scourge to a great extent, but some of the other countries, such as Serbia, Bulgaria, and Poland, were not so fortunate. It is stated that 120,000 Serbians died of this disease during the War, and it was only after vigorous steps had been taken in sanitary measures directed against the louse that the epidemic was got in hand.

After the long, exhausting Napoleonic wars, with the resulting poverty and destitution, typhus fever was prevalent in Great Britain and Ireland. About the middle of the century the improved economic conditions gradually led to the disappearance of the disease in Britain, although cases still occur in some parts of Ireland.

It is to Nicolle that we owe the advancement in our knowledge of this important disease. His work in Tunis on this subject dates from 1909. He showed that the blood of typhus cases is infective to monkeys, and, most important of all, that the infection takes place through the body louse. Just as in trench fever, the louse becomes infective after some five days, and it has been shown by the late Arthur Bacot of the Lister Institute that the excreta is also infective.

The minute bodies found in the typhus louse are, subject to some differences, very similar to those found in the trench-fever louse, and have been named *Rickettsia prowazeki* by Rocha Lima. What group these bodies belong to is still a matter of discussion. Some consider them to be protozoa, with an ultra-microscopical stage in man and a developmental stage in the louse, while others look on them as minute forms of bacteria. Although there is still some doubt as to the pathological significance of these Rickettsia bodies, the work of Sargent, Rocha Lima, Arkwright and Bacot, Wolbach, Todd and Palfrey has done much to establish a causal relationship between them and these two diseases, typhus and trench fever.

From the point of view of prevention, the important fact is that the infection is carried by the louse, and in the next great war it will be almost as necessary to prepare means for the destruction of the lice as of the enemy.

Rocky Mountain Fever.

A third disease belonging to this interesting little group—Rocky Mountain fever—occurs in certain localities in the United States. It provides another instance of a virus transmitted by an invertebrate host to man. As the result of the work of Ricketts and of Wolbach, the wood-tick, *Dermocentor venustus,* is now recognised as the vector. Rickettsia bodies closely resembling those found in association with typhus and trench-fever virus have been shown to be present in the stomach and tissues of the tick, and the same bodies have also been demonstrated in the tissues of infected guinea-pigs.

Another interesting disease of the undetermined group is sand-fly fever, the virus of which is conveyed from man to man by the sand-fly. A new era in its study has been opened up by the work of Whittingham and Rook, who have learned how to handle, breed, and keep sand-flies in captivity, and have shown that the virus is transmitted from generation to generation of flies without intervening passage through man or other higher animal. The knowledge of the life history of the flies will no doubt lead in due course to the suppression of the disease.

Another type of invertebrate vector is the Kedani mite, *Trombicula akamushi,* which transmits the virus of Japanese river-fever to man from wild animals. The dangerous character of this disease (Tsutsugamushi) and the minute size of the mite together have presented great difficulties to the Japanese investigators. Protection from the mite by special clothing and bathing after exposure to risk of infection are at present the most hopeful methods of prophylaxis.

Antitoxic sera have also been used with some measure of success in the prevention of diseases of this group. Degkwitz and others in Germany are reported to have been very successful in protecting children from measles and scarlet fever by injecting them with a small quantity of serum from convalescent patients. This method has also been found very useful under suitable conditions to protect cattle from foot-and-mouth disease.

But far more hopeful than protection by serum alone is the use of a vaccine to produce a lasting immunity, combined with antitoxin to prevent the vaccine from producing unpleasant results—the so-called toxin-antitoxin method. Most of the diseases for which this method of prophylaxis has proved valuable have been diseases of animals, such as pleuro-pneumonia of cattle, rinderpest, and foot-and-mouth disease; but quite recently the method of Dick, of Chicago, in scarlet fever has been supported by a number of observations. The system of testing and producing immunity is planned on the same lines as the Schick method for diphtheria.

Dietetic Deficiencies—Deficiency Diseases.

The preceding account is but a short and meagre history of the marvellous advance which has been made in the prevention of infectious diseases in our times, an advance due in great part to the work of two men, Pasteur the Frenchman and Koch the German; those who have come after them have merely followed in their footsteps, been their disciples.

Time will not permit even to touch upon the advances made in the prevention of other important diseases, such as the surgical infections and those caused by intestinal parasites, prominent among which are the hookworms and bilharzia. This advance has not been limited to the infectious group: it has been shared by other groups, notably those due to dietetic deficiencies, the so-called deficiency diseases. These deficiency diseases are just as important, or even more important, than the infectious, since they are always with us and exact an enormous toll in lowered health, lowered vitality, malformation, and inefficiency.

Until a few years ago it was taught in the schools that a complete diet consisted of certain proportions of proteins, carbohydrates, fats, and salts. But our knowledge is constantly increasing, our ideas about things constantly changing, and what is looked on to-day as absolute immutable truth to-morrow is seen in the light of some newer knowledge to be but a crude beginning. So the teaching concerning what constitutes a complete and healthy diet has changed, inasmuch as certain substances have been discovered in food-stuffs in the absence of which an adequate number of calories supplied in the form of proteins, carbohydrates, fats, and salts can alone neither promote growth nor support life indefinitely. These accessory food factors, or vitamins as they have been named, are present in such minute quantities in foods that they have never been isolated, and their chemical composition is therefore unknown. It is still a matter of opinion as to whether they really constitute parts of the structure of living tissues, or whether they merely act as catalysts or stimulators in the process of growth and metabolism. That they are definite chemical substances which can be added to or removed from a food-stuff, with good or evil results, has, however, been abundantly proved.

The untutored savage living on the natural fruits of the earth and the chase knows no deficiency diseases. It is only when man begins by artificial means to polish his rice, whiten his flour, and tin his beef and vegetables that the trouble begins. Civilised man living in comfort, drawing his food supply from the whole earth and able to vary his dietary at will, is in little danger; but it is otherwise with children and adults living under institutional conditions, with armies on active service, encountering extremes of climate, and with young infants on their naturally restricted diet. While it is true that deficiency diseases will only develop to their well-marked dangerous stage if the deficiency of accessory factor is severe and protracted, a slighter deficiency, if prolonged, may cause a condition of general ill-health and inefficiency not less important although ill defined and difficult to diagnose. This fact is of special importance in the case of infants and young children.

The Discovery of Vitamins.

At the present time, three, and possibly four, distinct vitamins have been described and studied, and it is probably only a matter of time for others to be discovered.

The discovery of vitamins dates to the middle of the eighteenth century. In 1747, James Lind, a surgeon in the British Navy, carried out a series of experimental observations upon sailors suffering from scurvy, the conception and performance of which were entirely admirable. By appropriate control experiments he showed that the medical means in vogue for the treatment of the disease were futile, when not harmful, but that orange and lemon juices were a specific cure. Lind attempted to ascertain the relative anti-scorbutic value of various fruits and green vegetables, but was unable to observe a "superior virtue" in one rather than in another. He confirmed Kramer's observations made at the beginning of the eighteenth century, during the war between the Turks and the Holy Roman Empire, that dried vegetables were useless, and adopts the explanation of his friend Cockburn "that no moisture whatever could restore the natural juices of the plant lost by evaporation," which Cockburn imagined were "altered by a fermentation which they underwent in drying."

Lind was struck with the beneficial effect of cow's milk in the treatment of scurvy. He explained it on the supposition of the milk "being a truly vegetable liquor, an emulsion prepared of the most succulent wholesome herbs." Lind applied himself to the applications of these discoveries for the prevention of scurvy in the Navy, and recommended lemon-juice concentrated to a syrup by evaporation to be carried in all ships and served out to the sailors. By the beginning of the nineteenth century the carriage of lemon-juice was made compulsory, first in the Navy and subsequently in the mercantile marine, with the result that the ravages of scurvy were prevented. With the advent of steam traction, too, the length of voyages was curtailed and supplies of fresh provisions were obtained at more frequent intervals. Scurvy became rare, and the medical profession, being no longer faced with this disease of dietary deficiency, soon forgot the significance of Lind's discoveries.

Before leaving this subject a curious fact may be related. The lemon-juice supplied to the Navy was at first made from lemons grown in Spain and the Mediterranean countries. Afterwards, when England took over the West Indies, it was made from the lime, and scurvy again broke out. The reason of this is now known to be that, whereas the lemon is particularly rich in anti-scorbutic vitamin, the lime is correspondingly poor.

The scientific study of the disease may be said to have lapsed for a century and a half, until Holst and his co-workers in Copenhagen investigated the etiology of scurvy anew on modern lines, with the help of experiments on animals. Their work, published in 1907 and 1912, formed the basis for the numerous researches carried out in England and America during and since the recent War. As a result of this work the etiology of scurvy, discovered in effect centuries earlier, has been firmly established as due to lack of a specific, undetermined, and as yet unisolated, constituent of fresh foods, especially of fresh vegetables and fruits, now known as Vitamin C.

In the meantime the existence of a second vitamin, the so-called anti-beri-beri, or anti-neuritic vitamin, Vitamin B, had been discovered. Eijkman's admirable studies at the end of last century, in 1897, on the etiology of beri-beri in the Dutch Indies, brought forward evidence for the view that this disease was of dietetic origin, and was caused by a diet consisting too exclusively of highly milled and polished rice. He showed that the disease could be prevented if the outer layer (or pericarp) and the embryo of the seed, which had been removed in the process of milling, were restored to the "polished" rice. Eijkman's discovery of the analogous disease in birds, *Polyneuritis gallinarum*, provided the necessary tool for further investigation of the subject. The researches of Grijns and others showed that the bran and polishings of rice were only one of many rich natural sources of the unknown principle preventing beri-beri, and it became evident that, while the disease is usually confined to tropical races subsisting largely on rice, the European white-bread eater is protected only by the varied diet he usually enjoys. Experience on active service shows that beri-beri may really develop on a diet of tinned meat and white bread or biscuit.

During the late War two examples of the use made of this new knowledge occurred in Mesopotamia. At the beginning of the campaign, on account of a difficulty in transport, there was a shortage of fresh food, with the curious result that scurvy broke out among the Indian troops and beri-beri among the British. The Indians were living on dried pulses, such as peas, beans, and lentils; the British on tinned beef and biscuits. The former diet was deficient in the anti-scorbutic vitamin on account of the complete drying of the seeds; the latter in the anti-beri-beri factor on account of the use of white flour from which the germ had been removed.

Some years ago it had been discovered that if dried seeds are germinated, a quantity of the anti-scorbutic vitamin is produced by the act of sprouting. This was done. The dried peas and beans were soaked in water and then spread out in shallow layers, to cause them to sprout, which they readily did in the warm climate. The germinated seeds were then issued to the Indian troops and cooked in the usual way. As a result of this simple procedure the scurvy completely disappeared.

In regard to the British troops it was known that the anti-beri-beri vitamin is contained in large quantities in certain cells, and notably in yeast cells. A small quantity of this substance in the form of marmite was added to the soldier's diet of bully-beef and biscuits, and the beri-beri in like manner disappeared.

It may seem strange that the conception of the rôle of vitamins in nutrition should have come first from the pathologist, and should not have emerged from the important advances in our knowledge of the physiology of nutrition which were made during the second half of the last century. The physiologists were preoccupied with the chemical composition of food-stuffs and their value for supplying energy and supporting growth, and with the necessity for supplying the requisite number of calories in a diet, distributed appropriately among proteins, fats, and carbohydrates, with adequate selection of mineral salts. It was only when these researches led to experiments in which animals were fed upon various mixtures of purified food elements that the investigators in this field began to realise that their repeated failures to rear animals upon such carefully arranged diets were not due to accident. The truth was suspected by Lunin in 1881, but it was not until 1912 that Hopkins published the classic experiments which proved the fact beyond a doubt. In the course of work along the same lines in the United States, McCollum and Davis in 1915 rediscovered Vitamin B, and, in addition, a third essential dietary constituent, a fat-soluble vitamin, present in butter-fat and certain other fats of animal origin, especially in cod-liver oil and other fish oils. This vitamin is known as fat-soluble Vitamin A.

Rickets as a Deficiency Disease.

The discovery of the fat-soluble vitamins proved to be of great importance in elucidating the etiology of this disease, which had for long been an unsolved problem. Some authorities had erroneously considered it to be an infectious disease, like tuberculosis. Another school held the so-called Domestication Theory, that it was caused by unnatural surroundings, involving a want of sunlight, fresh air, and exercise. A third considered rickets to be caused by improper feeding, though opinions differed as to the exact nature of the dietetic defect. The conclusion, first put forward by Mellanby in 1918, that a deficiency of fat-soluble vitamins plays a most important part in the causation of the disease is now generally accepted. This has been established by a large amount of work, both experimental and clinical, carried out by Mellanby himself, McCollum and Hess and their respective co-workers in the United States, and Korenchevsky and others in England. It may be laid down that if a young animal is supplied with a sufficiency of these vitamins, rickets will not develop. The question of prevention is therefore one of economics. The difficulty is that these fat-soluble vitamins are chiefly found in such food-stuffs as butter, eggs, the fat of beef and mutton, and fish oils, all expensive articles of diet which the poorer classes can seldom afford. The only "butter" used by them is probably some form of margarine, made from vegetable oils which contain little or no anti-rachitic vitamin. The question of prevention is for the sociologist. Science can only discover the causes and point the means. It is for governments and local authorities to carry out preventive measures in practice, and it is to be feared that science is often far ahead of the community in its share of the work.

Although the theory that rickets is an infectious disease has been exploded, a great and remarkable truth was contained in the domestication and hygienic theories which held that, among other unhygienic conditions, want of sunlight was concerned in the etiology of the disease. During the last five years it has been discovered that exposure to sunlight or to the ultra-violet rays of the mercury vapour quartz lamp can cure rickets in children. Experiments on animals have shown that the effective rays in the sunlight are also the ultra-violet. This discovery has indicated lack of sunlight during winter as one factor concerned in the large spring incidence of the disease in industrial cities in northern climates.

A complete and well-controlled research showing the interaction of diet and light in the prevention and cure of rickets in infants was gained in Vienna, since the War, by Dr. Harriette Chick of the Lister Institute and her four colleagues. There the curious fact came to light that infants fed on a diet deficient in anti-rachitic vitamin developed the disease only in winter and not in summer, and, moreover, could be cured in winter by exposure to artificial forms of radiation or by administration of cod-liver oil without any other change in diet or management. Another set of children who had a sufficient supply of fat-soluble vitamins in their diet, in the form of cod-liver oil, escaped the disease altogether.

Experiments on rats have also shown that in animals fed on a rickets-producing diet, rickets does not occur if the rats are exposed regularly to sunlight or to the rays of the mercury lamp, or other form of artificial ultra-violet radiation; whereas, if they are kept in the dark, rickets does develop. If, on the other hand, the diet is complete in all respects, including abundance of fat-soluble vitamins, the animals do not develop the disease, even if kept constantly in the dark.

How this is brought about is not known. At one time it was thought that the action of the ultra-violet rays on the tissues might enable the animal to synthesise fat-soluble vitamins, as it does in the tissues of plants, but recent evidence brought forward by Miss Margaret Hume in Vienna, and by Goldblatt and Soames at the Lister Institute, suggests that light can neither create nor act as a substitute for the vitamin. It seems rather to act as a stimulant, enabling the animal to make full and economical use of its store of fat-soluble vitamins, and when the store is used up growth ceases in spite of the continued action of the rays.

An important and practical point in regard to the connexion between diet and sunlight and the formation of the anti-rachitic vitamin is the relation to cow's milk. Recent work carried out by Dr. Ethel Luce at the Lister Institute has shown that milk obtained from a cow on pasture in summer contains a sufficiency of the growth-promoting and anti-rachitic fat-soluble vitamins. In winter, on the other hand, if the cow is stall-fed and kept in a dark stable, the milk may become deficient in these respects and young animals fed on it may become rachitic. This work shows that the seasonal variation in quality of the cow's milk may be an additional factor in the seasonal incidence of infants reared upon it. It also disposes of the idea, very current in some quarters, that cow's milk possesses low and negligible anti-rachitic properties and that the anti-rachitic properties of cod-liver oil are specific and peculiar to that substance.

Enough has been said to show that rickets may be regarded as a disease of sunless houses combined with a diet deficient in the anti-rachitic vitamin, and the means of prevention are sufficiently obvious, if not always easy and simple to carry out. Doubtless in the future this new knowledge in regard to the accessory food factors in diet will be used to a greater extent than it has been up to the present, in which case it is not too much to expect that the city children of some future generation will have better-grown bodies and stronger, healthier teeth than their predecessors of the pre-vitamin age. This might be attained in a comparatively near future if only man could be allowed to work out his salvation in peace. Instead of this, great wars come and throw back the work for generations.

To saddle the country with a million and a half of unemployed, with the consequent poverty, insufficient food, clothing and housing, is not calculated to further the prevention of disease and raise the standard of health. Is it too much to hope that in the revolving years a time may come when by a Confederation or League of Nations the world may be so policed that no one country will be able with impunity to attempt the destruction of its neighbour? Until this happens it is difficult to see how rickets, tuberculosis, and other diseases can be adequately dealt with in our city populations.

Diseases due to Ductless Glands

I can only briefly allude to the astonishing advance in our knowledge of the diseases caused by a defect or excess of secretion of the ductless glands. Many of these discoveries are among the fairy tales of science. All this advance has taken place in the comparatively short space of time under review.

Prof. Starling, one of the chief protagonists in this advance, in his Harveian Oration a year ago states this very vividly: "When I compare our present knowledge of the workings of the body, and our powers of interfering with and of controlling those workings for the benefit of humanity, with the ignorance and despairing impotence of my student days, I feel that I have had the good fortune to see the sun rise on a darkened world, and that the life of my contemporaries has coincided not with a renaissance but with a new birth of man's powers over his environment and his destinies, unparalleled in the whole history of mankind. Not but there is still much to be learned: the ocean of the unknown still stretches far and wide in front of us, but for its exploration we have the light of day to guide us; we know the directions in which we would sail, and every day, by the co-operation of all branches of science, our means of conveyance are becoming more swift and sure. Only labour is required to extend almost without limit our understanding of the human body and our control of its fate."

There is one point of likeness between the vitamins which we have been considering and these glandular secretions, or hormones, as they are named. Just as we have seen that the presence or absence of an extremely minute quantity of a vitamin may determine growth and health or disease and death, so an extremely minute quantity of glandular secretion may have a similar effect.

The anterior lobe of the pituitary gland is a very small body, yet an excess of its secretion will cause a child to grow into a giant; a deficiency, and the growing child will remain an infant.

The best known of the ductless glands is the thyroid, and the effect of its secretion is truly marvellous. A deficiency, and the child grows up a heavy-featured, gibbering idiot. Rectify the supply of thyroid secretion; the heavy features disappear, the eyes brighten, the intelligence returns, and instead of the former heavy-jowled imbecile you have a bright, happy, and normal schoolboy. On the other hand, if there is an excess of the thyroid hormone, exophthalmic goitre, or Graves's disease, is the result. Remove the redundancy and health returns.

The active principle of the thyroid has lately been shown to be a compound containing iodine. If there is no iodine in the soil or water, goitre is the result, as in parts of Switzerland, Canada, and the United States. This aspect of the subject was taken up some ten years ago by Dr. David Marine and his colleagues at Cleveland, Ohio. They find that endemic goitre may be prevented by the simple method of giving for a time minute doses of iodine, and conclude that with this simple, rational, and cheap means of prevention, this human scourge, which has taken its toll in misery, suffering, and death throughout all ages, can and should be controlled, if not eliminated, and look forward in imagination, a few generations hence, to the final closing of the chapter on endemic goitre and cretinism in every civilised nation in the world.

Many advances have also been made in our knowledge of the function and uses of other ductless glands, and, as you know, the latest victory in this field is the discovery of insulin and the successful treatment of severe diabetes, for which magnificent work your own townsmen Banting and Best deserve the highest honour.

In many other directions than those touched upon has there been progress in the prevention of disease.

It would take more than one address to describe the activities of the Rockefeller Foundation alone. Campaigns for the relief and control of hookworm disease, malaria control, the eradication of yellow fever, anti-tuberculosis work and education are being pursued on such a scale and at such a lavish expenditure of money as to leave us in the Old Country breathless with admiration and envy.

This Foundation, incorporated in 1913, was founded, in the words of the president, " to stimulate world-wide research, to aid the diffusion of knowledge, to encourage co-operation in medical education and public health." Its chartered purpose is to promote, not the exclusive prosperity of any one nation, but " the well-being of mankind throughout the world."

Science, indeed, knows no boundaries of nations, languages, or creeds. It is truly international. We are all children of one Father. The advance of knowledge in the causation and prevention of disease is not for the benefit of any one country, but for all—for the lonely African native, deserted by his tribe, dying of sleeping sickness in the jungle, or the Indian or Chinese coolie dying miserably of beri-beri, just as much as for the citizens of our own towns.

From what has been said, it is abundantly clear that during the comparatively few years that have passed since this Association first met in Canada, enormous advances have been made in the prevention of disease. Before that time we were still in the gloom and shadow of the Dark Ages. Now we have come out into the light. Man has come into his heritage and seems now to possess some particle of the universal creative force in virtue of which he can wrest from Nature the secrets so jealously guarded by her and bend them to his own desire.

But let there be no mistake; much has been done but much more remains to be done. Mankind is still groaning and travailing under a grievous burden and weight of pain, sickness, and disease. Interruptions are sure to come in the future as they have in the past in the work of removing the incubus, but, in spite of these, it is the duty of science to go steadily forward, illuminating the dark places in hope of happier times.

Scientific Problems and Progress.

ABSTRACTS OF ADDRESSES OF PRESIDENTS OF SECTIONS OF THE BRITISH ASSOCIATION.

CHEMISTRY AND THE STATE.

IN Section B (Chemistry) Sir Robert Robertson took " Chemistry and the State " as the subject of his presidential address. The relations of the State to chemistry in Britain originated in the necessity for self-protection; they developed from motives of expediency; and they have culminated in direct Government aid for research. From the time when gunpowder was first made for the State in the fourteenth century down to the production of amatol during the late War, the State has always interested itself in the manufacture of explosives, but important scientific research in this connexion began under Abel and his co-workers, Kellner, Deering, Dewar, and Dupré, who developed the use of guncotton and cordite. Outstanding advances in the manufacture of explosives emanated from the Royal Gunpowder Factory, and general research was carried out both there and in the Research Department, Woolwich. The War caused an enormous expansion of the State's activities in the production and investigation of chemical means of defence and offence.

The relations of the State to metallurgy were mostly sporadic before 1914, the main advances arising from private effort, but Percy, Abel, and Roberts-Austen, all of whom held official posts, assisted the Government in many inquiries, and more recently notable work on the non-ferrous alloys has been done at the National Physical Laboratory, ferrous metallurgy being studied in the Research Department, Woolwich. The State has always maintained a close connexion with minting, and many of the Mint officials, including Hofmann, Graham, Miller, Stenhouse, and Roberts-Austen, have made important additions to metallurgical science.

Expediency caused the State to levy duties on alcoholic liquors, tobacco, and other commodities. Richard I. imposed a duty on imported wine, and under Charles II. acts were passed to prevent the mixing and adulteration of wines (it is still illegal to mix wines of different kinds). Accurate methods of testing spirits, etc., have been elaborated in the Government Laboratory, and much work has been done there on the denaturing of alcohol.

Playfair, supported by the Prince Consort, pioneered the direct intervention of the State in sanitation and control of the quality of foodstuffs ; investigations on the adulteration of foods and drugs followed and led to the appointment of public analysts, to the extension of the work of the Government Laboratory, to the establishment of the Ministry of Health, and to the formulation of certain definitions and standards for spirits, dairy products, preserving and colouring matters in foods, etc. The State has also promoted or done very valuable work on the purity of water supplies, the disposal of sewage, the contamination of the atmosphere, and has established chemical control of many manufactures dangerous to health.

Although Humphry Davy was a member of the first Board of Agriculture, formed in 1793, progress in agricultural chemistry was left to private enterprise for more than a century; the establishment of the Development Commission in 1909 paved the way to important advances which have originated at Rothamsted and other State-supported institutions. The shortage of fixed nitrogen and of potash during the War made Government action imperative; and the valuable work of the Nitrogen Products Committee has been followed up by the establishment of a nitrogen industry at Billingham-on-Tees, where 150 tons of synthetic ammonia are now being produced daily.

The greatest advances in chemistry have been made in the universities and by private workers, but the contributions from Government institutions have not been unimportant; and the benefit has been mutual. During the War the State recognised its obligation to foster research, both in pure and applied science. Under the schemes of the Department of Scientific and Industrial Research the smaller chemical manufacturers are co-operating in the investigation of common problems, and the assistance extended by that department to academic workers shows that the State recognises the truth of the dictum that "research in applied science may lead to reforms, but research in pure science leads to revolutions."

Geology in the Service of Man.

Prof. W. W. Watts, president of Section C (Geology), selected "Geology in the Service of Man" as the subject of his presidential address. He pointed out that the mining industry, by providing exposures of rocks in mines, and by demanding as it did accurate knowledge of the nature and structure of the earth's crust, had been an important factor in the growth of the science of geology. He paid a tribute to the early work of Werner and William Smith from this point of view. It is a curious fact that these two pioneers of the science of geology were strongly imbued with a sense of the utility of geological science, and made their contributions to the establishment of the science with an economic motive. During the nineteenth century the purist attitude of mind became dominant among geologists, and it can scarcely be said to have faded out as yet; but, as Prof. Watts remarked, the feeling of mutual suspicion and distrust between the purely scientific and economic workers is fortunately passing away. The scientific and economic workers now find that they are mutually indispensable, and are everywhere co-operating in the work of developing and exploiting the mineral wealth of the earth's crust.

With reference to the study of geology as a factor in educational training, Prof. Watts deplored "the tendency in early education to squeeze out other sciences in favour of those that are called fundamental, and to suppose that, because it makes use of most other sciences, training in geology ought not to be begun until the other sciences have been mastered." He pointed out that, in consequence of this tendency, the habit of close observation is not being cultivated as it should be. The student's early propensity for making observations is blunted unless it be encouraged by studies such as those of practical geology, the pursuit of which has the additional advantage that it gives the student a stronger incentive to the study of the fundamental sciences and shows him their utility.

Under the sub-headings coal, oil, metals etc., stone etc., roads, water, power, agriculture and forestry, military science, geography, and biology, Prof. Watts showed in an interesting way how very wide, permeating, and altogether important are the influences of the science of geology in the service of man. The address will be read with much interest by all who appreciate the economic value of science in general and geology in particular.

Racial Problems and Colonisation.

As president of Section E (Geography), Prof. J. W. Gregory, in his address on "Inter-Racial Problems and White Colonisation in the Tropics," appropriately directed attention to the immense problems of population arising from the unification of the modern world by the movements and organisation of commerce. Peoples of very diverse heredity are brought into mass contact, and the results are difficult to evaluate, especially as prejudices of many and often conflicting types enter into the discussion. Prof. Gregory quotes views on many points, and scarcely attempts to give an opinion on racial fusions; he indicates South America as a region where such fusion has occurred and is still developing on a large scale, and the United States of America as a region where the strongest opposition to such fusion has been offered by both sides. He evidently thinks that the maintenance of black and white side by side but distinct in the U.S.A. is an impossibility, especially in view of the increase of southern European elements in the population of late years. In that opinion he wins the agreement of a great many thinkers and workers. Prof. Gregory, however, scarcely gives attention to modern demographic work in the U.S.A., such as that of W. F. Willcox, who claims that in every one of the Northern States negro deaths exceed negro births, and that this is probably true in cities generally. Moreover the negro, as Prof. Gregory shows, is tending to move to the towns. Willcox and his fellow-workers do not expect the negro to maintain himself at 19 per cent. of the population, but argue that in the year 2000 he may be only 5 per cent. This, however, may presuppose a rather large increase of whites, and may not take enough account of the influence of southern Europeans in producing "near whites." At any rate it seems clear that census errors in 1870 have spread an erroneous idea about increase of negro population in U.S.A.

Prof. Gregory touches the South African problem, where the "black" is at home and increasing, while the white finds more difficulty in maintaining himself physically and economically than he seems to indicate. He seems right in urging that the Nationalist Labour Coalition in South Africa is based on racial politics, with the ideal of black segregation, in the hope that large areas may become homes of pure Europeans. The hope is dim enough. Prof. Gregory is enthusiastic about the white Australia policy, and upholds strenuously the view that disease, not climate, is the enemy of white settlement in the tropics. From this point of view he makes the most of the partial success of North Queensland, and discounts failures in the Northern Territory as due largely to lack of organisation, railways, etc. At the same time he acknowledges that, where wet-bulb temperatures are high, the environment is against strenuous mental activity, though he does not go so far as does Dr. Leonard Hill towards suggesting that the white man would need to modify himself and his ways in order to occupy Northern Australia seriously. Nor does Prof. Gregory mention the probability that what may drift to Northern Australia may be a Pass-for-White population. He rightly points out that there are immense spaces that the surplus population of China may occupy in Asia, but he does not seriously refer to the delicate and pressing problem of the crowded population of Japan. It is doubtful whether many Japanese constitutions could stand interior continental climates in Asia at all. One cannot but welcome an interesting statement of a position taken up by a much-travelled geographer on the most urgent problem of our time.

Free Trade Doctrine.

Sir William Ashley took as the subject of his presidential address to Section F (Economic Science and Statistics) " A Retrospect of Free Trade Doctrine." There is a peculiar appropriateness in both speaker and subject. Sir William Ashley went to Toronto in 1888 to occupy the first chair of political economy in Canada; he has been throughout his career the chief academic critic of free trade in the English-speaking world. His address has, however, only an incidental bearing on current controversies. The doctrine that he expounds and criticises is the doctrine formulated by Adam Smith and his successors, in the century that began with the publication of " The Wealth of Nations " and ended with the new orientation given to economic studies by Jevons and Cliffe Leslie.

Sir William Ashley begins by formulating the doctrine for convenience of reference in nine propositions. Each of these he then expounds with an abundance of quotations from representative economists of the period, and proceeds to criticise in the light of economic developments during the period and since its close. In the main the address is an essay in the history of economic thought, marked by the literary grace and the pleasantly acid wit that characterise Sir William Ashley's critical work; so far as it has an object beyond this, it establishes the conclusion that the political doctrine of Smith and Cobden and Mill belongs to the thought and conditions of an age that is past.

It is the doctrine, not the policy, of free trade with which the address is concerned, and this the president shows conclusively is based, not on an inductive argument from experience, but on the optimistic philosophy (or theology) of Nature that was common to " The Theory of Moral Sentiments " and " The Wealth of Nations." The identities of phrase in the two are cleverly used to bring out the a priori character of the latter. Nature is beneficent; it follows that the unrestricted freedom of the individual to pursue his own interest can have only beneficent effects. Such freedom is a " natural " right; State interference is " artificial." It follows that the individual interest and the social interest are identical, and society is nothing more than a collection of individuals. A subsequent age, with a different philosophy, has had no difficulty in seeing that the use of " Nature " and " natural " in these connexions is question-begging. The purely economic elements in the doctrine show more definitely the influence of contemporary economic conditions; the criticism to which they are subjected is also different. They are tested by reference to economic facts and conditions of their own and other times, and their inadequacy brought out. Social policies have changed as much as social philosophies.

The free trade doctrine was the creation of philosophers and the instrument of practical men. This summary of its content and development brings out the changes that economics had to make in its objects and methods before it could claim to be scientific. The address is typical of the work which Sir William Ashley has done to free the study from the bonds of mere analytical introspection.

Engineering Position and Prospects.

Prof. G. W. Howe, in his presidential address to the Engineering Section, gave a *résumé* of the advances made in engineering during the last hundred years. He regarded Faraday's discovery of the principle of the electro-motor in 1821 as the birth of electrical engineering. It was not, however, until ten years later that Faraday discovered magneto-electric induction. The early workers did not realise that a dynamo could be used either as a generator of electrical energy or as a motor. Lord Kelvin installed one of the earliest house-lighting installations at 11, The University, Glasgow, in 1881, using a gas engine to drive a Siemens dynamo. The pressure was 85 volts and Swan lamps were used, but Kelvin had to design his own switches and fuses and think out how to support and distribute his lamps.

Prof. Howe mentions that in Glasgow he pays 5*l.* per ton for anthracite to burn in a slow-combustion stove. Assuming that the calorific value of anthracite is 14,000 B.T.U. per lb., this works out at 7·5 kilowatt-hours for a penny. He pays a penny for a kilowatt-hour for heating and cooking. For continuous operation, therefore, the high efficiency and convenience of a slow-combustion stove makes it much the more desirable. When, however, intermittent heating is desired the electric radiator may be the more economical. An interesting account is given of how the output attainable from a given size of machine has been slowly but continuously increased. This is due to the improvements in the electrical, magnetic, and mechanical properties of the materials used as well as to improvements in design. Considering the modern direct current motor, the freedom from trouble of the enormous number of motors in electric trams and trains is a testimony to their trustworthiness.

Prior to 1890 Ferranti had built the Deptford Power Station and was installing large 10,000 volt alternators to supply London with electric light. In 1913 the largest turbo-alternators had an output of 7500 kilowatts. Now, machines of 30,000 kw. and even 60,000 kw. are in operation. Electric traction has absolutely revolutionised the methods of transport within a single generation. Although 500-volt direct current supply has been standardised for tramways, the relative merits of direct current and alternating current for traction purposes are still being discussed. Prof. Howe is inclined to regard three phase supply for traction, notwithstanding its successful application in Northern Italy, as being antiquated. The battle is now confined to direct current at pressures between 1500 and 2000 volts and single phase alternating current. In the latter case the question of the most desirable frequency is not yet settled. The development of the alternating current traction motor during the early years of this century has made possible so many simplifications and economies in transmission that it is yet a moot point whether A.C. or D.C. is best for main line electrification.

Within the last thirty years the provision of an abundant supply of electric power has led to the creation of enormous electro-chemical industries. The production of aluminium, carborundum and calcium carbide by electrical energy obtained from waterfalls may be specially mentioned. In 1926 the jubilee of the invention of the telephone by Alexander Graham Bell will be celebrated. The great advances recently made in automatic telephone stations where the operator is entirely eliminated and the subscriber himself makes the required connexion are well described as marvellous. What were considered wild dreams, twenty years ago, of the future of radio-communication have been completely realised in everyday practice. The commonplace radio-broadcasting of to-day appeared outside the bounds of possibility a few years ago. Thirty years ago a ship at sea was completely isolated from the life and thought of the world. It is now in continuous communication with the land and with every ship within a range of many miles. Prof. Howe points out that in no branch of electrical engineering is there any question of finality being attained. Rapid development is taking place in every direction, and new natural sources of energy are continually being utilised for the benefit of humanity.

National Health and Physique.

In his presidential address to the Section of Anthropology, on "Health and Physique through the Centuries," Dr. F. C. Shrubsall reviews some of the evidence relating to improvement or deterioration in national physique from early times, and more especially under industrial conditions. Referring to the recent recruiting experience in Britain, he rightly points out that the National Service Survey of 1917–18 covered a population from which the best physical material had already been taken, and the marked inferiority in the average stature deduced from these returns as compared with that of recruits of British parentage drafted from the United States may be partly due to this fact, but also no doubt to the tendency of the best physical types to emigrate. School medical and recruiting data agree in showing the inferiority of the industrial as compared with the rural populations both in stature and general physique, but we are told that there is little or no evidence of deterioration of any one racial type in either respect since the beginning of the industrial era, but rather the reverse. The great increase in the expectation of life at the younger ages, which has undoubtedly occurred since Roman times, has been accelerated in the last two decades, as shown by the most recent life tables. The falling death-rate and improved health of the towns must be largely due to gradual removal of adverse conditions of labour, housing, and sanitation, which probably reached their worst level early in the last century, with the consequent stamping out of certain epidemic diseases and reduction in infant and adult mortality.

To proceed from this, however, to draw the conclusion that we are therefore physically and mentally a fitter race is only, it may be urged, to create a false sense of security. The evidence that there has been an advance in physical and mental characters at all comparable with the improvement in environment, if at all, is most inconclusive, though it cannot be doubted that such changes are making the race happier. The tendency of public health measures to aid the survival of inferior stocks may on the contrary have the reverse effect, and the declining fertility and marriage rate of the classes with the best physique in recent years is a matter of serious import for the future. Such eugenic considerations, which are of primary importance in the determination of national physique, are scarcely given their full weight in the address, and its optimistic tone will not appear to all students of racial problems to be justified by the facts.

The closing plea for an extension of anthropometric investigations in Britain, using the term in its wider sense, is, however, well worthy of consideration, for, to quote from the address, "it is only on the basis of careful physical and mental surveys that legislation directed towards social and racial hygiene could properly be introduced and rightly justified." When the Board of Education refuses to countenance the loss of half a day's education for the purpose of an anthropometric research on modern lines on the adolescent boys of a London school, one can only conclude that Britain has not yet awakened to the fact that the lack of such information in this country is a deplorable handicap to the intelligent discussion of such questions.

Specific Treatment of Infections by Artificial Remedies.

For his presidential address before Section I (Physiology), Dr. H. H. Dale chose for his subject "Progress and Prospects in Chemotherapy," which he defined as the specific treatment of infections by artificial remedies. He showed how recent investigations have attempted to solve the difficult problem of the method of action of specific remedies. The view that a drug acts as a direct poison to the parasite is quite insufficient, as also is Ehrlich's doctrine that in order to be specific a drug must have a maximal affinity for the parasite and a minimal one for the tissues of the host. It is becoming increasingly evident that drugs act favourably not only as a result of any action they may have on the parasite, but by virtue of the response of the tissues of the host. Ehrlich and Shiga showed that Trypan red would cure a mouse infected with *Trypanosoma equinum*, but that it failed in the case of the guinea-pig, rat and dog infected with the same trypanosome. Similarly Bayer "205" rids mice of trypanosome infections but is much less active in the same trypanosomes in the ox and horse.

It is evident that the host factor plays an important part in the curative process. Ehrlich found during his experiments with atoxyl that strains of trypanosome became resistant to the drug, and that this was maintained though the virus was passed through a long series of mice. Mesnil and Brimont, however, showed that if the virus was passed into the rat it was no longer resistant, though when again inoculated into mice the resistance became at once apparent. It would seem that the trypanosomes in the mice had become tolerant, not of atoxyl itself but of some product resulting from the action of atoxyl on the tissues of the mouse, though still remaining susceptible to a similar substance derived from the action of the drug on the tissues of the rat.

Neither Trypan blue nor Bayer " 205 "—and this is true of many other specific remedies—has any visible toxicity for trypanosomes when applied to them *in vitro,* though some physiological change is brought about as demonstrated by a loss of virulence. Salvarsan has no lethal action on spirochætes or trypanosomes *in vitro,* but after reduction to the corresponding arsenoxide it is intensely toxic to them. Voegtlin and his co-workers have produced evidence that such a reduction or oxidation resulting from contact of the drug with the tissues of the host accounts for its remarkable action in spirochæte and trypanosome infections. Levaditi demonstrated that atoxyl became lethal to trypanosomes *in vitro* after it had been incubated with an emulsion of liver, and he supposed that the actual curative agent was a substance " trypanotoxyl " resulting from a combination of atoxyl with some constituent of the liver or other tissue. Similarly, the therapeutic action of bismuth salts was attributed by Levaditi and Nicolau to a similarly produced " bismoxyl." Voegtlin has shown that the toxic action of the organic arsenoxides on trypanosomes and host tissues is depressed if various sulphydrile compounds are injected simultaneously with the drug, and as a result of the work of Hopkins he has suggested that the resistant strains referred to above may be due to the trypanosomes having acquired a capacity for producing such sulphydrile compounds in excess of their vital needs.

Another illustration of the participation of the tissues of the host is seen in the case of emetin in amœbic dysentery. The alkaloid has no action on the amœbæ *in vitro,* but is endowed with remarkable therapeutic properties when administered to human beings suffering from this infection. It appears to have little or no action on the same infection in cats. Whether the drug so affects the human tissues that they are no longer capable of affording nourishment to the amœbæ, or whether the amœbæ themselves are weakened so that they fall victims to the natural protective power of the host are problems which still await solution. Morgenroth has expressed the opinion that quinine acts in malaria by combining with the red blood corpuscles and so rendering them unsuitable for invasion by the young parasites.

The tissues of the host may influence the action of a drug in another way. They may fix the drug so that its rapid excretion is prevented and by a gradual liberation of small quantities of the drug itself, or of some substance they have elaborated from it, prolong the action on the parasite. Morgenroth has shown that " Rivanol " is fixed by the red blood corpuscles or subcutaneous tissues and in inflammatory conditions due to streptococci it is gradually given up and retards the development of the cocci. Similarly Bayer " 205 " is held up in the body for long periods, for animals which have received a dose of the drug are protected against infection, while the serum of such an animal may actually bring about a cure in one already infected. It has been shown that Bayer " 205 " enters into combination with certain constituents of the blood which is thereby altered in character.

It is along lines such as these that chemotherapeutic investigations are being conducted, and though in many cases it has appeared that specific remedies have been discovered empirically, during recent years advances have been made which go far towards affording a rational explanation of the various mechanisms involved in their action and which, in the future, will yield results of importance from the point of view of practical therapeutics.

Purposive Striving as a Fundamental Category of Psychology.

Psychology is something of a newcomer among the sciences, so that it is not surprising that there should be doubt about its standing among its older sisters. Psychologists are not quite sure what it is that they are studying, or how they should study it. Some of them doubt whether their subject is a branch of physical science at all; others think it would be valueless if it were not. Prof. W. McDougall devotes his presidential address to the Psychological Section to reassuring his faint-hearted colleagues. He insists that it is the business of the psychologist to study his subject by any and every means within his power, without casting side glances at what the students of physical sciences are doing or troubling about what they may be thinking about him. Above all, he should not restrict the scope of his inquiries for the sake of preconceptions about what is correct scientific procedure; the end will justify the means. He rebukes equally the " behaviourists," who want to confine themselves to purely physical methods, and the subjective school, who refuse to make use of observation of physical processes. He rebukes also those who try to belong to both schools with the help of the doctrine of psycho-physical parallelism.

Prof. McDougall conceives of psychology as the study of human nature, and therefore psychologists must take account of all the facts of human nature whether they like them or not. No intelligent discussion of human affairs is possible, as he points out, without the use of such terms as motive, intention, desire, will, responsibility, aspiration, ideal, striving, effort, interest, all of which involve the notion of purposiveness. Any system of psychology which excludes such a notion or explains it away is doomed to sterility and can never find much application to practical affairs. Applied psychology is now a reality both in medicine and industry. Those who have been successful in this field have not been doctrinaire " behaviourists " or subjectivists, but observers who have been ready to study the facts in any way they could and leave the theories to look after themselves. This is very sound advice of Prof. McDougall's, and might well be taken to heart by students of all possible branches of knowledge.

Physiological Aspects of Parasitism.

In his address to Section K (Botany), the president, Prof. V. H. Blackman, dealt with the relationship of host and parasite and their mutual reactions. The differences between animal and plant pathology were first noticed, notably that relating to disease-resistance. In animals, the resistance mostly studied has been acquired immunity, a type not known in the plant world, where the resistance existing is natural immunity. Whatever be the behaviour of individual cells in plants after a parasitic attack, there is no acquired resistance and no general bodily reaction to disease, hence the application of serum therapy would appear to be precluded. Even if such sera could be prepared, there would be the difficulty of transmitting the substances throughout the plant-tissues and the passing on of the immunity acquired to the new organs which are constantly developing.

With regard to the processes concerned with the achievement of parasitism in plants, the two chief modes of entry, apart from wounds, are through stomatal pores or by actual penetration. The entry through the stoma is clearly the most facile one (though the nature of the reaction which brings it about is still obscure), and it is somewhat of a biological puzzle that any germ-tube should follow the hard road of epidermal penetration. The probability of a negative chemotropism of the germ-tube to its own waste products playing any considerable part in the process does not appear to be very strong, and the evidence for a positive chemotropism to substances diffusing from the host cells is insufficient. It would seem, therefore, that a contact stimulus must play the major part, though it is unlikely that thigmotropism (stereotropism is suggested as a more satisfactory term) is alone responsible for penetration. With regard to the actual mechanism involved, Prof. Blackman and his colleagues have put forward strong evidence for the view that the process is purely mechanical and that enzymes play no part.

The elucidation of the quality of natural infection has been studied particularly in the Erysiphaceæ and Uredineæ. In the latter group, Biffen and his colleagues have shown that resistance in *Puccinia glumarum* in wheat is really the result of hypersensitiveness. The mesophyll cells of the resistant variety are readily infected, but the infected cells react so violently that they are killed and the invading parasitic hyphæ with them. Hypersensitiveness has been shown by Stakman to be the key to resistance of American wheats to *P. graminis f. tritici*. There is no recovery of attacked cells and no production of antibodies either in susceptible or resistant forms. The difference in the behaviour between the cells of the two classes must lie in the differences in the normal physiological processes. Hence this aspect of plant pathology is dependent for its advance on plant physiology.

Academic Freedom.

Principal Ernest Barker's presidential address to Section L (Educational Science), on "The Nature and Conditions of Academic Freedom in Universities," is opportune and much to the point. For one thing, the remarkable growth of modern universities in England in the last two decades has raised the question of academic freedom in a new form, and for another, a little clear thinking upon a subject with so many ramifications is very desirable. Dr. Barker realises the "tangled web of environment" in which the modern university is placed, and does something to unravel it. His analysis is clear, logical, and thorough. At the outset he makes a very proper distinction between the freedom of the teacher and that of the university. He then proceeds to discuss each separately and in some detail.

Perhaps the first part of Dr. Barker's discussion will prove more interesting to the average university teacher than the second. In it he deals with the freedom of the teacher, and, true to his own principles, does not hesitate to express himself with that frankness and freedom which he desiderates. He raises many points and has something of interest to say on most of them. While we may agree with him that a "professor is wise to be severely moderate and master of himself," he will probably agree with us that such wisdom, without occasional relapses, would make academic life, to say the least, somewhat dull. Again, while we may agree with him that "it is difficult to be at once a publicist and a scholar," he will probably agree with us that if professors had become publicists only "in the gravest emergency," public life would have been much the poorer for the limitation. His remarks upon the difficulties which may arise in handling such subjects as history, government, economics, and modern languages are specially pertinent, and it may well be true, as he seems to think, that the cause of academic freedom in the future will be fought with regard to chairs connected with the subjects of politics and economics.

It would have been interesting to have had Dr. Barker's views on university teachers as parliamentary candidates. He seems to think that such candidatures raise "desperate difficulties," but does not state what these difficulties are. Perhaps they are not so great as he thinks, and it may be that there would be advantages largely outweighing them. Here it would seem that Dr. Barker, contrary to his usual practice, passes over an important issue, and one which will become increasingly important in the future. Again, it is curious and apparently illogical for so doughty a champion of academic freedom to suggest that the professoriate should elaborate and *enforce* among themselves a code of professional conduct. It would be immensely interesting to attend a conference or council which set out to draw up such a code! With two qualifications Dr. Barker, so far as the individual professor is concerned, is in favour as a general principle of freedom uncontrolled by any assumption of responsibility by the university.

With regard to the second part of the address dealing with the broader question of the freedom of the whole academic community, Dr. Barker, after a short historical reference, confines himself largely to the discussion of university finance and its general effect upon academic freedom. Here, again, the whole position is thoroughly probed and its many implications carefully considered. The whole address is thought-provoking, exceedingly well handled, and a distinct contribution to a subject of vital importance.

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