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New Aspects of the Nitrogen Problem.

SIR WILLIAM CROOKES'S disturbing pronouncement, made in 1898, on the subject of the approaching failure of the world supply of wheat for lack of combined nitrogen, lives in the memory of many. "Are we to go hungry and to know the trial of scarcity?" he asked, and added, "those present who may attend the meeting of the British Association thirty years hence will judge how far my forecasts are justified." Naturally, a negative answer to his question was given at the British Association meeting last year, but had he said "sixty years hence," no one would have dared to give a confident reply. On the other hand, his prophecy in regard to the manufacture of combined nitrogen has come true. Led by Germany, nearly every civilised country in the world is actively producing synthetic fertilisers. Now, it should be noted that Crookes confined his attention to the need for nitrogen in the production of wheat. Recent events in the agricultural world, however, justify some consideration being given to a wider aspect of the nitrogen problem; for, as a recent writer has said, the sum total of life upon this planet is limited by the amount of available nitrogen in combination; important as wheat is in human dietetics, the supply of *meat* is equally vital. The farmer everywhere is in fact engaged in the manufacture and marketing of combined nitrogen in one form or another. He *buys* nitrogen in the form of manures and feeding stuffs, and markets it again as corn, meat, or milk. He *makes* nitrogen when he sows clover and other leguminous plants; and he *conserves* it for future use when he lays his land down in grass.

Under ordinary farming conditions in Great Britain, meat and milk are not produced by grass alone. Intensive farming requires that animals shall be fed on concentrates, that is to say, foods rich in nitrogen, and the use of such foods has two advantages: the protein they contain goes in part to make meat or milk, while the portion not digested, as well as that eventually rejected as waste, goes to enrich the soil. It follows that intensive agriculture in the last analysis involves a process whereby foreign nitrogen is brought on to the farm, is converted into products such as corn and meat, again, in part leaves the farm, and in part is added to the soil. We have, therefore, two stages in the exploitation of land for the production of human food, one typical of the apical development of medieval farming, in which the soil of a locality produces the maximum of human food

by the united efforts of Nature and the farmer, and the other, typical of farming after the discovery of artificial manures and feeding 'cakes,' in which nitrogen in one or other of two forms is brought on to the farm from outside, subjected, in part, to a conversion process and added to the sum total of home production of food. It may be noted, too, that the purchase of foreign feeding stuffs is merely a transference of nitrogen 'made' by natural agencies from one portion of the globe to another. In the case of ordinary nitrogenous manures, also, Nature plays a leading part; ammonia salts are waste products of coal consumption: sodium nitrate from Chile is believed to come fundamentally from the excreta of sea-birds, and others, such as blood, bones, etc., are in the same category.

Since the days of Crookes's vaticinations, however, we have entered on a third stage. Agriculture is now drawing on a purely artificial and non-natural source of combined nitrogen, one that makes no call on the resources of the soil elsewhere, or on the natural agencies by which atmospheric nitrogen enters into combination. "The fixation of nitrogen," said Crookes, "is one of great discoveries awaiting the ingenuity of chemists. . . . It is vital to the progress of civilised humanity. . . . Unless we can class it among certainties to come the great Caucasian race will cease to be foremost in the world, and will be squeezed out of existence." The hoped-for discovery has now been made. As a recent writer has said, "It is now the era of nitrogen plenty." The estimated world production of combined nitrogen is now about one and a quarter millions of tons, and it is increasing rapidly year by year. But how does the production of combined nitrogen affect human food? Crookes answered the question so far as wheat is concerned. What about meat and milk? It is obvious that if meat is produced by the feeding of a cereal (such as oats) to animals, an abundance of synthetic nitrogenous fertilisers should cheapen the production of meat. But, as matters stand, the cost of meat is governed by the price of the pasture-fed animal *plus* the cost of purchased foreign foods. In favoured regions in Great Britain it is possible, no doubt, to fatten an ox on home products alone, but in any event the store animal, that is, the animal before it is 'finished' for the butcher with albuminoid and fatty foods, is a product of grass lands. It follows, then, that if we could invariably feed a cow, or finish an ox or sheep on grass alone, we should relieve the farmer of a big item of cost—that of cake and corn purchased outside the farm.

We have, then, narrowed the problem to this. Is it possible by the use of synthetic nitrogenous fertilisers so to improve our pastures that they will be capable of fattening the meat-producing animal? Science has something to say on the subject—and something new. Research on animal nutrition, led by Kellner, the well-known German worker, has been proceeding for more than a generation. Grass in the form of *hay* has not been overlooked. Its energy value, its starch-equivalent, have been determined: its practical feeding value for maintenance, for production, either alone or in combination with other foods, has been ascertained, but until quite recently its precise value in *pasture* conditions was unknown.

Scientific knowledge has, however, recently made a great advance. Workers in the Cambridge School of Agriculture have proved that young *pasture* grass, that is, grass before any lignification of the tissues has set in, is entitled to rank as a concentrated food, both in respect of protein content, digestibility, and starch-equivalent. Its dry matter actually contains so much as 25 per cent. of digestible protein and 75 per cent. of starch-equivalent. Further, being the natural food of herbivores, we may assume that its mineral and vitamin contents are properly balanced. So that now a scientific view of the subject warrants the confident statement that if the farmer can supply his milch cows and fattening animals with an abundance of young grass, he can reduce the purchase of extraneous foods. Further, as a means of producing that abundance, he can use synthetic nitrogenous fertilisers; and this is not simply a paper philosophy. During the past two years the theory has been tested in Great Britain on a number of farms (including that at Melchet Court, the property of Sir Alfred Mond), and it has been demonstrated that, provided pasture land is kept closely grazed and that growth is continuously stimulated with nitrogenous and other manures, animals can be kept in healthy *productive* condition for six months in the year on grass alone. Moreover, and this is important, the number of animals which can be so kept on a specified acreage is greater than that possible by ordinary farming methods.

Of course, productive animals cannot be kept on grass all the year round; at the most they can be so kept for six months in the year, and in any case the practical farming problem presented by the new scheme is far from simple. Under any conditions grass does not grow at a uniform rate during these six months, and consequently a problem of management has to be faced which, for its solution, may necessitate both feeding for limited periods with foreign foods, and the setting

apart of an area of grass land for hay in the standard way. Two further scientific problems also await solution—one, for the plant-breeders, is the making of plants capable of producing a growth of herbage during part of the winter months; the other, for the engineer, is the feasibility of cutting grass in the young condition and preserving it during the winter. A solution on the former lines does not appear to be likely, but the possibility of the second solution is well in sight. The leading producers of synthetic ammonia in Great Britain are actively engaged in exploring the whole problem. (See, for example, "Farm Notes," issued by Messrs. Nitram, Ltd.) They have in operation an extensive series of field trials of which the object is to test the new system of rotational grazing of grass treated with combined nitrogen: they are also at the present time making a cake of dried and compressed young grass, and feeding experiments with this substance will be initiated in the coming autumn and winter.

An approach is therefore being made to the complete realisation of Crookes's dream, namely, that the requirements of the country for combined nitrogen shall be satisfied within the country itself—that our imports of that vital requirement shall be reduced to a minimum. Be that as it may, it is satisfactory to know that, as a result of the enterprise of the latest of the great industrial corporations, a further exploitation of the nitrogen problem, as envisaged by a great man of science, is being undertaken.

Variety and Environment in Lizards.

Der Artenwandel auf Inseln und seine Ursachen, ermittelt durch Vergleich und Versuch an den Eidechsen der dalmatinischen Eilande. Von Paul Kammerer. Nebst einem Anhang: Zur Systematik der adriatischen Insel-Eidechsen, von Otto Wettstein. Pp. xiv + 324 + 8 Tafeln. (Leipzig und Wien: Franz Deuticke, 1926.) 30 gold marks.

A MELANCHOLY interest attaches to this paper, the last from Kammerer's pen, which was published only a few months before his tragic death last year. Like his other publications, it is based entirely on work done before the War; for since the War, owing especially to the socialism which became rampant in Vienna, the University of Vienna has become so impoverished that it was unable to pay any but starvation salaries to its staff, and Kammerer left its service and supported himself by journalism and popular lecturing from 1924 until his death.

In 1909 and 1911, and again in 1914, Kammerer made a prolonged tour amongst the Adriatic islands, visiting in all fifty of them. The size of the islands varied from tracts of country equal in area to the Isle of Wight to mere islets a few hundred yards across and rocky 'skerries.' The object of these excursions was to find out whether distinct races of continental species of animals were to be found on these islands; and if so, how they were related to their nearest allies on the adjacent continent. As he himself says, his purpose was to follow in the footsteps of Darwin and Wallace, and to glean from the study of these island races light on the origin of species.

A preliminary investigation convinced him that the most suitable animals for his purpose were lizards, for these abound in all the islands. Seven species in all were found, namely, two geckos, *Tarentola mauretanica* and *Hemidactylus turcicus*, one 'blind-worm,' *Ophisaurus apus*, and four species of Lacerta, namely, *L. major*, *L. oxycephala*, *L. serpa*, *L. fiumana*. Of these seven species, however, *Lacerta major* (which is a large form, 18 inches to 2 feet long) and the 'blind-worm' Ophisaurus showed no variations; Tarentola has the habit of clinging to ships and driftwood, and so owes its wide distribution to human agency. Kammerer's attention was therefore concentrated on the remaining four. The gecko Hemidactylus is a nocturnal or at any rate a crepuscular species, and *Lacerta oxycephala* confines itself almost exclusively to bare rocks. The other two, *L. fiumana* and *L. serpa*, are, however, diurnal and frequent herbage and brushwood, and it is they which show marked variations in the different islands, and it is from the study of them that Kammerer obtained the most light on the problem which he sought to solve. These two species, according to Kammerer, are 'good' species: he says that the experienced naturalist never mistakes the one for the other in the field, but that when their diagnostic characters are masked by superimposed 'island' characters they are difficult to distinguish. *L. serpa* inhabits the whole of the Italian peninsula and *L. fiumana* the whole of the Balkan peninsula, but the line of division between their territories runs along the Balkan coast, so that several large islands there fall to the share of *L. serpa*; and, curious to relate, it sometimes happens that an island is occupied by one species and the rocks around it by the other. Kammerer has some speculations as to the geological causes of this irregularity of distribution, but they are outside the scope of the subjects with which this review has to deal.

It should be noted in passing that Boulenger regards these two species as local varieties of *Lacerta muralis*, and with this opinion the reviewer, after inspecting the types at the British Museum, is inclined to agree; but whether they are considered as true species or varieties is entirely irrelevant to the question at issue. Their territories never overlap: even in the rare cases where they are both found in one of the larger islands, the areas which they respectively inhabit are separated by a 'lizardless' band of country.

Both *L. serpa* and *L. fiumana* give rise to well-marked island varieties, and the most marked of these are found in the smallest islands. In the larger islands it is only possible to find distinctions between island and continental populations by the statistical method: isolated individuals often turn up with peculiarities which become constant and universal in the populations of the smaller islands. These smaller islands, therefore, constitute the crux of the problem, and in endeavouring to account for the production of the strongly marked varieties found in them, Kammerer is approaching the problem of the origin of species from the same viewpoint as did Eimer long before him; for Eimer began his investigations into the causes of evolution by finding and describing a distinct 'variety' or species of lizard on one of the Faraglioni—the rocks in the neighbourhood of the island of Capri in the Bay of Naples.

These varieties differ from the type in colour, size, and shape. The colour of the type is green or greyish-green, with longitudinal rows of dark patches on the back and blue 'ocelli' in various places, such as the armpits and the underside of the throat. The colour below is yellow, sometimes with a reddish tinge, or pale grey. The island varieties can be jet-black, so that markings are not distinguishable from the background; they may be half as long again as the type and broad in proportion, and the tail is marked by a peculiar thickening just beyond its origin.

That isolation is an all-important factor in the production of varieties is clear from the fact that when two populations on the same islet are separated by some barrier which prevents them from intermixing, incipient differences make their appearance. Thus in the islet of Tajan there is a deep valley with perpendicular sides which completely separates the lizards of the eastern half of the island from those of the western half, since no *L. serpa* will ever climb downwards. The eastern lizards show in the male sex a red coloration on the belly, whilst in the western half both sexes show it.

Granted that isolation is a pre-requisite for the formation of a new variety, it can only act by preventing cross-breeding, and the question remains to be answered—is it chance variation accompanied by natural selection, or is it the direct action of the environment that is the effective cause of the change? Kammerer first examines the case for natural selection. If the black colour is protective, against which foes does it protect? The main enemies of the young lizards are the older lizards, rats, crows, and snakes. But the young in most cases, as on the islets Pomo and Melisello, show considerable traces of the ancestral colouring and only attain full blackness as they grow up, when the first of the enemies is no longer effective. Rats are nocturnal and hunt by scent, and are only found in some islands. Crows only visit islands near the coast, and snakes only occur on a few of the islands. Seagulls never attack lizards, which have, as a matter of fact, established a kind of symbiosis with them, for the lizards haunt the nests of these birds and search the plumage of the nestlings for parasites without molestation; at the end of the nesting season the lizards are plumper and in better condition than at any other time.

On the other hand, Kammerer was able to bring proof that the melanism is due to the direct action of the environment and principally to one factor in it, namely, radiation from rock surfaces. Here he anticipates and answers an objection raised by many naturalists (amongst them Prof. Graham Kerr in his recent book on "Evolution") that only work in the field can detect the causes of evolution, since experimental work, under laboratory conditions, can give no idea of what goes on in Nature. Kammerer replies that field observations can give *suggestions* as to the causes of evolution, but that the validity of these suggestions must be controlled by experiment. Now Kammerer shows that healthy young *Lacerta serpa* of typical green colour can be rendered quite dark if exposed for $1\frac{1}{2}$ to 2 years to strong radiation reflected from stones. *If such a pair in middle life are transferred to normal conditions and allowed to breed, they will produce normal green young, but these when they grow up under typical conditions nevertheless repeat a certain portion of the parental darkening.* From every island which Kammerer visited, never fewer than twenty and sometimes as many as fifty specimens were sent home to Vienna and there made the subjects of experiments.

The experiment just referred to is only one of a number of which Kammerer gives an account, and they leave no doubt in the mind of the

unbiassed reader that Kammerer has fully proved his point. As to the causes of the increased size and the thickened tail, Kammerer freely confesses that he has only surmises; since in the few generations he was able to rear, before the War interrupted his labours, he was unable to analyse their causes by experiment. He *thinks* that both are cases of over-compensation following respectively on starvation and injury. The black lizards go through seasonal orgies of abundant food, alternating with periods of starvation; and the loss of the tail, owing to mutual quarrels on the islands, is so frequent that the lizards are known to the natives, not as black—that is taken for granted—but as the lizards 'of many tails.'

Not only did Kammerer blacken green lizards by exposing them to dryness and radiant heat, but he recalled the black lizards of Melisello to their ancestral green colour by keeping them for two generations in a cool and moist atmosphere. He analyses the anatomical bases of the colour. There are three pigments—a yellowish-red lipochrome, melanin, and lastly guanin, which produces the blue colour by interference effects. The green is due to the combined effect of the guanin and lipochrome. He shows that as the temperature of the vivarium is increased, first the lipochrome and then the guanin is destroyed, and the melanin extends its range. This state of affairs is reached at 37° C. As the temperature is increased to 39° C., which is the utmost that the lizards can stand, the melanin disappears and a bleached albino results.

The response to radiant heat varies from species to species. *L. serpa* responds more quickly than *L. fiumana*. The more a variety is accustomed to heat in its natural habitat, the more slowly it responds to increased heat. The southern populations of *L. fiumana* are extremely resistant—it looks as if they had acquired an 'immunity' recalling the immunity produced by vaccination.

Kammerer of course does not deny the existence of natural selection, but he insists that what is selected is not the random variation in a lucky direction, *but the individual that responds best to the environment*. Variation, he says, appears at first sight to be random, but when it is looked into closely it is quite orderly and consists of plus and minus variants on a typical mean. There are different systems of organs which he mistakenly compares to the Mendelian genes, which react independently of one another. Thus in some varieties of lizard, blackening is attained by the appearance of melanin in the background; in others the black patches of the pattern spread until they overwhelm the background. Further, lizards and snakes, like amphibia, have the power of adapting their colour pattern to that of the environment, and this power is exercised through the eye. It is a question of a delicate balance of stimuli whether this power, or the direct response of the skin, shall gain the upper hand. In the islet of Pelagosa, for example, which is covered by a yellowish-green vegetation, *L. serpa* is bright green but the snake Zamenis is represented by an intense melanic variety. The gecko Hemidactylus has a particularly mobile response to its environment by change of colour, recalling in this the well-known chamæleon; yet even here the environment makes an impress on the hereditary constitution, for there is one islet where, owing to the absence of Lacerta, this species has become diurnal, and Kammerer ascertained by keeping this variety alongside of typical specimens in the same vivarium in Vienna that the responses of variety and type to the same environment were different. Kammerer maintains, in fact, that the first step in the formation of a variety is a continual heightened response in the same direction which gradually become engrained in the constitution. "*Physiological change precedes morphological change.*" *L. oxycephala*, as mentioned above, frequents bare rocks and, unlike *L. serpa* and *L. fiumana*, will descend as well as ascend. This species has given rise to a black variety on the upper arid slopes of the mountains of Herzegovina (*L. oxycephala Tomasinii*), where the lizards are exposed to pitiless radiation. Thus a variety can originate just as well on the mainland as on an island if intercrossing with neighbouring groups is prevented.

We may in conclusion say a word on the addendum by Dr. Wettstein. This is an admirable systematic review of the Kammerer material. He establishes several new sub-species on the basis of this material, and he mentions the fact which has a direct bearing on the causes which broke Kammerer's heart and drove him to suicide, namely, that a good deal of this material had lost all its colour and was hopelessly macerated and ruined when he came to examine it, by neglect in the museum during and after the War. The reviewer is aware that he speaks for only a small minority of his colleagues, but he predicts that in twenty or thirty years' time, when those fierce partisans whose calumnies wore out Kammerer's courage and drove him to his death, have passed away, Kammerer will be ranked alongside Lamarck, Darwin, and Wallace as one of the great architects of evolution.

Really, when one passes from perusing the endless and fruitless pursuits of the elusive gene by the Mendelians, to reading the clear and beautiful arguments of this work, one has the feeling of having passed from the babbling of the nursery to the reasoned debate of the forum.

E. W. MACBRIDE.

The Founders of Seismology.

The Founders of Seismology. By Dr. Charles Davison. Pp. xii + 240. (Cambridge: At the University Press, 1927.) 12*s.* 6*d.* net.

THE title of this book at once raises the question of what is a founder. For Dr. Davison the answer is simple; he is any one who is no longer living. Yet a different point of view might be adopted, for, if an architectural metaphor is to be used, the history of few branches of knowledge can be divided more readily than seismology into the two periods, of laying the foundations and of building the superstructure. The limit between the two periods lies in the first decade of the present century, and may be more precisely fixed at the time of the Californian earthquake of 1906. Subjected to elaborate investigation and a sumptuous publication of results, the increase of knowledge and the precise measurement of effects, which had only been recognised in a qualitative and even uncertain way, was very largely instrumental in inspiring a change in our outlook on the fundamental principles of both the old and the new seismology.

Earthquakes have been a subject of study from early times, but the science of seismology, in its more modern sense, did not begin before the eighteenth century, and by the middle of the nineteenth the main principles had been established on which all further work has been based. So far, however, the science had only dealt with the *seismos* which was known to and studied by the ancient Greeks—that is, the disturbance which can be felt, which may cause damage or destruction to the works of man, or may alter the features of a landscape, according to the degree of violence attained, but in the last decade of the century a new seismology was born. The incarnation of this new science may be dated from the discovery, by Rebeur-Paschwitz, that records could be obtained, with suitable instruments, of disturbances, evidently connected with destructive earthquakes, at places far beyond the region in which even the feeblest manifestation of the work could be detected by the unaided senses of man; and by the beginning of the following century it had been well established, and generally accepted, that these distant records revealed the existence of three distinct forms of wave motion, travelling at different rates and along different paths, from the origin to the place of record. This is the foundation on which has been reared the whole superstructure of that newer seismology which has shown us that the earth is composed of a series of concentric shells of materials, differing in physical character and, presumably, in chemical composition; which has given rise to investigation of the character, and revealed the existence of previously unsuspected forms, of wave; and to other results which only a generation that has forgotten, or chosen to ignore, its Greek could describe as seismology, but are equally interesting and important by whatever name they may be called.

Nor has the older seismology stood still. The report on the Californian earthquake of 1906 still belongs to the period of foundation-laying. The work was dominated by the idea of a centre of origin, though this was no longer regarded as of such limited dimensions that it could be treated as a point; it had become a fissure extending for a length of nearly 300 miles, but was still regarded as the origin both of the destructive earthquake and of the distant records. The cause, too, was regarded as the shock resulting from fracture, due to a slowly growing strain, which had gone on accumulating, with occasional partial relief, for a period of at least a century. A re-examination of the record of older earthquakes, and the study of more recent ones, has altered this; it has been found that, in destructive earthquakes, the origin of the surface shock is not so simple as had formerly been supposed, that instead of being a single fracture, or limited to the central portion of the affected area, the origins are often very complicated and spread over a large proportion, even to almost the whole, of the tract over which the shocks can be felt; it has also been found that the origins of the surface shock and of the unfelt distant record are by no means the same. The destructive earthquake can be proved, by local observations, to be of very shallow origin, generally, if not always, of less than ten kilometres in depth; and the same is true of the great majority of shocks which can be felt but do not cause damage or give rise to distant records. The disturbance which is registered at long distances has been shown, by the great series of observations studied, especially by Prof. H. H. Turner, to originate at depths which must be

measured in hundreds of kilometres, and the examples are steadily increasing in number where the geographical position of the origin of the long-distance records does not agree with that of the greatest violence of surface shocks, but may be at a considerable distance, even to a hundred miles or more. Yet the two are evidently in some way connected with each other, and if we liken the origin of one to the discharge of a great gun and of the other to the explosion of its shell, it is easy to see that the disturbance produced by its own charge of explosive would be very different from that which would result if it happened to strike an ammunition waggon or dump. In this way we may dimly realise the connexion between the long-distance record and the earthquake proper, and may find an explanation of the fact that there seems to be no quantitative relation between the two ; a highly destructive earthquake may give a small record, while a much larger one may accompany a disturbance which is only felt as a moderate and harmless shock near the origin.

Such, in brief outline, is the scheme on which a useful and interesting book might be written. Dr. Davison, in dealing with the works only of those individuals who are no longer living, has adopted a safer and probably more permanently serviceable line. This course is not devoid of inconvenience, for the end of some has been so recent, in two cases so late as 1923, that their work belongs as much to the building of the superstructure as to the laying of the foundations, and the absence of reference to the work of those still with us leads to a very partial and even misleading aspect of the present state of our knowledge. This, however, forms but a fraction of the work ; the rest of it gives us something that was much wanted. A general knowledge of the early history of the subject of his study is useful to every worker, but for each to go separately through the old literature would be an unjustifiable reduplication of toil, which Dr. Davison's work has rendered unnecessary. An extensive and, what is more important, an accurate reader, Dr. Davison has in pre-eminent degree the knack of extracting the nutricious kernel from the husk and shell in which it is clothed, and of expressing clearly those results which are of permanent interest or importance. He has produced an excellent account of the early history of the study of seismology, which contains what every serious worker at the subject ought, and all that, except for very special research, he needs, to know, of these older works and workers. R. D. O.

Newton and Descartes.

(1) *Sir Isaac Newton : a Brief Account of his Life and Work.* By Prof. S. Brodetsky. Pp. xii + 161. (London : Methuen and Co., Ltd., 1927.) 5*s.* net.

(2) *La vie raisonnable de Descartes.* Par Louis Dimier. (Le roman des grandes existences, Tome 5.) Pp. vi + 281. (Paris : Librairie Plon, 1926.) 15 francs.

(1) PROF. BRODETSKY has followed up his great success in organising the Newton celebration at Grantham by publishing what is easily the best short book on Newton's life and work. It is really even more than this, for it would be difficult to find anywhere a clearer and more instructive account of the genesis and meaning of the differential and integral calculus, as well as the way in which the law of gravitation brings together and completes the work of Galileo and Kepler. All this is done by a first-rate mathematician with a turn, like his hero, for the practical and applied side of mathematics.

To have accomplished this, with a lively narrative of Newton's personal life and all the relevant public occurrences of the time, within a compass of 160 pages, is a remarkable feat, and it is to be hoped that Prof. Brodetsky will go on to employ the talents which he has revealed in this volume by treating some other of the great figures in science in the same way. Nothing could be more stimulating to a young student than to read and re-read this book, mastering the admirably simple diagrams and looking up the references to contemporary thinkers with whom Newton was in touch. It is, in fact, a model of how the history of science should be presented—short, interesting, personal, suggestive, and competent. It does not attempt to cover the ground of the sciences which Newton studied and advanced, but it illuminates the advance and creates at every point that most wholesome of all appetites—the desire to know more.

To the student of general history, the connexions with other contemporary events, with which Prof. Brodetsky rightly and richly sprinkles his pages, will be specially welcome, for they help to build up the growing idea of the unity of history, and they show also how easily and in what small space it may be done, if we set out to do it and have the requisite knowledge. Newton's general philosophy fits in with that of Milton, whose "Paradise Lost" was completed at the same moment as Newton's two capital discoveries ; Newton practised jumping with and against the gale in the storm which accompanied Cromwell's

death; the first part of the "Principia" was published just as Charles II. was dying, and with the *imprimatur* of Samuel Pepys; and so on.

Une œuvre de vulgarisation du premier ordre.

(2) Close on Prof. Brodetsky's popular account of Newton comes a short French book on Descartes which offers other points of interest. M. Dimier, as compared with Prof. Brodetsky, is literary, personal, and, above all, Catholic. His book is beautifully written in a terse, pointed, and unadorned style, and Descartes is a still more unqualified hero to him than Newton is to the English writer.

Two capital and connected points are aimed at in the treatment: first, that Descartes' thinking was essentially synthetic and religious; second, that he was primarily inspired in his philosophic work by a desire to combat the popular scepticism of the day.

If one makes due allowance for the one-sidedness and exaggeration of this view, one may certainly gain a good deal of sidelight both on Descartes' work and on the life and thought of his time.

It is true—on the first point—that Descartes was primarily metaphysical and philosophic, whereas Newton was primarily mathematical and positive. Newton was above all concerned to make sure of his conclusions with regard to a particular law or set of observed facts. Descartes was from the first seeking to know, and to connect the whole of his knowledge in one coherent and unassailable system. This is in general the difference between the philosophic and the scientific approach, and it may be paralleled in the nineteenth century by the difference in the attitude and the influence of two leading men—again a great Frenchman and a great Englishman—Comte and Darwin. In each case the influence of the philosophic type is more diffused and indirect, and of the scientific more direct and constructive of fresh scientific truth.

On the Catholic question which pervades the book before us, it is sufficient to say that while Descartes was never anti-Catholic or sceptical, and conceived his main work to be the establishment of a body of certainties on a deistic basis, yet he certainly did not start from theology but from mathematics. His philosophy was inspired by mathematics, and he feared assaults from Catholic critics as much as from the Calvinists who got up a great case against him in Holland. On the details of all this and of his correspondence on moral questions, M. Dimier is instructive and interesting, and well deserves to be read. F. S. MARVIN.

The Chemistry of Petroleum.

The Scientific Principles of Petroleum Technology. By Prof. Dr. Leo Gurwitsch. Translated and revised by Harold Moore. Pp. xvi+470+8 plates. (London: Chapman and Hall, Ltd., 1926.) 25*s*. net.

A FURTHER addition to petroleum literature is at the present time almost a challenge to criticism, in view of the voluminous writings extant on every possible branch of the subject; only flagrant heresy and iconoclasm, a brand-new theory of origin, for example, would seem to justify a new text. Though this book claims neither excuse, it is acceptable for three good reasons: that it has been an authoritative German text since 1912, revised in 1924, and now admirably renovated for the benefit of English readers by its translator, Mr. Harold Moore; that it presents the European and not the American viewpoint; and that it is less concerned with commercial oil-refining than with the scientific principles on which that industry thrives. The author holds high academic office at the University of Baku and, as might be anticipated, his writing is coloured with experiences of Russian petroleum and biassed to the work of European colleagues, truly a refreshing departure from recent tendencies.

We have here a real text-book of the chemistry and physics of petroleum, two remarkably complex subjects when considered for their own sakes and not for their economic applications; in fact, one of the features of this volume is its indication of the enormity of unfinished research, of work still to be done, of knowledge yet to be gained, before we can claim understanding. As a text-book it leaves little to be desired. Carefully arranged, lucid in style, concise in presentation, entirely technical but never fogged with petty detail, masses of formulæ or wild speculation, the work makes an immediate appeal and deserves, as it will undoubtedly achieve, a place in the front rank of English literature on the chemical technology of petroleum.

The discussion centres on three main factors: raw material, manufacture, and products, each treated from the scientific viewpoint, *i.e.* the first principles involved. Petroleum, the raw material, is first reviewed and its chemistry and physics explained so far as this is at present possible. Manufacture concerns essentially distillation processes and sulphuric acid refining. The products benzine, illuminating and lubricating oils, paraffin wax, and vaseline are similarly described. While

theory and experiment remain uppermost throughout, the rationale of industrial operation is not neglected, but rather follows as an illustration of the doctrines expounded.

Deficiencies there are bound to be in a work of this character, but they are for the most part innocuous; the treatment of sulphur and nitrogen compounds is poor in its brevity (pp. 113-119), likewise inert gas components of natural gas (p. 124); the misuse of the geological term 'weathering' as applied to evaporation of petroleum (p. 175); the data of crude oils of the world are antiquated and there are serious omissions of Mid-Continental and Colombian crudes (Ohio-Indiana is not the accepted Mid-Continent field); the use of the term 'resin' (p. 200) for the asphalt-content of Balachany oil is misleading and should not be allowed to confuse an already clumsy and 'muddy' nomenclature; the section on products is far more sketchy than the rest of the text, especially in regard to the vital subject of lubrication. All this pales, however, by the excellence of the translation and the esteem which one instinctively feels for one who is a master of a particularly complex subject. Prof. Gurwitsch is fully entitled to renewed congratulations.

Our Bookshelf.

The Epic of Mount Everest. By Sir Francis Younghusband. Pp. 319 + 16 plates. (London: Edward Arnold and Co., 1926.) 7*s*. 6*d*. net.

SIR FRANCIS YOUNGHUSBAND has written a concise and inspiring account of the three expeditions which were organised by the Royal Geographical Society and the Alpine Club. The first expedition reconnoitred the mountain in 1921; the following year the second expedition attempted to climb the mountain, but failed to reach the summit. At the climax of the third attempt, in 1924, Mallory and Irvine were seen for a moment climbing fast, and within reach of the goal. Did disaster overtake them before or after they accomplished their task? Unless those two gallant climbers did in fact reach the summit, and left a record there, the mystery may never be solved.

The author makes it clear that the ascent of Mount Everest is possible, and the mountain will eventually be climbed. He attributes the failure in 1924—if indeed it was a failure—to two causes. The first was the exhaustion of the best climbers in the gallant rescue of four porters, who had lost their nerve in coming down from Camp IV. The second was the attempt to use oxygen. Oxygen does not increase the strength of a climber sufficiently to make up for the weight of the apparatus.

Though the ascent of Everest is possible, it can never be easy or safe. Only the toughest and most determined climbers have any chance of reaching the summit, and to do so they must first acclimatise themselves to altitudes of more than 20,000 feet. In order that the climbers may reach the last stage in good condition, at least six camps must be established between the base at 17,000 feet, and the jumping-off point at above 27,000 feet. This involves the use of a large number of porters; the 1924 expedition employed seventy, but had not enough. Finally, the weather must be propitious.

There can be no doubt that, if the Tibetan authorities once more open the road to the mountain, Everest will be attacked again and again, until it is vanquished. The victory will not add anything to human knowledge, or to the material wealth of the world. But the mountain offers a perpetual challenge to the boldest climbers. To use Sir Francis Younghusband's own words, "Everest stands for an adventure of the spirit." Yet amongst those who, from the scorching plains of India or the arid plateau of Tibet, lift up their eyes unto the hills, there may be some who mutely hope that the uttermost peak may never be desecrated by the foot of man; and that also is an affair of the spirit.

Essentials of Volumetric Analysis: an Introduction to the Subject, adapted to the Needs of Students of Pharmaceutical Chemistry. By Prof. Henry W. Schimpf. Fourth edition, revised and enlarged by Dr. Alfred I. Cone. Pp. xiv + 370. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1926.) 15*s*. net.

As an introduction to the subject, this book doubtless covers the requirements of students of pharmaceutical chemistry. It does not, however, in matters of detail, arouse the reviewer's enthusiasm. The introduction of unusual abbreviations is confusing; the arithmetical examples are frequently expounded in an unnecessarily elementary manner; the use of exactly normal solutions, instead of the employment of a factor, is directed; the explanation of the use of excess of free acid in permanganate titrations is incomplete, so as to be quite misleading; the use of the symbol O_3, except to indicate a molecule of ozone, is to be deprecated; the standardisation of *N*-sulphuric acid by titrating 10 c.c. with "recently prepared and standardised *N*-potassium or sodium hydroxide" is open to obvious criticism. In addition to the usual inorganic volumetric exercises, the analysis of sugars, oils, alkaloids, urea, formaldehyde, and organic nitrites is described, and a short section is devoted to the principles underlying the determination of hydrogen ion concentration. A. A. E.

A Treatise on Viticulture. By Prof. A. I. Perold. Pp. xi + 696. (London: Macmillan and Co., Ltd., 1927.) 25*s*. net.

ALTHOUGH written at Stellenbosch, South Africa, and dealing very largely with viticulture in South Africa, this work is also applicable to cultivators and students in other parts of the world, for the

author gives many particulars of outdoor vine culture in California, Australia, and Europe, and describes very fully the several species of Vitis from which the cultivated grapes have originated. The book is not meant for the cultivator alone, but also for students, for it embraces all phases of the vine, passing from the historical, morphological, and biological, through the various processes of cultivation, to the preparation and marketing of the crop in the numerous forms in which it appears in commerce.

Following a general introduction, the author discusses both the external and internal morphology of the vine, the descriptive matter being aided by good illustrations. More than forty pages are then devoted to biological questions, which include germination of seeds, the factors governing bleeding after pruning—a question that often gives considerable trouble in Great Britain if pruning be left rather late—development of shoots, fructification, the chemical composition of grapes, ripening of wood, etc.

Chap. iv. deals with classification. Reference is made to the various genera composing the family Ampelidaceæ; then the numerous species of Vitis are reviewed, with special descriptions of those which produce grapes of commercial value, or are suitable for stocks on which to graft or bud cultivated forms or hybrids. The numerous hybrids between American species are described and comparisons are made between them, and between them and the European and Asiatic forms of *Vitis vinifera*.

A special chapter then directs attention to details of propagation, and another to diseases and their treatment. Chap. x. deals with cultivation, giving special attention to manuring; whilst the following chapter describes methods of pruning and training. The remainder of the book is devoted to the products of Vitis and their preparation for the market.

The book is likely to prove of considerable value to students, cultivators, and others interested in the vines and their cultivation.

The Zeiss Works and the Carl Zeiss Foundation in Jena: their Scientific, Technical, and Sociological Development and Importance popularly Described. By Prof. Felix Auerbach. Translated from the fifth German edition by R. Kanthack. Pp. iv+273. (London: W. and G. Foyle, Ltd., n.d.) 10*s*. 6*d*. net.

THE name of Abbe will probably remind most English readers of a certain theory of image formation in the microscope, perhaps also of some refractometers and other optical devices, but now that Prof. Auerbach has turned minstrel, and produced the saga of the Carl Zeiss Foundation with Abbe as the hero, protean, magnificent, we can scarcely escape the conviction that his hero's claim to greatness lies as much in sociology as in optics.

The fact that the first half of this well-illustrated book is a kind of conversational illustrated catalogue of the Carl Zeiss products and their history, an excellent advertisement through its atmosphere of solid achievement and great potentiality, is not without significance in explaining the production of the English translation. This part of the book calls for no particular comment, except that certain outside inventors whose instruments have been made by Zeiss might have been mentioned, to say the least. The latter part of the book, however, will well repay any student of industrial organisation who finds time for its perusal. As Prof. Cheshire observes in his foreword, Abbe's scheme has now passed through the experimental stage. It has survived the shocks of war and war's ending. Its story is told with genuine feeling, not untouched by poetry, as befits a modern saga.

The epilogue laments that "the German people are impoverished, their savings, large and small, are gone and their purchasing powers have dwindled to the lowest level." Several pages in the book are devoted to a description of the Zeiss planetarium, and we now hear that at least eleven German cities have ordered such instruments. Those who know the cost of these will have much more respect for the purchasing power of the German people than seems to be the lot of Prof. Auerbach.

An Asian Arcady: the Land and Peoples of Northern Siam. By Reginald le May. Pp. xiv+274+64 plates. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin, Marshall and Co., Ltd., 1926.) 21*s*. net.

NORTHERN SIAM—the Lao country—has received little attention from travellers, and although the teak trade has attracted not a few Europeans, information about it is scanty. This is the more to be regretted as it well deserves Mr. le May's designation of 'Arcady,' and its people ethnologically present many points of interest. This account of the country and its people is therefore welcome, especially as it is illustrated by a large number of excellent photographs. The author has dealt with his subject historically and analytically in an ethnographic account of Lao customs and beliefs, which, though not systematic, contains many interesting data; and descriptively, in an account of a journey through the country. He has also included extracts from the references of early travellers. The first of these is Marco Polo, who, however, did not visit the Lao himself. The Lao were originally an offshoot of the Tai from China, and ethnologically they stand midway between the Shan and the Siamese. Nominally Buddhist, their beliefs are largely animistic, with a firm belief in the power of witches. A characteristic practice is that of roasting the mother of a new-born child, a custom also followed in the Malay peninsula—in a recently reported case with fatal results.

Racial Origins of English Character: with an Appendix on Language. By R. N. Bradley. Pp. 192. (London: George Allen and Unwin, Ltd., 1926.) 6*s*. net.

WHETHER mental qualities can be associated with racial characters is a question to which both anthropologists and psychologists have recently devoted

considerable attention, but with no marked result. Yet it is a matter of some moment, especially in the application of the results of science to the practical affairs of life. Mr. Bradley, boldly ignoring difficulties, has presented his readers with an analysis of the English character and achievement in the various departments of life—religion, politics, literature, science, and art—which is based upon the racial differentiation into Nordic, Alpine, and Mediterranean. He has an acute observation, a wide knowledge of his fellow-countryman, and a pretty sense of humour. His courage in essaying a difficult task will no doubt receive its due reward in a shower of hostile criticisms; but we hope that his critics will at least be grateful that he has given them something to criticise and that his mistakes may lead to the elaboration of a sounder method. Mr. Bradley, in evaluating racial character, relies upon material which ultimately is based upon impression. Until the psychologist can devise some objective method of determining and evaluating racial mental characters, study of the question is rendered nugatory by the personal equation.

Leitfaden der praktischen Experimentalphysik: für Vorlesung und Unterricht. Von Dr. Reinhard Mecke. Unter Mitwirkung von Dr. Anton Lambertz. Pp. vi + 195. (Berlin: Julius Springer, 1926.) 9·60 gold marks.

THIS useful work is a reprint of the technical advice concerning physical lecture experiments given in the introductory volume of Geiger and Scheel's handbook of physics, which has appeared in 24 volumes. It describes 533 lecture experiments covering the whole range of physics. Many of these are new, and in all of them due consideration is paid to the modern resources at the disposal of the experimenter. This applies particularly to the thermionic valve. We notice elegant methods of demonstrating stream lines by means of coloured liquids, the Johnsen-Rahbek effect of friction due to small currents, experiments with the speaking arc, and some very pretty and ultra-modern spectroscopic demonstrations. A valuable feature of the book is the addition of the essential definitions and formulæ, together with the chief numerical data. As the work is not a text-book of physics, nothing but what is essential to the success of the experiments is given, and given in the smallest compass. But wherever desirable, references to original papers or text-books are appended. Altogether an admirable book.

The Caves of Mendip. By H. E. Balch. (The Somerset Folk Series, No. 26.) Pp. 82 + 18 plates. (London: Folk Press, Ltd., 1926.) 2*s*. net.

IN this little book, which forms one of a Somerset Folk Series, the author, whose work in cave exploration has long been so well known in the west of England, gives a fascinating account of what he terms elsewhere the 'Netherworld of Mendip.' Some of the adventures described, such as those in the Lamb Lair, Harptree, and in Eastwater Swallet, show that cave exploration may afford all the risks of mountaineering with the additional possibilities of getting drowned or wedged in a narrow passage. An impressive point is the evidence given of the existence of vast caves which have never yet been reached. The cave to which most space is allotted is naturally Wookey Hole, and a few illustrations of the remains left by its Palæolithic and later inhabitants are reproduced from the author's larger work on the subject. Other illustrations are from photographs by Mr. J. H. Savory, to whose keenness and skill all Somerset spelæologists owe so much. The author points out that much work is in progress or remains to be done on the caves of the Mendips, and in this connexion allusion may be made to the admirable work carried out since the War by the Spelæological Society of the University of Bristol.

Elementary Algebra. By F. Bowman. Part 2. Pp. viii + 431. (London: Longmans, Green and Co., Ltd., 1927.) 6*s*.

THE second part of Mr. Bowman's "Elementary Algebra" contains much of the modern analysis which is generally known as 'higher algebra.' Beginning with convergency and the usual series, he passes on to the complex variable and eventually discusses the fundamental theorem of algebra that every equation has at least one root. The consequence of this arrangement is to bring determinants, permutations, and combinations at the end of the book.

The treatment throughout is admirable, especially in the chapters on convergency and complex numbers. Geometrical illustrations are used in an instructive manner and care taken to clear up small points which create difficulties to beginners, *e.g.* on pp. 19 and 28.

It seems unnecessary to assume that students who are reading the algebra covered by this book will not be familiar with some analytical geometry and calculus, and the space given to these subjects might well have been used to give a fuller treatment of convergency and thus make the book more useful for those preparing for mathematical scholarships at universities.

Animal Mind. By Frances Pitt. Pp. 340 + 22 plates. (London: George Allen and Unwin, Ltd., 1927.) 15*s*. net.

MISS PITT'S work is the modern version of the old anecdotal natural history which Edward Jesse and others made familiar to early-Victorian naturalists. But the new version is much revised and improved, for Miss Pitt's knowledge of the ways of common birds and mammals is deep, and in endeavouring to interpret habits and incidents she is seldom betrayed into the facile explanations which often satisfied the earlier writers. The observations are acute and reveal many striking facts well worth testing in a wider field, such as the response of the eating instinct of a young fox to the presence of a trace of fur, while plain flesh was ignored. The book is well adapted for the general reader as well as for the trained naturalist.

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.*]

Weber's Theory of Molecular Magnetism, and the Internal Field.

THE name of W. Weber is one of those outstanding continental names which are associated with epochs in the development of science, and are regarded with honour in Britain. Yet in Britain there has been evident a considerable amount of misunderstanding regarding Weber's initiation of the essential features of the modern theory of molecular magnetism. That misunderstanding seems to have originated in an unfortunate wording of a remark made by Maxwell in his exposition and development of Weber's work ("Electricity and Magnetism," vol. 2, 2nd ed., p. 76).

The two essential features of the modern theory are clearly stated by Maxwell. First he says (p. 74): "Weber's theory differs from this in assuming that the molecules of the iron are always magnets, even before the application of the magnetising force." Secondly, he says (p. 76): "The molecules do not turn with their axes parallel to x (the direction of the magnetising force), and this is because each molecule is acted on by a force tending to preserve it in its original direction, or because an equivalent effect is produced by the mutual action of the entire system of molecules." It is the statement in the last clause which contains the second essential feature.

In addition, Weber adopted Ampère's view that the molecular magnetism results from molecular currents; and, to this view, modern physics has merely added the restriction that these currents are convective.

In the first sentence quoted above from Maxwell, the first feature of the modern theory is explicitly ascribed to Weber: in the second sentence, the second feature is not directly ascribed to him. If that feature were not due to Weber, that sentence would, in accordance with the rules regulating scientific priority, fix it as the property of Maxwell and constitute him as the originator of one-half of the essential fundamental postulates of the modern theory. But Maxwell is making no claim for himself. In his next sentence he adds that "Weber adopts the former of these suppositions as the simplest."

This last remark clearly points out that Weber discussed the second feature. Therefore, unless he explicitly abandoned it, he was the originator of both of the basic postulates of the modern theory. Maxwell's words do not necessarily mean that Weber abandoned the second supposition. They only assert that he did not follow it out; and, further, that he did not do so because that supposition was not so simple as an alternative which was chosen by him.

Now the most minute search of Weber's paper (*Pogg. Ann.*, 1852), word by word, reveals two facts—(1) Weber not merely, as Maxwell implies, *asserts* the second feature of the modern theory, he *reiterates* it again and again; (2) Weber not merely avoids any choice between that feature and another one, for reasons of simplicity or otherwise: *he persistently avoids the consideration of any alternative.*

Therefore he, and he alone, is the author of the modern theory of molecular magnetism.

Moreover, Weber was not merely the originator of the fundamental ideas. He was their first developer. No later worker can do more than apply his views more widely. Weber himself illustrated the application of these views, in two cases, by a formal development of the action due to a neighbouring molecule; and that application constitutes one of those gems of intuitive insight which characterise the work of the masters.

Therefore Maxwell cannot, in the sentences quoted above, apart from a serious misunderstanding, be ascribing to Weber a choice between a non-magnetic force and one of magnetic origin. That is perhaps the most natural interpretation of his words, *yet he does not explicitly mention a non-magnetic force any more than does Weber.* That idea was introduced by other workers.

Weber did make one choice, and that evidently for reasons of simplicity as Maxwell said, though he did not state them as such. In speaking of the force which must be acting so as to drive back a magnet to its position of equilibrium when it has been deflected from it through an angle ϕ, far from saying a non-magnetic force, he says, "But this back-acting force, arising from the mutual actions of the molecules, must increase with the deflection, and can be represented by $D \sin \phi$, where D denotes a constant magnitude which one can call the molecular directive force" (p. 166).

That is Weber's direct assertion in introducing the very expression for the resultant force with which Maxwell deals. Therefore, as above stated, Maxwell could not possibly assert or mean that Weber abandoned the view that the force had a source apart from the mutual molecular magnetic interactions. On the other hand, it is to be noted that Weber's theory fixes the expression for the force whenever the distribution of the surrounding molecules is given. The thing that Weber definitely avoided, and that for the sake of simplicity alone, was the necessarily laborious evaluation of the true expression for the internal field. He took the only other possible method of approved scientific exploration, the method of postulation of a simple and sufficiently approximate expression for it. Maxwell, apart at least from an accidental failure to notice Weber's own statement regarding the nature of D, could mean nothing else than that; but the wording of his statement can unfortunately lend itself to the other interpretation.

The incorrect supposition that Weber abandoned the idea of mutual interaction of the molecules by means of their magnetic fields alone has not been quite universal in Britain. Jeans, for example ("Electricity and Magnetism"), describes the correct position with great clearness.

The later development of the subject by Ewing was largely directed towards the illustration, by means of models, of that mutual interaction of molecules which Weber first put forward, and against all postulates of the existence of quasi-elastic forces which had been made by certain other writers, amongst whom, however, Weber is not to be found.

The task of subsequent work is the evaluation of the force symbolised by D. Weber made the most drastically simplifying postulate regarding it. He assumed it to be constant, and found the result to be in agreement with observation in the case of soft iron: and he insistently reiterated the statement that he was dealing only with non-retentive iron. It was Maxwell who pointed out the over-stringent nature of Weber's postulate if retentiveness is to be taken into account, and he widened it accordingly. That was Maxwell's work, not Weber's, and in it he followed Weber in tentatively assuming a simple

form for the law rather than determining it by mathematical development, which the state of experimental knowledge at the time could scarcely justify.

In the more recent development of Weber's ideas the question has been again raised whether the internal molecular magnetic field is sufficient to account for observed phenomena. Thus Weiss, who adopted Weber's assumption regarding the internal field to fit it for application to crystalline media, was led by thermomagnetic phenomena to ascribe very high values to the internal field relatively to even strong external fields. He afterwards pointed out that the high values may include equivalent values of fields which are actually non-magnetic, but may, for example, be electrostatic if the molecular magnet is also an electric dipole; and this view leads to values of the molecular electric susceptibility which are consistent with results of observation.

Now an application of Weber's theory to a determination of the actual law of force, due to the mutual actions of the molecular magnets in a homogeneous crystal, readily indicates that the magnitude of the internal field is of the same order as that of fields which are normally used in the investigation of the magnetic properties of substances. It shows, even without numerical evaluation, that the least possible value of an external field which is able to magnetise a cubic crystal in any direction relative to its crystalline structure is equal to five-eighths of the maximum internal field. That is to say, the maximum internal field acting upon a molecular magnet is not twice as strong as the external field which is just able to turn the molecular magnets out of their stable directions, and so to magnetise the crystal in any direction. *This is true whatever be the nature of the internal directive field which tends to maintain the magnets in their stable positions.* If that internal field has in part an electrostatic origin, the remaining magnetic part is proportionately smaller.

This is in accordance with the observations, described in a recent issue of NATURE (Mar. 5, p. 353), on the deflexion of β-particles in their passage through thin magnetised nickel foil.

If we postulate that there is equipartition between the average translational energy per degree of freedom of the molecules and the average rotational energy of a molecular magnet, the axis of which is maintained, in consequence of the heat motions, on the average at an angle ϕ with the direction of the resultant field, we find, on evaluation of the internal field, that, at ordinary temperatures, this postulate is not satisfied. The change of potential energy of a molecular magnet, due to the rotational effect of heat motions, amounts only to about 1 per cent. of the energy per degree of freedom. This seems to indicate that the internal structure of the molecule is such that, in the collisional interchange of energy amongst molecules, only about 1 per cent. of the whole is communicated to the subatomic portion of the structure which is concerned with the manifestation of magnetic quality.

W. PEDDIE.

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Evolution: Emergent and Resultant.

THE recent articles by Dr. P. Chalmers Mitchell and Prof. C. Lloyd Morgan (NATURE, May 21, p. 748, and May 28, p. 786) clearly show the increasing importance of the problem of emergence. But it seems to me that Prof. Morgan advances a criterion of emergents which is seriously defective, and so prevents any reconciliation of the opposed viewpoints. In the first place, he appeals to "matters as they now are," and quite apart from what future discovery may reveal. It follows, therefore, that as knowledge expands, much that is now regarded as emergent may prove to be resultant, since it will become deducible from the phenomena of some "earlier phase"; and to this progress no limits can be assigned in advance.

This attitude is plainly an appeal to the ignorance which prevails at any given moment; and it at once destroys any *absolute* distinction between the emergent and the resultant. Now the trend of research, in my opinion, undeniably involves this loss of absoluteness, as Dr. Chalmers Mitchell maintains. For while it will always be impossible to deduce the macroscopic qualities of combinations from the macroscopic qualities of their elements, the more complete knowledge of microscopic and ultra-microscopic qualities does enable the qualities of combinations to be both explained and predicted. In this respect success depends on the capacity of the inquiring mind; so that as mind evolves, emergents must give way to resultants. If, for example, we accept Prof. Morgan's criterion, then to Galileo electromagnetic storms, due to solar radiation, would be emergent, while to us they are resultant. Similarly, many of the phenomena presented by vitamins, not being as yet deducible, are still emergent, but will probably be resultant for future bio-chemistry.

The criterion of being, or not being, deducible is thus wholly relative and transient; and it obscures what I take to be the sole genuine attribute of all emergents, whether deducible or not; that is, uniqueness, or the possession of characters previously unprecedented. From this more inclusive and permanent viewpoint, atoms and crystals emerged, exactly as did life and sentience at still later stages; and this quite apart from the partial, or complete, explanation of their origin. For each of these was, when it first appeared, in its own specific way unique, exactly as "Hamlet" would remain unique even though it could be fully accounted for in terms of Shakespeare's life and character. Such absolutely unique combinations occur, of course, throughout the entire universe, and present one of its most marvellous and significant features. So that although "out of three sounds he frame, not a fourth sound, but a star," still

A star's a star for a' that.

J. E. TURNER.

University of Liverpool,
June 16.

IF there be a valid distinction between resultant and emergent advance the question arises: How may this distinction be expressed with precision and clearness? One way of expressing it is that developed by Dr. Broad. It comes to this. There are certain integral wholes, composed of constituents in specific relations, of which it may be said that their characterising properties are not deducible from the most complete knowledge of the properties of the constituents taken severally in isolation, or taken collectively in some other set of specific relations. Such a whole is said to be emergent. The theory of emergence is on trial. Of it Dr. Broad says that "it is a matter of controversy whether it actually applies to anything"; but he adds that it embodies "a logically possible view with a good deal in its favour." If, then, the theory be on trial as a scientific proposition —and such it purports to be—it must, I submit, be tried out on the basis of existing scientific knowledge. I should not designate this as an appeal to ignorance.

Dr. Turner suggests that, instead of saying that the emergent, as something distinctively new, is not deducible from the data afforded by our present knowledge of the old—the characterising properties of the living organism, for example, not deducible from our existing knowledge of not-living entities—it would be better to say that the character of the emergently new is unprecedented. One should welcome any suggestion that may conduce to clearness and precision. But some may ask in what respect the unprecedented differs from the not-deducible. Has it a wider or a narrower reach? Were I to use the word 'unprecedented' it would have for me a wider reach, since there are quite possibly, and I think very probably, thousands of instances in which some given mode of the algebraical summation of resultant features has never occurred before, and is, in that sense, unprecedented. But if this be so, we have here no criterion of that which is emergent as distinguished from resultant.

It seems, however, to be Dr. Turner's opinion that whereas the notion expressed by 'not deducible' prevents any reconciliation of opposed viewpoints, the implication of 'unprecedented' may tend to further such reconciliation. What, then, is this implication? It may be such as Prof. Alexander, Dr. Broad, and Prof. Whitehead would gladly accept. But we need a clearer statement of what unprecedented means and all that it means. In view of reconciliation, is there some implication, which Dr. Turner surmises may be taken for granted?

C. LLOYD MORGAN.

Adsorption Isothermals.

IN his book "Colloid and Capillary Chemistry" (page 111 of translation by H. Stafford Hatfield, London, 1926) Freundlich remarks in reference to the adsorption of gases: "a theoretically well-founded equation, giving the a, p curves over a considerable range, is not known. The empirical general parabolic equation $a = \alpha p^{1/n}$ in which α and $1/n$ are constants, is still nearly always used." The quantities α and $1/n$ are functions of the temperature and are constant when this is constant.

Freundlich refers to the theoretical studies of Polanyi, Langmuir, A. M. Williams, and others, and quotes the equations for the adsorption isothermal which some of these workers have proposed.

One naturally hesitates to introduce another equation into the field, but feels encouraged to do so if the new formula appears more suggestive than the older ones. I have recently been much impressed by the manner in which

$$a = \frac{f(T)p^{T/273x}}{1 + \phi(T)p^{T/273x}}$$

agrees well with experimental observations in a variety of published cases. In this equation a has its usual significance, the amount adsorbed; T is the absolute temperature of the experiment; $f(T)$ and $\phi(T)$ are functions of T, being constant when the temperature is constant; p is the equilibrium pressure of the gas, or may be replaced by c, the equilibrium concentration, for cases of adsorption of solute from dilute solution. Clearly if $\phi(T)$ is positive the amount adsorbed attains a saturation value, but if $\phi(T)$ is negative it becomes infinite at a certain pressure.

The symbol x is of interest. It is often actually unity, and in all cases that I have so far examined, exceedingly good agreement with experiment has resulted when x has been given a low integral value, as shown by the following:

Adsorption of carbon monoxide, argon, nitrogen on charcoal	$x = 1$
Adsorption of water vapour on cotton, wood, leather	$x = 2$ or multiple of 2
Adsorption of acetone in water on blood charcoal	$x = 2$
Adsorption of bromine in water on blood charcoal	$x = 2$
Adsorption of isoamyl alcohol in water on blood charcoal	$x = 4$
Adsorption of benzoic acid in benzene on blood charcoal	$x = 3$

It should be noted that when the formula now proposed is substituted in Gibbs's adsorption formula:

$$a = -\frac{c}{RT}\frac{d\sigma}{dc},$$

we arrive at the following equation showing the effect of concentration on the surface tension of a solution:

$$\frac{\sigma_M - \sigma_L}{\sigma_M} = \frac{f(T)}{\phi(T)\sigma_M} R \,.\, 273x \log (1 + \phi(T)c^{T/273x}),$$

which reduces to the empirical formula put forward by V. Szyszkowski (*Zeits. f. physik. Chem.*, **64**, 285; 1908) when $T = 273$ and $x = 1$.

Some years ago I had occasion to make measurements of the absorption of radiant energy from a stream of full radiation, temperature 373° absolute, by gases and vapours, and obtained data, more complete than any found published at the time, showing the variation of the proportion of the energy absorbed with the pressure of the absorbing gas in a column of constant dimensions. The equation suggested in the preceding for the adsorption isothermal can be applied with success in this case; T is the temperature of the radiation, p is the pressure of the absorbing gas, a is the energy absorbed, $x = 1$ for carbon dioxide, benzene vapour, $x = 2$ for water vapour. It is not difficult to conceive a relationship between the phenomena of adsorption and of radiation absorption.

The nature of my employment does not permit me to devote much more than my leisure hours to a study of this kind, and I shall be glad to communicate to any interested worker who may have facilities to pursue the matter both experimentally and theoretically, such results as I have, so far, been able to accumulate.

H. BRADLEY.

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The Mechanism of Enzyme Action.

FOR a long time two viewpoints regarding the mechanism of enzymatic activity have profoundly influenced our conceptions in this field. To Oscar Loew is due the credit for the original suggestion that the enzymes possessing atomic groups with kinetic lability are able, even at a comparatively low temperature, to perform chemical action. This suggestion was later abandoned more and more, and we now generally assume that, as in the case of heterogeneous reactions, the reactants are adsorbed by the enzyme in order that reaction may ensue. In accordance with this we believe with Bayliss that the reaction velocity is determined by the concentration of adsorption complex, that is, reactant—enzyme, present in the system. The possibility of carrying out such reactions depends doubtlessly on certain conditions of the surface, which are also profoundly influenced by the hydrogen ion concentration.

Preliminary experiments carried out with certain zymase solutions which behave as lyophile colloids confirm this assumption. The reactivity of these

solutions could be increased in such a manner that in laboratory tests the first stage of the reaction of zymase, for example, on glucose, produces 4, 5, and more c.c. of carbon dioxide per minute, so that a cell-free zymase solution can easily be prepared which will produce (using 20 c.c. of the zymase preparation containing 5 per cent. of the substrat) 100 c.c. or more of carbon dioxide in less than one hour. Similar effect of increased production of oxygen was obtained by the decomposition of hydrogen peroxide by means of catalase from fresh tobacco leaves.

The reactivity of the surface of the enzymes concerned in this reaction may be tremendously increased by appropriate peptisation, and the velocity of the reaction later undergoes a decrease which cannot be due yet to the decreasing concentration of the reactant. Further experiments have shown that this capacity to react in an intensive manner can be maintained, within certain ranges, in both cases by working with living cells or with the colloidal cell-free solutions. The experiments carried out indicate that certain chemical compounds are capable of forming an adsorption film on the surface of the enzymes which has the rôle of a *protector* (F. F. Nord, *Protoplasma*, **2**, No. 2; 1927). It might thus be assumed further that certain compounds which are supposed to have the effect of an 'activator' of an enzymatic reaction are in reality not activating the reaction, but only insufficiently protecting the enzyme from the damaging effect of intermediate or final metabolic products of the reactions concerned. It might be regarded, therefore, as correct to assume that regardless of the absence or the presence of a protector, which might even be a specific protector, there is always a certain concentration of enzymes present which is potentially capable of acting. However, since the reactivity of the enzyme is dependent on its surface activity, it undergoes immediately with the initial reaction alterations which decrease relatively the velocity of the reaction independently of the concentration of the reactant. In the course of the reaction the ratio between active and 'damaged' enzyme may decrease more and more below 1. Our present experiments have shown that it is possible to delay the speed of the reaction reflected in the change of the quotient noted above.

Since the most favourable conditions for the performance of an enzymatic reaction are in most cases not known, the statements above suggest the conclusion that in a great number of so-called 'activations' of enzymatic reactions by means of chemical compounds, in fact no 'activation' takes place by influencing enzymatic reaction through these compounds, *but the so-called 'activators,' which appear to be really protectors, enable the enzymes to act under conditions which are more nearly those which might be expected to be prevalent in ideal cases.*

The experimental work has been carried out in collaboration with Kurt W. Franke. The details will be prepared for publication in the near future.

F. F. NORD.

Division of Agricultural Biochemistry,
University of Minnesota,
April 12.

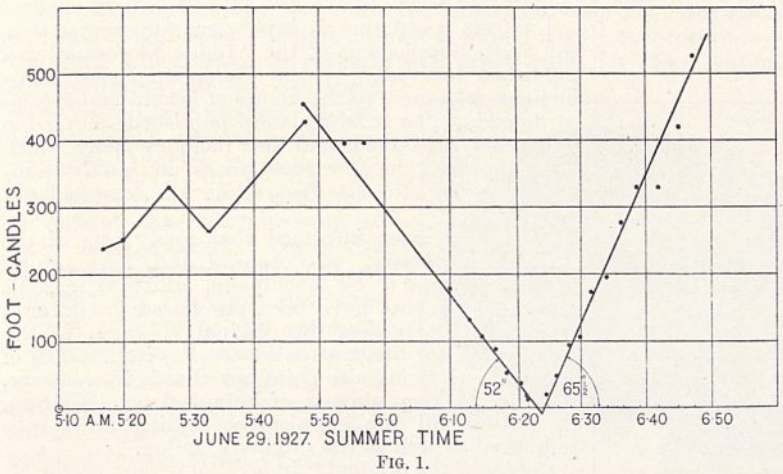

FIG. 1.

Photometric Measurements during the Total Solar Eclipse.

IT occurred to me that it would be interesting to measure the illumination received by a horizontal surface exposed to the hemisphere of sky during the whole period of the eclipse.

I had the good fortune to see the eclipse from a large flat field to the south-east of Bankfield Lane, Southport. There were some distant low houses to the north-west, and some distant trees to the west-south-west, but for the purpose in question it may be assumed that the white test surface, placed six inches above the ground, was exposed to the hemisphere of sky, except for the obstruction of light caused by my crouched body. This was allowed for before the results were plotted (Fig. 1). The readings were taken by means of a daylight photometer (a lumeter).

Practically the whole of the sun's disc was visible for the whole of the time, but there was a haze all the time. Sometimes this haze was noticeably thicker, but fortunately this variation occurred towards the beginning and end of the readings. The regularity of the readings from 5.48 A.M. (with the exception of 5.57 A.M. when the haze was noted) to 6.47·5 A.M. seems to show that the haze must have remained constant during that period. My position when reading was north-east of the test surface, so that the direct sunlight was screened from the surface.

It will be seen that the two inclined lines intersect at 6.24 A.M. (mid-totality), and that the line of decreasing illumination makes an angle of 52° with the horizontal, while in the case of the line of increasing illumination the angle is 65·5° This is due to the greater elevation of the sun during the latter period.

Several accounts of the eclipse refer to the "sudden switching off of the light at totality." This does not seem to be borne out by the curve. It was also thought by many that the light after totality was much greater than before. The curve does support this impression to some extent, but probably most of it was due to the physiological effect of the eye (pupil and retina) adjusting itself gradually to the decreasing light and then suddenly receiving the bright light after totality.

For the convenience of readers when studying the curve, it may be mentioned that at Southport on June 29, the sun rose at 4.47 A.M. Summer Time, first contact occurred at 5.30 A.M. Summer Time, and last contact at 7.21 A.M. Summer Time.

A. S. E. ACKERMANN.
17 Victoria Street, S.W.1.

THE appended graph (Fig. 1) records the intensity of daylight during the recent total eclipse at Criccieth. The measurements were made by a Trotter photometer set up to face that part of the clouds which hid

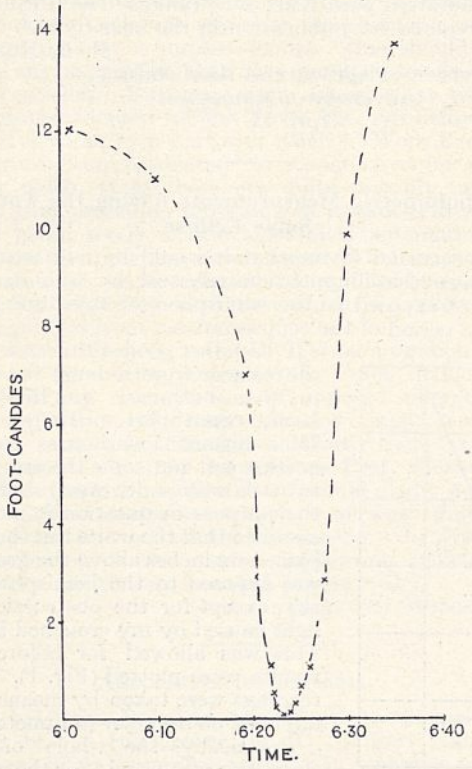

FIG. 1.

the sun from Mr. A. Taylor and his colleagues at the observing station there.

The sudden onset and retreat of the darkness is well shown. The minimum recorded intensity (at $6^h\ 23^m$) was 0·05 foot-candle, so that in 7 minutes after totality the intensity of daylight increased more than 270-fold.

J. H. SHAXBY.

Physiology Institute,
University College,
Cardiff.

The Hythe Skulls.

I AM gratified by the letter of the editor of *Biometrika* in NATURE of July 2, which suggests, though it does not say, that Miss Hooke did not mean to hint that I had wilfully selected certain skulls from the Hythe collection and discarded others which did not suit my purpose. This disclaimer was urgently needed. The suggestion of the editor that only the largest and thickest skulls had been picked out of the stack in 1851 is rather irrelevant, since the question of size is not the point.

What anthropologists who have quoted my paper are interested in is whether these skulls are broader and shorter than any other series of medieval or modern English people shows, and I submit that an average based upon 590 skulls, so long as the imputation of purposive selection is withdrawn, is not likely to differ appreciably from that of a like number recovered since. The question of whether it is advisable to deduce results from skulls which have been reconstructed from fragments, possibly crushed and warped with damp, is quite an open one. In my experience the results are often grotesque caricatures of the original skull, and measurements taken from them are more likely to vitiate than to improve a fair average. In any case, the estimate of five years in which to piece together the fragments in the great stack at Hythe shows an optimism which, though I may admire, I cannot share. It might be done in fifty years, but the results would be quite untrustworthy. Any one interested in these skulls will find a later paper of mine upon them in *Archæologia Cantiana*, vol. 30, p. 203, in which I give my reasons for believing them to be largely of foreign origin, though I freely admit that in my first paper I assumed them to be those of Kentish people.

F. G. PARSONS.

St. Thomas's Hospital,
London.

"Index Kewensis."

I UNDERSTAND that it is not generally known that the Sixth Supplement of the "Index Kewensis" was published last year by the Clarendon Press. This includes references to the names of genera and species of flowering plants which were published during the five years 1916–1920, and also includes many which had appeared in previous years in publications which, owing to the War, were not available at Kew.

As I have been informed that many sets of the "Index Kewensis" in botanical and horticultural libraries appear to be incomplete, and that in some cases supplements have been purchased for libraries which do not possess the original volumes, I have been asked to direct attention to the importance of the work. I would also point out that it is necessary, in order to keep abreast of botanical nomenclature, to possess all the supplements which have been published as well as the original "Index."

Copies of the original "Index" or of any of the six quinquennial supplements may be obtained from the Secretary, The Clarendon Press, Oxford.

ARTHUR W. HILL.

Royal Botanic Gardens,
Kew, Surrey,
June 24

An Early Reference to Continental Separation.

THOSE geologists who are interested in the Wegener hypothesis of the shifting of continents and the literature of the subject may like to know that while reading an old book entitled "Eclipses, Past and Present," by the Rev. S. J. Johnson (James Parker and Co., 1874), I was rather surprised to find the following remarks: "If we study our earth carefully, we shall see that everywhere it bears marks of having undergone a fearful catastrophe. Fossil substances, which originally belonged to the sea, have been found on the heights of mountains; the bones of animals have been discovered in countries the most remote from those they inhabit. Again, *if we look at our maps, we shall see the parts of one continent that jut out, agree with the indented portions of another. The prominent coast of Africa would fit in the opposite opening between North and South America, and so in numerous other instances.* A general rending asunder of the world would seem to have taken place. . . ."

I have italicised the important words.

W. WRIGHT.

24 Balham Park Road,
S.W.12.

Stone Age Man in Kenya Colony.

By L. S. B. LEAKY.

IN September 1926 I sailed from England accompanied by Mr. B. H. Newsam to investigate certain prehistoric sites which I had known of for some years in Kenya Colony. My expedition received financial aid from the Percy Sladen Memorial Fund and the Government Grant Committee of the Royal Society, the assistance of which is gratefully acknowledged. Stone tools of many types had been collected by myself and many others from the surface in Kenya Colony and the other East African territories for a good many years, and it was hoped that the work of the expedition this year would bring to light sites containing stone tools associated with human remains.

This expectation has been more than justified, as the following details will show, and it is hoped that the finds which have been made will prove sufficiently important to call forth more extensive financial assistance, so that work may be continued in 1928 on a more comprehensive scale. A large number of further sites of great promise have been located. Until the specimens obtained have been brought to England and submitted to experts and carefully examined and compared with other prehistoric remains, it is naturally undesirable that I should make any definite statement as to the racial or cultural affinities of my finds, so the following general statement and outline must for the present suffice.

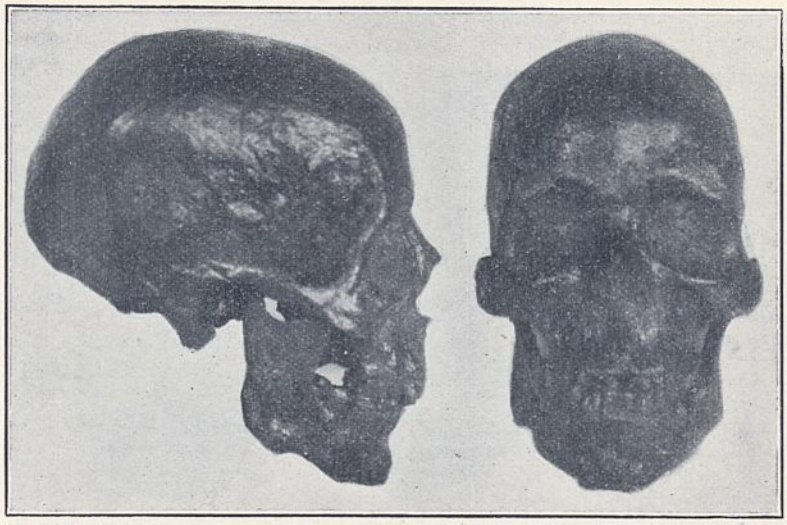

FIG. 1.—Side and front views of Skull No. 9 from the Nakuru site.

THE NAKURU SITE.

The first site excavated which yielded important results was situated on Major Macdonald's farm, Nakuru. Traces of ten burials were found in the lower levels of the deposit at depths ranging from 8 ft. to 12 ft. The majority of these human remains were very fragmentary with the exception of Skull No. 3 and Skeleton No. 9, which was in an almost perfect state of preservation. This find was reported in the *Times* of Dec. 28 last. All the human remains found were definitely associated with a microlithic industry which I consider Mesolithic, and which bears striking resemblances to that industry in Uganda which Mr. Wayland has named Magosian. No attempt has been made to classify the tools out here, but this will be done immediately on arrival in England.

The skulls from the Nakuru site (see Fig. 1) do not resemble the skulls of the modern negro races *inhabiting this country*; nor, apart from extreme dolichocephaly, do they show any of the more marked characters usually considered typical of existing negro or negroid races. The face, instead of being short, is very long, but is not disharmonic as it is proportionately broad, giving an upper facial index of 57·1. The nasal opening is only of medium width, the nasal index being 50·9. The nasal bones are long and are not flattened as in typical negroes, and there is a medium bridge. The lower margin of the nasal aperture has a well-defined sill and not the groove so common in negroid skulls.

The mandible is remarkable in several respects. The horizontal ramus is very deep, especially in the region of the chin, which is very pronounced. The ascending ramus is also very high. This is largely due to, and necessitated by, the great height of the vault of the palate, which—measured from the chewing surface of the second molars—is 29 mm. This is remarkable, being as great a height as that recorded for Rhodesian man by Sir Arthur Keith ("The Antiquity of Man," vol. 2, p. 400). This measurement is given as being 7 mm. more than in the average English palate, while the average palate depth of six negro skulls measured locally is only 16·08 mm.

THE ELMENTEITA SITE.

The other site from which important results have been obtained is on Mr. Monroe's farm, Elmenteita. From this site the remains of at least twenty-six stone-age individuals have been recovered. The site is situated at the base of a small cliff below which there now runs a small stream. The bones were found in an alluvial sand, and were in a very disturbed state, being all mixed up and not lying in skeletal form. Five or six long bones, all femurs, for example, would be found lying in the same sand-filled crevice. Skull fragments and mandibles turned up in all sorts of odd corners with, here and there, pottery fragments and tools. It is at present difficult to account for this state of affairs, and the pros and cons of the various possible theories must be held over until a future date.

In the deposit with the human remains were found a number of obsidian tools mainly of a more primitive type than those from Nakuru, but including a few lunates and other Nakuru types. There was also a certain amount of pottery, some of it with the same decoration as found on the Nakuru examples; numerous animal bones, including skulls, mandibles, and teeth; disc shell beads; and one stone bowl similar to one of the Nakuru types.

At first it was thought that the skulls from the two sites were of the same type, but this is not substantiated by a close comparison made recently, although there are certain similarities. It is even doubtful if all the skulls from the Elmenteita site will prove to belong to the same race. Nevertheless, all the mandibles from this site show common characters, while they differ markedly from the Nakuru mandible.

Skull A from Elmenteita is certainly different from Skull No. 9 from Nakuru. The photographs (reproduced as Figs. 1 and 2) show both the similarities and the differences. In the Elmenteita skull the forehead is low and receding; the nose is much longer than in the Nakuru skull, while the width is much the same, this resulting in a lower index, which is actually 47·4. Moreover, instead of a sill at the base of the nose there is a groove; there is a trace of sub-nasal prognathism, the alveolar index being 103; the height of the vault is nothing like so great, while the mandible is of a quite different type. This is amply brought out in the photograph. The similarities lie in the length of the skull as compared to the breadth, the cranial indices being 68·2 (Elmt.) and 69·8 (Nak.); the upper facial length, which is 80 mm. in both specimens; and the bi-zygomatic breadth, which in each case is greater than the maximum skull breadth, being 136 mm. (Elmt.) and 140 mm. (Nak.).

Another skull type found at Elmenteita has a much broader skull, giving a cranial index of 76. It has a good forehead, and is orthognathous. This type, however, also differs from the Nakuru type.

Perhaps the most surprising feature of the Elmenteita crania is the narrowness of the nose as compared with the length. The four specimens upon which it is possible to take measurements yield the following results:

	Length.	Breadth.	Index.
Skull 'A' . .	59 mm.	28 mm.	47·4
Skull 'B' . .	60 mm.	24 mm.	40
Skull 'C' . .	50 mm.	22 mm.	44
Skull 'D' . .	50 mm.	22 mm.	44

FIG. 2.—Side and front views of Skull A from the Elmenteita site.

These figures are certainly not those suggestive of negro affinities. It seems doubtful even if those Negroid races which to-day have narrow noses can approximate to these figures.

Full details of the work done and objects found will be published as soon as possible after our return to England in September with this season's specimens.

In NATURE for Jan. 8, p. 61, there is a short note on my work based on a report in the *Times* of Dec. 28, 1926. This note contained some inaccuracies and I would be grateful if I may be permitted to correct two of them. I am referred to as "of the Cutler Dinosaur Expedition." I am not a member of this expedition, nor, so far as I know, has an expedition under such name existed out here. In 1924 I had the honour of being, for one year, a member of the British Museum East Africa Expedition which was excavating for Dinosaur remains in Tanganyika Territory under the leadership of the late Mr. Cutler. Further on, reference is made to my "work in investigating stone-age remains in Uganda." Nairobi and Nakuru are towns in Kenya Colony, and it is regrettable that the archæological work in the two countries should be confused.

Some Difficulties in Relativity.

By Prof. S. BRODETSKY, University of Leeds.

THE special theory of relativity was formulated by Albert Einstein twenty-two years ago. The general theory with its application to universal gravitation was published eleven years ago. The relativistic viewpoint has become an accepted principle and instrument in physical science. Yet a complete understanding of the ideas underlying it is comparatively rare among laymen, and far from being universal even among men of science. This is natural, since the theory of relativity presupposes a break with preconceived notions, hallowed by unquestioning acceptance at the hands

of untold generations of experience and thought. We shall in this article consider a few of the difficulties that have come to the notice of the writer.

At bottom, the cause of all the difficulties associated with the special theory is the fact that the signals, which we have used from time immemorial for the purpose of correlating events at different places, travel so fast that it only became possible quite recently to measure their speeds. Even sound travels much faster than anything experienced in actual life until a few generations ago. Light travels so fast, indeed, that to many people it is still a matter of surprise to hear that it is not instantaneous in its effects. Our primitive conceptions of time and space are therefore such as correspond to an infinitely fast signal, and a readjustment of ideas is required in order to reach conceptions of time and space that correspond to a signal that travels with finite and measurable speed.

Thus it appears to some people somewhat arbitrary to lay down the postulate that in empty space (infinitely far removed from the influence of matter) the speed of light must be the same to all observers, no matter what velocities they may have relatively to one another. Not everybody can visualise readily two frames of reference and argue from one to the other. Perhaps the argument will appear simpler if put as follows.

It is as much a fundamental of classical mechanics as it is of relativity mechanics that we cannot discover the absolute motion of a material body. Modern astronomy has long since discarded such views as the fixity of the centre of the earth, or of the centre of the sun, or of the centre of mass of the solar system, or of the centre of mass of the stellar system in which we live. We cannot say, therefore, what is the absolute motion of any material body, such as a long bench. Take two points, AB, fixed on this bench: Can we correlate the times at these two points? This is only possible by sending a signal from A to B. If A sends out this signal at, say, ten o'clock on his watch, B receives the signal and knows that it is then ten o'clock to A.

The signal, however, takes some time to go from A to B, and naturally B will make a correction for this by saying that he receives the signal later than it leaves A, the delay being the distance AB divided by the speed of the signal. Now the bench AB is itself in motion in a manner which is quite unknown. Suppose that it moves with velocity u from A to B: then the speed of the signal relative to AB will be diminished by this amount, so that if its absolute speed is c the delay between A and B is $AB/(c-u)$. But u is unknown. Hence the delay is unknown, and we reach the conclusion that it is quite impossible to correlate the times at A and at B!

We refuse to accept such a conclusion, because it destroys the basis of all natural knowledge. There are only two ways of escaping this conclusion. One is to suppose that c is infinite; the other is to assume that the speed of the signal relative to the bench is quite independent of the motion of the bench, so that if this speed is called c, the delay is always AB/c.

Now even if we could imagine or postulate a mystical signalling agency which travels with infinite speed, we must remember that scientific observations are made with the aid of instruments like telescopes and microscopes, which presumably cannot philosophise, and can only register events as impressed on them by natural agencies. All our observations, whether directly or with instruments, depend upon visual or optical coincidences (sound is never used for really accurate measurements). We are therefore forced to postulate that light travels with a finite speed which is independent of the motion of the observer. Further, we must restrict this postulate to light, and accept that other speeds are affected by the motion of the observer: otherwise we would come into conflict with common experience. Besides, the convection coefficient $1-1/\mu^2$, which gives the amount by which the speed of light in a medium like water (refractive index μ) is affected by the motion of the medium itself, is a direct proof that the fundamental speed which remains unaffected by the motion of the observer is indeed the rate at which light travels in a vacuum.

Another difficulty that has been mentioned is the following. According to relativity, apparently, if an interval of time is measured by two observers A and B, then the value obtained by A will bear to the value obtained by B the ratio $(1-v^2/c^2)^{-\frac{1}{2}}$, where v is the velocity of B relative to A. But the velocity of A relative to B is $-v$, so that the value obtained by B should also be $(1-v^2/c^2)^{-\frac{1}{2}}$ times the value obtained by A. This sounds absurd, and is reminiscent of the rather tantalising game with paradoxes that exponents of relativity used to indulge in before admiring and bewildered audiences. But consider the facts carefully.

The Lorentz transformation is:

$$x'=\frac{x-vt}{(1-v^2/c^2)^{\frac{1}{2}}},\quad y'=y,\quad z'=z,\quad t'=\frac{t-vx/c^2}{(1-v^2/c^2)^{\frac{1}{2}}},$$

where (x, y, z, t) refer to A, and (x', y', z', t') to B, the direction of the relative motion being along the x, x' axes. Hence we get

$$\Delta t'=\frac{\Delta t-v/c^2\,.\,\Delta x}{(1-v^2/c^2)^{\frac{1}{2}}},$$

$$\frac{dt'}{dt}=\frac{1-v/c^2\,.\,dx/dt}{(1-v^2/c^2)^{\frac{1}{2}}}.$$

The ratio of the intervals dt, dt' thus depends also on dx/dt. If dx/dt is zero, we get $dt'/dt=(1-v^2/c^2)^{-\frac{1}{2}}$. But now let $dx/dt=v$; then $dt'/dt=(1-v^2/c^2)^{\frac{1}{2}}$. Whereas in the first case we measure an interval between events at a place fixed relative to A, we are in the second case measuring an interval between events at a place fixed relative to B. There is no inconsistency; the results are in fact consistent and logically correct.

A further difficulty arises in a similar way. If B have velocity v relative to A, then both x' and t' in terms of x and t have the same factor $(1-v^2/c^2)^{\frac{1}{2}}$ in their denominators. Hence it would seem that

any velocity ought to appear the same to both A and B!

The fallacy lies in arguing from

$$x' = (x - vt)/(1 - v^2/c^2)^{\frac{1}{2}}$$

with $t = 0$, and from

$$t' = (t - vx/c^2)/(1 - v^2/c^2)^{\frac{1}{2}}$$

with $x = 0$, and then applying the two results, obtained for different conditions, to a velocity, in which the length and the time refer to the same conditions. The correct procedure is thus:

$$\frac{dx'}{dt'} = \frac{dx - vdt}{(1 - v^2/c^2)^{\frac{1}{2}}} \Big/ \frac{dt - vdx/c^2}{(1 - v^2/c^2)^{\frac{1}{2}}}$$

$$= \frac{dx - vdt}{dt - vdx/c^2} = \frac{dx/dt - v}{1 - v/c^2 \,.\, dx/dt}.$$

In order to get $dx'/dt' = dx/dt$ we must have

$$\frac{dx}{dt}\left(1 - \frac{v}{c^2}\frac{dx}{dt}\right) = \frac{dx}{dt} - v$$

which leads to (i.) $v = 0$ or (ii.) $dx/dt = \pm c$. (i.) is trivial; (ii.) means that only the speed of light is the same to both observers.

In the general theory of relativity very few persons attempt to follow the reasoning that establishes the equations of the gravitational field, and most people are prepared to take for granted the definition of ds^2 in terms of the differentials of the four space-time co-ordinates. Where they begin to see 'physical' arguments is in connexion with the statement that the path of a particle of very small mass must be a 'geodesic' in the space-time continuum thus defined. The following difficulty has been raised: "It is said that the nearest way from any place to any other place on the earth is by following a geodesic. Surely this is not the case, for the nearest way is through a tunnel cut in a straight line."

It is an unfortunate fact that the best examples of geodesics are in connexion with curves on surfaces. These examples are therefore invoked in order to bring nearer to the minds of laymen the notion of geodesics in general. The effect is seen in the puzzle just quoted, and in the conclusion reached by the questioner: "Einstein's idea of space seems to be that which a fly might have walking round inside a glass globe."

When we talk about a geodesic on a surface, then we postulate a being that is restricted to moving about on the surface, and is physically and constitutionally incapable of getting away from the surface. The being may have intellectual knowledge of points off the surface, but such points are outside its physical or dynamical ken. Thus a tunnel through the earth is simply irrelevant to the question of geodesics on its surface. This is in actual agreement with life, as tunnels which are of such a length as to produce shortening of the path relative to the geoid are outside the domain of the practical, and all tunnels in use are constructed for the purpose of keeping as close as possible to the geoid and realising the geodesics on it.

Simplification, however, does not always lead to intelligibility, and it is doubtful whether the non-mathematical student of relativity is well advised to envisage geodesics on a surface, in order to understand geodesics in the four-dimensional space-time continuum. Consider rather geodesics in three dimensions in the following sense. In modern practical life time is often more important than distance, the former being endowed with an economic cash value denied to the latter. If A, B are two points in space, how can one go from A to B in the shortest possible time? If the space is empty, and there are no aids or hindrances in the form of accelerative forces or resistances, intuition tells us that the geodesic (in the time sense) is what we ordinarily call the straight line joining A to B in empty Euclidean space. But now suppose that the space contains aids and hindrances to the motion. Suppose, for example, that between A and B there is a slab of matter through which the motion is necessarily slower than in the empty space. Then one needs no mathematics to see that unless the slab has plane parallel faces perpendicular to the line AB, the geodesic is not the straight line AB. The path of a ray of light in passing obliquely through a thick plate of glass is a relevant and clear example. Still more striking is the path of a ray through a prism. The time taken by the light in travelling between two points, one on each side of the plate or prism, is less than what would be required for any other path between these points, and deviating only slightly from the actual path.

The advantage of considering geodesics in three dimensions is two-fold. In the first place there are no 'tunnels' to distract attention. In the second place it is not very difficult now to conceive that the four-dimensional space-time continuum has varying properties from place to place, so that a geodesic would not in general be straight as understood in the empty space of Euclid. The path of a particle would thus be curved, as viewed from the standpoint of empty Euclidean space, and it is not difficult to see that the natural paths may be, say, circular or elliptical, or in accordance with the more complicated results of the general theory of relativity.

This brings us to the last difficulty which we shall discuss here: it is in connexion with the bending of light rays which are affected by the sun's gravitational field, or rather by the properties of the space-time continuum in the neighbourhood of the sun. Can this not be attributed simply to the attraction exerted by the sun on the light—since we now know light to have both corpuscular and wave properties? It has been argued that even if the observed deflexion is found to be double that given by Newton's law of gravitation in accordance with classical mechanics, yet one might "doubt whether such a calculation is possible until we know the size and mass of the corpuscular element of light with the same degree of accuracy as we know the size and mass of electrons."

The fact is, of course, that the deflexion that would be obtained on the basis of the Newtonian

theory is quite independent of the size and mass of the hypothetical corpuscular element of light. One might indeed invent some modification of the classical Newtonian theory so as to obtain the observed deflexion. But there is surely no point in postulating a theory which does not exist, in order to avoid accepting a theory which sums up in a remarkable manner so many of the laws and phenomena of mechanics, astronomy, and optics.

We all love sensations, and recently a prominent daily newspaper published a column about an alleged forestalling of Einstein by a German astronomer, who a century ago calculated the deviation of a ray of light on the basis of Newton's law of gravitation and the corpuscular theory of light. The formula there given is actually a correct deduction from the inverse square law, but when it is worked out numerically the result is just half of Einstein's value, and of the average value obtained at the eclipses in recent years. The relativity theory of gravitation not only 'explains' gravitation in the sense of representing it as a deduction from reasonable views of the space-time continuum, giving as a first approximation the Newtonian inverse square law, but also yields just the correction required to account for the observed motion of Mercury, and further gives a deflexion of light rays passing near the sun in agreement with observed fact.

Obituary.

MR. A. D. MICHAEL.

THE debt which natural science owes to the work of amateur microscopists has often been commented on. Not a few names of weight in systematic zoology are those of men who turned a fascinating hobby into a serious study, and by patient and prolonged observation acquired a familiarity with the living creatures that the professional zoologists often have cause to admire and envy.

Of this type was Mr. A. D. Michael, well known as an authority on the mites (Acarina), whose death at an advanced age was recently reported. Not only did he produce admirable systematic monographs on several families of the group, but also he was successful in unravelling many details of their often complicated and puzzling life-histories. Together with his wife, who assisted in all his researches, he acquired remarkable skill in minute dissection, and his accounts of the internal anatomy of many forms will not soon be superseded. One of his most interesting discoveries concerned the forms known by the name Hypopus, which are minute, hard-shelled mites with vestigial mouth-parts, found attached to various winged insects by means of suckers. Their nature had been the subject of a great deal of discussion, but by patient observation and experiment Michael was able to show conclusively that the Hypopus is an alternative developmental stage in the life-history of various Tyroglyphidæ (the family which includes the cheese-mite) adapted to secure the dispersal of the species.

Mr. Michael was born in London in 1836. He was educated at King's College, London, and became a solicitor, succeeding to his father's practice. He seems to have taken up microscopy shortly after his marriage in 1865, but his first published paper on the Acari appeared in 1878. His later publications, some fifty in number, appeared mainly in the *Journal of the Royal Microscopical Society*, the *Journal* and the *Transactions* of the Linnean Society, and the *Journal of the Quekett Club*. Nearly all of these were finely illustrated by his own pencil, as were also his monographs of the British Oribatidæ (2 vols., 1883, 1888) and British Tyroglyphidæ (2 vols., 1901, 1903) published by the Ray Society. In 1898, he contributed a revision of the Oribatidæ of the world to "Das Tierreich." He was in succession president of the Quekett Microscopical Club (1885–87) and of the Royal Microscopical Society (1893–96), and vice-president of the Linnean Society (1896–1900). Shortly before his death he presented his large collection of finely prepared microscopic slides of Acari to the British Museum (Natural History) and his microscopes to the Royal Microscopical Society. He died in a nursing home at Bournemouth on June 16 last. W. T. C.

AN appreciation by C. Hart Merriam in *Science* of April 8, of Dr. William Henry Dall, reminds us that by the death of this veteran conchologist on Mar. 27 last, zoology is deprived of one of the last remaining naturalists of the old school. Although chiefly known as a student of the Mollusca, Dr. Dall's activities were by no means confined to this group, his papers and monographs on a variety of subjects all ranking high in scientific literature. His earlier work was chiefly on the natural history of Alaska, which he visited as one of the scientific staff, and later as head, of the Western Union International Telegraph Expedition. Besides exploring and mapping much of the Yukon River, he found time for observations on birds, fishes, and whales, the results of which, as well as geographical works on Alaska, were all published before 1880. From 1871 until 1874, Dr. Dall was surveying the Aleutian Islands and adjacent coasts; from 1880 until his death he was honorary curator in the National Museum, and palæontologist of the United States Geological Survey from 1884 until 1925. From 1893 until 1927 he held the chair of invertebrate palæontology in the Wagner Institute of Science, from 1899 until 1915 was honorary curator of the Bishop Museum, Hawaii, and in 1899 again visited Alaska with the Harriman Alaska Expedition as one of the scientific guests. Dr. Dall's unique experiences thus render his works peculiarly valuable, whether he is remembered as a zoologist, palæontologist, or explorer.

News and Views.

THE appointment is announced in the *London Gazette* of a Royal Commission on Museums and Galleries under State control in London and Edinburgh. The announcement is a welcome indication of the interest of the Government in the great national collections for which it is responsible. For many years the majority of the twenty institutions named in the terms of reference has each pursued its own course unhampered by consideration of the development of sister institutions, and now the promise arises of a means of unifying efforts and correlating activities, which cannot but result in benefit to the institutions themselves and particularly to the public which supports and makes use of them. The need for such an investigation has recently been strongly urged in NATURE by Sir Ray Lankester, and also in a leading article in our issue of April 16. The Commission is a strong one. Every member has had wide administrative experience: finance is specially represented by the Lord D'Abernon (chairman) and Sir Thomas Heath; artistic interests by the chairman, Mr. Evan Charteris, Sir Martin Conway, and Sir Robert Witt; education and the libraries by Sir George Macdonald and Dr. A. E. Cowley; the buildings in which the properties are housed by Sir Lionel Earle; and science by Sir Richard Glazebrook and Sir Henry Miers, the last of whom was himself at one time an assistant in the British Museum (Natural History). It is unfortunate that the Commission includes no one intimately qualified to weigh the evidence from the biological sciences, although they must occupy a large part of the inquiry, since they cover most of the Natural History Museum at South Kensington, the Royal Botanic Gardens at Kew, a large section of the Royal Scottish Museum, and the Royal Botanic Garden in Edinburgh, the name of which, surely by some slip, does not appear in the terms of reference.

IT is interesting to notice that in this official announcement the present clumsy title of the "British Museum (Natural History)" is simply replaced by "Natural History Museum"—a change long since advocated in these pages. The terms of reference are of the widest character. They include an inquiry into the legal position, organisation, administration, accommodation, and structural condition of the buildings and general cost of the institutions; an investigation of the past growth of the collections and estimate of the probable growth in the next half-century. Consideration is to be made of possible means of lightening the financial burden upon the taxpayer, either by curtailing expenditure or by instituting a more general system of entrance fees. The questions of duplicate specimens and their distribution by sale or loan to provincial museums; of better correlation between the exhibits of the State institutions; of hampering conditions attached to benefactor's bequests and the possibility of their removal or modification, are all specified as part of this comprehensive inquiry. An exceedingly important clause, which may well lead to a turning-point in the history of British national museums and galleries, reads: "to consider whether the existing administrative responsibility for the various institutions is the most appropriate under modern conditions and whether it conduces to the most advantageous distribution and display of the national treasures, and to report whether it would be desirable, while preserving certain defined powers to their Trustees or Directors, to place them all under some central authority or under different authorities than those at present controlling them." The terms of reference treat the national collections as educational units isolated from and independent of the rest of the educational system of the country. The position is a mistaken one; it is to be regretted that no hint is given of a desire to bring museum and art collections into active and responsible connexion with the great teaching institutions which lie outside the control of the State.

THE King of Spain has presented to the Natural History Museum, South Kensington, a group of Spanish ibex (*Capra pyrenaica victoriæ*) from Sierra de Gredos, Avila, Spain. It is a new race which was named by Prof. A. Cabrera after the Queen of Spain. The group, which consists of a male, female, and young, was mounted and realistically arranged in its natural rocky surroundings by Senor Luis Benedito, of Madrid, and the case containing it has been placed in the Central Hall, immediately facing the entrance. These specimens are the first of the race to be received at the Museum and form a valuable accession to the collections. The male and the young one were shot by the King on his estates. The race was a few years ago in danger of extinction, but, thanks to the King's active efforts to preserve it, its numbers have now increased to many hundreds. At the presentation, which was made by King Alfonso on July 7, King George was also present, and their Majesties were received by four of the Trustees—the Archbishop of Canterbury, the Earl of Crawford and Balcarres, Lord Rothschild, and Mr. F. Cavendish Bentinck—and by Sir Frederick Kenyon, Dr. W. T. Calman, Major E. E. Austen, Dr. W. D. Lang, Dr. G. T. Prior, Dr. A. B. Rendle, and Dr. G. F. Herbert Smith. The Spanish Ambassador and the Duke of Miranda were also present.

ELSEWHERE in this issue a communication from Mr. L. S. B. Leaky deals with the discoveries relating to early man in Kenya Colony, to which reference was made in NATURE of Jan. 8 last. Mr. Leaky's more detailed account fully confirms the importance of this discovery, although for the moment, pending a detailed examination of the implements, pottery, and skeletal remains, and a closer acquaintance with the conditions of the finds, judgment as to its full significance must remain in suspense. It is obvious, however, that this fresh evidence of early man in East Africa presents some very striking features. Particularly interesting is the addition to the sites outside Europe upon which

a microlithic industry has been found, especially if Mr. Leaky's contention that it is mesolithic can be sustained. Features of the skeletal remains with which this industry is associated mark it off most emphatically as the culture of a race quite distinct from any of the present or of the known recent inhabitants of the country. Reference to the illustrations will confirm the distinctive character of certain features which Mr. Leaky describes, especially the remarkable character of the Nakuru mandible with its high ascending ramus and the long and narrow non-negroid nose of the Elmenteita people. We regret that in our previous note, as pointed out by Mr. Leaky, it was inadvertently stated that his previous archæological investigations had been carried out in Uganda instead of Kenya, and that it was not made clear that his present expedition had no relation to the previous expedition of which he was a member.

FIFTY years ago a significant event occurred in the history of the human race, whether regarded from the biological or the sociological point of view—the trial of Charles Bradlaugh and Mrs. Annie Besant for republishing Dr. Charles Knowlton's pamphlet "Fruits of Philosophy," in which principles and methods of what are now called birth-control were described. From that trial sprang the neo-Malthusian or birth-control movement; the Malthusian League having been formed on July 26, 1877, followed by leagues in Holland, Germany, France, and several other European countries, and culminating in the American movement pioneered by Dr. W. J. Robinson and Mrs. Margaret Sanger. The interest evoked by the trial was so great that hundreds of thousands of copies and translations of the Knowlton pamphlet, of Dr. George Drysdale's "Elements of Social Science," and other booklets were sold within the next few years, and the birth-rate of England and several other countries, which had been rising before the trial, showed a more or less strong downward tendency from that year. Man had already begun to apply science to master most of the external forces of Nature, but he was still subject to the law of the struggle for existence due to excessive reproduction; and the year 1877 opened up a new era of man's control over his own destiny by the substitution of rational for natural selection. The Malthusian League will celebrate the jubilee of the Knowlton trial and of its own formation by a dinner at the Holborn Restaurant on July 26, at which Prof. J. M. Keynes will preside, and the speakers will be Dr. Annie Besant, Mr. H. G. Wells, Dr. C. V. Drysdale, and Mr. J. Sumner. Particulars can be obtained from the Secretary of the League, 120 Victoria Street, S.W.1.

THERE were at one time few British men of science more widely known than Sir Frederick Abel, the famous chemist, the centenary of whose birth falls on July 17 of this year. All his life Abel was associated with notable men and institutions. One of the twenty-six original students of the Royal College of Chemistry, he was made one of Hofmann's assistants and became the successor of Faraday at the Royal Military Academy, Woolwich. This appointment determined his career and most of his original work related to explosives. He collaborated with Dewar and with Noble, and with Dewar was the inventor of cordite. His standing was such that at various times he was president of the Chemical Society, of the Institution of Electrical Engineers, of the Iron and Steel Institute, and of the British Association. Neither did his public services end here, for on his retirement as Chemist to the War Office he was made chairman of the General Committee on Explosives, and for several years was Secretary and Director of the Imperial Institute. He took a leading part in promoting the testimonial to Hofmann in 1888 and delivered one of the Hofmann Memorial Lectures to the Chemical Society. Abel died on Sept. 6, 1902.

AN interesting development in the financing of industrial research has recently taken place in Australia. For many years tobacco has been grown in various districts, but for the most part the colour and aroma have been unsatisfactory, comparing most unfavourably with Virginian leaf. A leading tobacco manufacturing company in the Commonwealth, The British-Australasian Tobacco Co., Pty. Ltd., has incorporated as much of the local leaf in its products as its customers will accept, and has made considerable effort, without much success, to discover the reasons for its inferiority. It has now offered to provide £20,000 towards the cost of a thorough scientific investigation of the whole problem of tobacco-growing, on condition that the Commonwealth and State Governments provide £10,000. If, when this sum is exhausted, the results obtained appear to justify it, the Company will give an additional £30,000 if the Governments will give a like sum. Thus altogether £90,000 will be available for the investigation.

THE Commonwealth Government has accepted this generous offer, and the executive control of the work is to be handed to a committee of three members, Mr. H. W. Gepp (chairman of the Development and Migration Commission), Dr. A. C. D. Rivett (chief executive officer of the Council for Scientific and Industrial Research), and a third member to be nominated by them, who will probably be Dr. Darnell Smith of the N.S.W. Department of Agriculture. Dr. Smith has recently completed some very successful work on the control of blue mould in tobacco plants. The services of experts in tobacco growing both in the Commonwealth and abroad will be sought, but it is expected that many years of work will be required before the problem of growing first-class Australian leaf is solved. This is one of the first instances of a business organisation placing large funds for the investigation of a national problem in which it is interested at the disposal of government institutions, and it is to be noted that the Company has deliberately refrained from seeking any measure of control of the work or of the expenditure upon it.

SEVERAL interesting photographs of the eclipse of the sun on June 29, including the picture reproduced in NATURE of July 9, were shown at the meeting of

the British Astronomical Association on July 6. Among the lantern slides exhibited were some striking photographs of the corona taken at Giggleswick by Dr. R. L. Waterfield. One of these is here reproduced (Fig. 1) with the disc enlarged to double its diameter on the original negative. This picture was obtained with a Wray visual lens of 4-in. aperture and 60-in. focal length. A super-speed panchromatic plate (reputed speed, 1250), kindly prepared and provided by the Imperial Dry Plate Co., was used, and the exposure was just under one second. Five

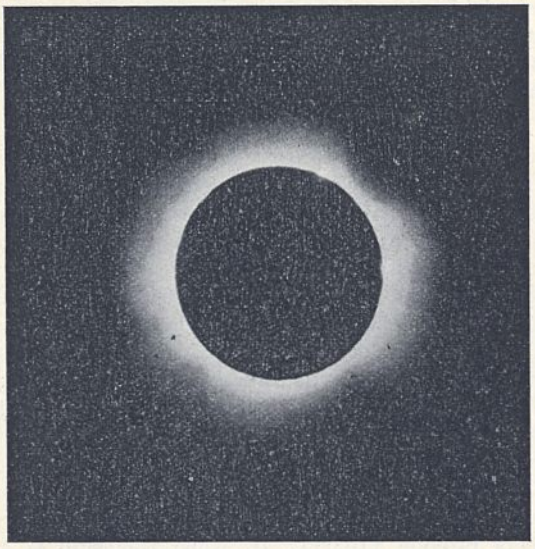

FIG. 1.—Photograph of solar corona, taken at Giggleswick on June 29 by Dr. R. L. Waterfield. ×2. Exposure 1 sec.

inches in front of the plate a Beta (Ilford) filter was placed, and this, by cutting out both the blue and red ends of the spectrum, corrected the visual lens and avoided sky scattering. The exposure factor of the filter was 3; hence the effective focal ratio was increased from *f* 15 to *f* 45. A large part of the extent, and much of the fine detail, has, of course, been lost in the process of reproduction, so that the accompanying illustration does not do justice to Dr. Waterfield's beautiful picture. We understand, however, that lantern slides are being prepared by Messrs. Hamblin, Ltd., 15 Wigmore Street, London, W.1, and will shortly be on sale.

COMMANDER R. E. BYRD, who recently flew the Atlantic and last year flew from Spitsbergen to the Pole and back, proposes to lead an expedition to the Antarctic leaving America in the autumn. According to the *Times* his base of operations will be on the edge of the Ross Barrier and the purpose of the expedition will be scientific exploration of Antarctica. The expedition will number about fifty men and will take two aeroplanes in addition to dogs and sledges. The aeroplanes are to be provided with floats interchangeable with skis. One of the machines will be three engined and used for a flight to the Pole. The other smaller machine, with one engine, is to be employed in reconnaissance work. Commander Byrd is reported to have expressed his belief in the existence of a large area in the continent not covered by snow. Enough is known of Antarctica to make it possible to deny the probability of this. At the same time, if landing-places prove suitable, some useful general work might be done by aeroplane, particularly to the south and east of Edward Land. In the autumn a projected Argentine expedition has already announced its plans of flying from Graham Land to Victoria Land.

THE terrible floods which have recently occurred in the Lower Mississippi Valley have been taken as the text for an article issued by Science Service of Washington on the ancient issue of forests versus engineering works as means of preventing floods. America lacks any results based on actual scientific experimental work in this direction. But it is pointed out that the older countries of the world have spent long years (the word might have been centuries) in the hard school of adversity and in acquiring experience in this matter and have learnt many lessons. France, Italy, Switzerland, and Spain have suffered severely in the past through the disafforestation in mountainous regions of the catchment areas of the big rivers. Large sums of money have been spent in Europe and much patient experimental work has been carried out to build up the knowledge and scientific data which are available at the present day. In dealing briefly with this matter, the writer points out that floods are not only detrimental, through the sheer weight and force of the water, to property, both house and land, as also a danger to life; but he shows that they carry along with them in their destructive path great quantities of the earth's most fertile soil, which fills up reservoirs and irrigation works, silts up rivers and streams, chokes harbours and forms bars across the mouths of previously navigable rivers. He instances America's danger owing to the unchecked lumbering of the forests which has for so long taken place; and concludes his note with the statement that expert opinion nowadays is unanimous in making use of a combination of engineering methods and forestry to control floods, rightly saying that both foresters and engineers in Europe hold that the establishment of a forest cover is a very necessary step.

THE new giant dirigible R100, which is being built at North Howden, Yorkshire, will have accommodation for a hundred passengers and a crew of fifty. The electrical equipment is being provided by the Metropolitan Vickers Electrical Company and presents novel features, as considerations of safety and the necessity of using the lightest possible material complicate the problem. It is necessary to use equipment of the least possible size and the highest efficiency. Two generators giving a total output of 25 kilowatts are to be installed in the machinery cars, where they will be driven by the small petrol engines used for starting the main driving engines of the airship. The casings and fittings throughout the ship will be made of light alloys. A cable having its conductor

and sheathing both of aluminium will be used. As the envelope has a capacity of five million cubic feet of gas, every precaution has to be taken to prevent open-air sparking due to any fault in the wiring. The sheathing of the cable, although it is strong, is capable of considerable extension. In the event of undue forces being applied to it, the conductor will break whilst the sheath is still intact, and thus an external spark will be prevented. The electrical system provides for compartment and navigation lighting, compartment heating, cooking, water heating, and radio signalling.

RADIO beam communication has been making most satisfactory progress in Great Britain, mainly due to the ability of the engineers of the Marconi Company. The beam systems connecting the Post Office directly with Canada and Australia are working well. The system connecting London and Cape Town is finished, and the last of the Imperial group of the radio beam stations connecting London and India will be inaugurated next month. In the original contract it was specified that communication with Cape Town should be maintained for at least eleven hours a day. Senatore Marconi found in 1924 that when the wave-lengths transmitted were less than 100 metres, excellent communication could be maintained during the night time. He also found out that when the wave-length was lowered below 30 metres, daylight signals could be sent but night signals deteriorated. Further investigation showed that to Cape Town, wave-lengths of 33 metres were excellent during darkness and waves of 16 metres were equally excellent during daylight. By using two wave-lengths, therefore, they are able to maintain almost continuous service. The Marconi Company calculates that good traffic operation, high-speed duplex operation at speeds of more than 100 words per minute, can be maintained for about 22 hours per day outwards to Cape Town and about 20 hours a day inwards from South Africa. These results are as welcome as they are unexpected. This is the first station to use two wave-lengths, one for daylight and the other for night communication. It is particularly convenient that the standard time of the Union of South Africa is only two hours fast of Greenwich time. Sunset and sunrise therefore in both countries occur at nearly the same time. In the case of the Australian service, only one wave-length is used, but transmission takes place in one direction round the world during one portion of the 24 hours and in the opposite direction during the remainder of the time.

THE Institute of Physics gives notice that its examination of candidates for associateship will take place in London in September next. The latest date of entry for the examination is July 31. Forms of application can be obtained from the secretary, 1 Lowther Gardens, S.W.7.

RESEARCH Fellowships for work on textiles or any problem having a bearing on wool, in chemistry, engineering, physics, zoology, or other sciences, and Advanced Scholarships for those intending to enter the woollen and worsted industries, are being offered by the British Research Association for the Woollen and Worsted Industries, particulars of which are obtainable from the Secretary, Torridon, Headingley, Leeds. The latest date for the receipt of applications is July 31.

THE following have been elected honorary fellows of the Royal Society of Edinburgh: *British Honorary Fellows*—Sir William Bragg, Sir David Bruce, Sir J. B. Farmer, Sir F. G. Hopkins. *Foreign Honorary Fellows*—Niels Bohr, professor of physics, University of Copenhagen; Jules Bordet, professor of bacteriology, University of Brussels; Albert Einstein, professor of mathematical physics, University of Berlin; Hans Horst Meyer, emeritus professor of pharmacology, University of Vienna; Johannes Schmidt, Carlsberg Laboratorium, Copenhagen; Richard Willstätter, professor of chemistry, University of Munich.

A service of air liners for passengers and mails is being rapidly developed in America. Science Service of Washington gives details of several of the longer routes. A service between San Francisco and Chicago is now open and will be extended to New York in August. The transcontinental journey is timed to take 32 hours compared with about four days by rail. Other routes now working are between Boston and New York, Salt Lake City and Los Angeles, and Seattle and Los Angeles. The long-distance routes are now lighted for night traffic. On Aug. 1 the air mail routes will pass from government to private control, and most of the lines which now carry only mails will then cater for passengers also.

THE preliminary programme has been received of the fifth International Congress of Genetics, to be held in Berlin on Sept. 11-18. The presiding committee includes leading geneticists from various countries interested, and general addresses have already been arranged to be given by such well-known workers as Wettstein, Rosenberg, Pearl, Federley, Vavilov, Pézard, Correns, Seiler, Crew, and Muller. English, French, and German are proposed as the official languages, and other languages may be admitted by action of the Congress. The membership fee is 15 Reichsmark, while the subscription price for a copy of the *Proceedings* of the Congress is fixed at 30 Reichsmark. Ladies accompanying members to the Congress pay no additional fee. Those intending to read papers before the Congress are asked to notify the Committee before Aug. 1. The Congress is divided into three sections: (1) General genetics and cytology. (2) Heredity in man and eugenics. (3) Animal and plant breeding. In addition to papers and demonstrations, excursions during and after the meetings are being arranged. Requests for further information should be addressed to Prof. Erwin Baur, Albrecht-Thaer-Weg 6, Berlin-Dahlem.

AT the recent meeting of the Trustees of the Beit Memorial Fellowships for Medical Research, Dr. H. H. Dale, head of the Department of Biochemistry and Pharmacology of the Medical Research Council, was

appointed a member of the advisory board in succession to the late Prof. E. H. Starling. The following elections to fellowships were made, the subject of research and value and term of the fellowship being indicated after the name:— *Senior Fellowship in Tropical Medicine* (£1000 a year for five years): Dr. E. Hindle—spirochætosis, with special reference to the causation of yellow fever. *Junior Fellowship in Tropical Medicine*: Dr. H. P. Hacker—problems in the prevention of malaria. *Junior Fellowships* (£400 a year): Dr. F. R. Winton—the physiology and pharmacology of urinary secretion and the physiology of mammalian plain muscle; Mr. W. R. Wooldridge—bacterial chemistry and its application to immunological problems; Mr. W. T. J. Morgan—the structure of the hexosephosphoric acids by the method of methylation and subsequent oxidation; Mr. P. Eggleton—the carbohydrate metabolism of contractile tissue and a comparative study of different types of contractile tissue; Mr. G. F. Marrian—the physiological rôle of vitamin B, and the chemistry and physiology of the adrenal glands; Mr. A. R. Fee—the oxygen usage of the kidney, with particular reference to the action of pituitrin, and the factors controlling the elimination of acids and alkalis by the kidney, by the isolated heart-lung-kidney preparation and other methods. Three appointments of Junior Fellows to Fourth-Year Fellowships and one appointment of a Fourth-Year Fellow to a Senior Fellowship were also made.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A master for mechanical engineering subjects and mathematics at the Sheerness Technical Institute and Junior Technical School—The Principal, Technical Institute, Sheerness (July 18). Assistant chemistry and engineering drawing and mathematics masters at the Junior Technical School, Smethwick—The Director of Education, 215 High Street, Smethwick (July 23). An assistant to the director of the Clinical Laboratory of the Manchester Royal Infirmary, with research experience in physical or organic chemistry or in biochemistry—The General Superintendent and Secretary, Royal Infirmary, Manchester (July 28). A principal of the Mansfield Technical College—The Director of Education, Shire Hall, Nottingham (July 30). Two research fellows in the Department of Glass Technology, The University, Sheffield—The Registrar, The University, Sheffield (Aug. 6). A student probationer (Aug. 13) and a technical laboratory assistant at the Millport Marine Station of the Scottish Marine Biological Association—The Secretary, Scottish Marine Biological Association, 88 Bath Street, Glasgow. A professor of chemistry in the University of Melbourne—The Agent-General for Victoria, Australia, Victoria House, Melbourne Place, Strand, W.C.2 (Oct. 1). A lecturer in mathematics at the Gordon College, Khartoum—The Controller, Sudan Government London Office, Wellington House, Buckingham Gate, S.W.1. An assistant lecturer in science at the Training College, Carmarthen—The Principal. An engineering workshop instructor at the Battersea Polytechnic—The Principal, Battersea Polytechnic, Battersea, S.W.11. A demonstrator of pathology in the University of Bristol—The Registrar. Two entomologists in the agricultural department of Kenya and two entomologists in the agricultural department of the Straits Settlements and the Federated Malay States—The Private Secretary (Appointments), Colonial Office, 38 Old Queen Street, S.W.1.

Our Astronomical Column.

THE NAUTICAL ALMANAC FOR 1929.—A number of changes and additions in this issue of the "Nautical Almanac" call for comment. At the meeting of the International Astronomical Union at Cambridge in 1925, a resolution was adopted to the effect that the ephemerides should give 5-figure values of the logarithms of the quantities $\rho \sin \phi'$ and $\rho \cos \phi'$, including the effect of altitude, for each observatory. This has already been done, and natural values as well as logarithms are given. The number of observatories listed has been more than doubled, while the list has been divided into two—active observatories and former observatories. A third or index list gives every conceivable cross-reference. The lists appear to be very complete, and it is stated that in each case the authority for the latitude and longitude is a reply sent by the observatory to a circular letter.

The list of Standard Times has been greatly extended, and Non-Standard Times added, so that two pages summarise the times adopted in every civilised country.

There is an addition which should be welcome to those who compute orbits of comets and asteroids. This is the sun's co-ordinates, both spherical and rectangular, for the equinox of 1950·0, for each midnight in 1928 and 1929. The longitude and latitude are given both to 0°·00001 and to 0″·1, and the natural radius vector (an invitation to calculating machines) to seven decimals; first differences are printed throughout. The co-ordinates X Y Z are given to seven decimals as usual, but with first and second differences.

Two pages are devoted to interpolation tables, in the critical form, giving coefficients of the second, third, and fourth differences. It is believed that this is the first occasion on which the principle of critical tables has been applied to published interpolation tables. They can be recommended not only to astronomers, but also to all who have to deal with the art of interpolation.

The other features remain as in 1928. It is stated on page 667 that considerable changes are contemplated in the "Almanac" for 1931. The "Almanac" is available either in paper covers as formerly, or bound in cloth.

THE STONYHURST COLLEGE OBSERVATORY.—The Report of this observatory for 1926 is to hand. The solar disc was drawn on 281 days; the mean daily disc area of spots, in units of 1/5000 of the visible surface, was 5·33, as compared with 3·53 in 1925 and 1·36 in 1924. The activity was equally divided between the northern and southern hemispheres. The magnetic activity increased in sympathy with the spot activity. There were 31 per cent. 'quiet days' as compared with 36 in 1925. 32 earthquakes were recorded in 1926, 55 in 1925, and 106 in 1924.

Research Items.

THE LAPCHAS.—Vol. 31, No. 4, of the *Journal and Proceedings of the Asiatic Society of Bengal* is a study of the folklore of the Lapchas of Sikhim, supplemented by incidental notes on their social anthropology, by Mrs. C. de Beauvoir Stocks, which is based upon observations made on two journeys in that country in 1925. Very little attention has been paid to the Lapchas and, owing to contact with Tibet—the Sikhim Rajas are of Tibetan descent and are recognised as in a sense alien by the people—and India, and their conversion to Buddhism, their folklore shows extraneous influences, also perceptible in their customs and beliefs, but not always easy to disentangle in the present stage of our knowledge of them and their immediate neighbours among the Himalayan peoples. For example, the conceptions of gods is vague, and apparently it had not attained any advanced stage of development when it was superseded by Buddhism. It would appear that there were five deities, but even their names may have been forgotten as the terms at present applied to them in certain cases are purely descriptive, *e.g. It-Mo*, "The Ancient Mother," while others are of Tibetan origin. The five original deities are a family of mother, father, two children, and a son of the mother. Among them the creative power is attributed to the female deities. The mother is probably the living force of the animal and vegetable world. An especially significant figure is the *Bong-thing*, or medicine man, the son of a goddess who was sent as a Shaman to relieve human beings from the tortures of the demons. In Lapcha belief, as in Tibetan Buddhism, and in India, demons play a very prominent part, and the heroical tales are filled with demoniacal beings, ogres, etc., who haunt every locality which presents some dangerous or unusual character, such as the unhealthy jungle with its dangers from wild animals, or a hill-top, or cascade. One demon inhabiting the top of Mt. Tendong was said to take a toll of two lives in each year.

EGYPT OVER THE BORDER.—Sir Flinders Petrie in Part II. of *Ancient History* for 1927 describes the results of his excavations in Palestine during the past winter. The site chosen for excavation was Tell Jemmeh, which has been conjectured to be the site of Gerar. It has fifty feet depth of ruins, all dating from before the Roman period, whereas the "ruins of Umm Jerar," formerly identified with Gerar, are entirely of late Roman Age. The site is evidently, from the size of the ruined granaries, of importance as the centre of a great corn country. This fact, in conjunction with its position, explains much of the Genesis narrative. Four periods of construction so far have been examined: (i.) The granaries, which belong to the latest occupation of the site in the fifth and fourth centuries B.C. These must have served as the base of the Persian army in maintaining the Persian hold on Egypt, for they are much larger than the needs of the inhabitants would require, being twenty and thirty feet across and probably thirty and fifty feet high. (ii.) A fort similar to those of Naukratis with pottery of the seventh century B.C.; foundation deposits of model corn-rubber and calf bones marking it as of Egyptian origin. Scythian bronze and arrowheads were found around it as well as an iron arrowhead of the type found later in central Russia. (iii.) Chambers built without any regular plan with Cypriote pottery of the eighth and ninth centuries B.C. (iv.) Buildings of grand style built of great yellow bricks in a thoroughly Eygptian method of construction, which at latest can be assigned to the time of Shishak. Thirty feet of ruins still remain to be uncovered.

SPRAYING POTATOES.—Potato blight is a disease which attacks the haulms and foliage of the plant, and also causes the tubers to rot. In general it may be expected in Great Britain between mid-May and mid-June, though the time of its appearance varies in different parts of the country, usually being later in the north and drier eastern counties, for it is greatly encouraged by wet and mild conditions. Methods for the prevention and control of this disease are given in the Ministry of Agriculture's Leaflet No. 23. Bordeaux and Burgundy spray mixtures are especially recommended, successful results having been obtained since their first employment in 1885. Both contain copper sulphate, mixed with milk of lime and washing soda respectively, and full details of their preparation are given in the leaflet. The spray forms a gelatinous film over the surface of leaf and stem, acting as a protective rather than a remedy against the fungus, therefore spraying should preferably be done *before* the blight is detected. A second application after an interval of three or four weeks is recommended, and in wet summers a third may be needed. Dusting with powders is also used, but the results are not so satisfactory, as a less efficient film is formed. Further, the commercial article is liable to contain impurities, whereas the ingredients of the spray mixtures are readily obtained pure. Dusts are therefore not recommended except in cases where a shortage of labour or water occurs, though they are preferable to no action at all. The cost of one spraying is probably between 5*s.* and 7*s.* 6*d.* per acre, 100-120 gallons of mixture being required; to this must be added the cost of labour. The increased value of the crop may on an average be reckoned as equivalent to the selling price of one to two tons per acre.

GREENHOUSE FUMIGATION.—A number of pamphlets have recently come to hand dealing with greenhouse fumigation by means of calcium cyanide. With the expansion of the greenhouse industry there is an increasing demand for efficient fumigants. The old method of generating hydrocyanic acid gas by means of sodium cyanide or potassium cyanide and diluted sulphuric acid involves both trouble and some skill. Within the last two or three years calcium cyanide has been widely tested in the United States and placed on the market. In England this compound has also attracted some attention and a certain number of trials have been made. According to Mr. H. W. Miles (*Annals of Applied Biology*, vol. 14, 1927, p. 240), for the majority of plants, routine fumigations require only one-quarter ounce of calcium cyanide per 1000 cubic feet of space to maintain a high degree of pest control. Its special advantages are the ease attending its use, since the powder is merely poured from its container into a measuring receptacle and distributed along the greenhouse paths, the house being then closed down and locked. On coming in contact with atmospheric moisture the calcium cyanide slowly evolves hydrocyanic acid gas. With the dosage mentioned it is stated that an area of 40,000 cubic feet can be fumigated at a cost of 1*s.* 8*d.* plus the cost of labour.

ACARINE DISEASE IN HIVE BEES.—*Bulletin* 33 (1927) of the North of Scotland College of Agriculture, by Dr. John Rennie, deals with the cause, nature, and control of Acarine disease in the hive bee. It is now tolerably well known that in this disease the thoracic breathing tubes of the bee are infested with mites which pass their whole existence in that situation. These mites are true parasites belonging to the family Tarsonemidæ and to the species *Acarapis woodi*

Rennie. Worker, drone, and queen bees are all liable to infection and, when the mites become securely established, affected bees eventually become disabled. This is primarily due to the continuous loss of blood, which the mites absorb through their piercing mouth-parts. There is, further, a blocking of the air-tubes by the mites, which thus restricts the oxygen supply of the bee and causes a deterioration of the tissues connected with the infested parts. Weakened bees may work for a long time, but finally become unable to fly or to share in the normal life of the colony: the larvæ or brood of the bee, however, are never infested. The difficult subject of treatment of the disease is discussed at length. With slight infestations and with a stock numerically strong in autumn, there is a possibility of survival. In cases of this kind where the percentage of infested bees in a random sample is about 30 per cent. or less, treatment of the hive with a mixture of chloropicrin, camphor, and methyl salicylate in minute doses is advised. This mixture, it is claimed, kills the parasitic mites without seriously interfering with the bees. Stocks badly infested in autumn or spring are useless; they merely function as sources of infection and are best destroyed. In cases of summer infection, treatment with volatile substances is not expedient, and success in such cases rather lies in management, so that the maximum of young foraging bees is produced at the time of honey flow. This is best effected by the early introduction of young queens, which produce bees faster than the disease can destroy them. Stocks thus saved, even though only temporarily, can be maintained for a time, at least, with profit.

SALMON OF THE OUTER HEBRIDES.—We have for the first time information on the salmon of the Grimersta District, Lewis, as a result of examination of scale measurements and other details obtained by Mr. W. J. M. Menzies (*Fisheries, Scotland, Salmon Fish.*, 1926, 6 (January 1927)). A total of 803 fish taken on rod and line in 1925 are dealt with. Of these fish, 80 per cent. were grilse, the remainder being mostly 2 and 2+ winters fish. Compared with east-coast districts the scarcity of small summer fish was marked. The grilse were mostly taken in July, August, and September, 57·3 per cent. of the whole season's catch of grilse occurring in July. Previously spawned fish were only slightly more numerous than in the steadily netted districts of the east coast. The average smolt age was considerably higher than in most other east-coast districts, 60 per cent. migrating in their third year; this is perhaps to be correlated with the scanty food supply available in the waters, which are surrounded by infertile, peaty and rocky country. One-year smolts were entirely absent, and 5 per cent. of the parr stayed in the fresh water for four or even five years before migrating. The grilse were a pound heavier and nearly two inches longer, on the average, than those from the Dee and Spey, but it is to be remembered that in the Grimersta district they run later than they do on the east coast, which possibly gives more time for feeding and growing. The scale erosion on the grilse begins in July, that is, very soon after cessation of feeding, the percentages with eroded, or, rather, absorbed, scales being 49·2 per cent. in July, 99·1 per cent. in August, and 100 per cent. in September. A check in growth was also noticed on the grilse scales, occurring apparently at about the same time as is the case for east-coast fish.

NATURAL PLANT HYBRIDS.—Numerous natural hybrids have been recognised in the flora of New Zealand, and Mr. H. H. Allan has recently described several of these hybrid swarms in a series of short papers in *Genetica* (vols. 7 and 8). Some of the hybrid forms have been produced artificially by crossing. *Coprosma Cunninghamii*, which was described by Sir Joseph Hooker as an extremely variable species, is found to occur wherever *C. robusta* and *C. propinqua* grow together. An artificial cross of these species produced a uniform F_1 closely resembling some forms of the wild *C. Cunninghamii*. *Melicope simplex* × *M. ternata* gives a series of wild forms which are believed to be partly the result of epharmonic response by the individual to wind-swept conditions and partly the sorting out of suitable forms by the diverse conditions. Other apparent wild hybrid swarms are *Nothopanax anomalum* × *N. simplex*, *Hoheria augustifolia* × *H. sexstylosa* and *Corokia buddleoides* × *C. Cotoneaster*. A hybrid community of Hebe (the shrubby Veronicas) is more fully studied in conjunction with Messrs. G. Simpson and J. S. Thomson. The Hebes at Blanket Bay are found to show a mingling in various degrees of the characters of *H. elliptica* and *H. salicifolia* var. *communis*, which are also found in the community. The conditions indicate a freely intercrossing population of forms in areas where both species occur; and the same is believed to apply to various other pairs of species of Hebe as well as other genera. These results will be further elucidated by crossing experiments which are being undertaken.

CURRENTS OF THE ENGLISH CHANNEL.—Mr. J. N. Carruthers (*Jour. Marine Biol. Assoc.*, vol. 14, No. 3, March 1927, pp. 685-721) reports on an experiment with drift bottles, both surface and bottom, carried out by the Ministry of Agriculture and Fisheries and the Marine Biological Association jointly in July 1924. The bottles were liberated at the International Stations E2 and E3, and on the steamship route Southampton–St. Malo. Of the surface bottles, those which did not run ashore on the Channel coasts were carried rapidly up Channel into the North Sea and across to the Dutch and Scandinavian shores. Many reached the Skaggerak, some 700 miles away, travelling at an average rate of 6 miles a day or more. During the period covered by the experiment there was an almost unbroken prevalence of south-westerly winds. It cannot of course be inferred from these results that the water mass as a whole moved with the velocity indicated, and further experiments with well-submerged drifters would be valuable and interesting. The results have, however, enabled Mr. Carruthers to work out a relation between velocity of wind and surface current which corresponds closely with that found by R. Witting in the Baltic. The information yielded by the bottom bottles is summed up by Mr. Carruthers as follows: "There seems to be in Long. 2° W. (approximately) a parting of the ways in respect of the movements of the bottom water. To the north of 50° N. Lat. there appears to be a west-going bottom set, whereas to the south of this parallel there is a set in an easterly direction."

SPEED OF LIGHT IN MOVING BODIES.—In the tenth volume of the *Archives Néerlandaises des Sciences Exactes*, Prof. P. Zeeman has collected together the work done by himself and his colleagues to determine the fraction of the speed of a moving body through which light is passing, which must be added to the normal speed of light to give the actual speed of the light. According to Fresnel, this fraction should be $1 - 1/\mu^2$, where μ is the refractive index of the material for the light used. According to Lorentz, this fraction should be increased by $(-\lambda/\mu)d\mu/d\lambda$ where λ is the wave-length. The measurements were made on water flowing through pipes and on quartz and flint-glass rods to which a to-and-fro motion was given by means of a revolving crank and connecting rod. The method

used was in principle that of the Michelson interferometer. The results agree with the formula of Lorentz.

THE POSITIVE COLUMN OF GEISSLER DISCHARGES.—Prof. Güntherschulze has recently published the results of an extended series of measurements made by him on the electric fields present in a uniform positive column. The point on which he lays particular stress is that the mean free path, rather than the pressure, is the relevant variable, and that it is therefore necessary to take into account the temperature of the ionised gas, which can be calculated in the way proposed many years ago by Warburg. With this precaution, the results of his measurements are fairly well expressed by two semi-empirical formulæ. For polyatomic gases the potential gradient is determined by the mean free path and by the diameter of the tube, and is practically independent of the current density : for monatomic gases the gradient is independent of the mean free path (and hence of the pressure), but is a function of both the current and the size of the tube. The processes of ionisation and conduction in a discharge-tube are still imperfectly understood, in spite of much recent work on the subject, but the data in these papers (*Zeitschrift für Physik*, **41**, p. 718, and **42**, p. 763) provide valuable material for future theoretical development.

THE X-RAY INVESTIGATION OF INDIA-RUBBER.—In the *Chemiker-Zeitung* for May 21 is an account of two lectures by Dr. J. R. Katz of Amsterdam on the application of X-ray analysis to the structure of india-rubber. So far, rubber in the unstretched condition has yielded very little information beyond the production of an 'amorphous ring spectrum,' similar to that obtained from liquids. Recent work by the author appears to substantiate the hypothesis put forward by him in 1925 that rubber changes on stretching from an amorphous to a crystalline condition, the degree of change depending upon the extension. X-ray examination has revealed indications of a three-dimensional orientation of molecules, undiscernible in the unstretched material, although some of it still remains amorphous, as shown by the unchanged diameter of the 'amorphous ring' of the spectrum. Moreover, there is a critical extension, below which the phenomenon is not observed. The conflicting results of W. H. Keesom's attempt in 1922 to apply a modification of Bragg's formula—which was specially designed for crystals—to calculate the mean distance of adjacent molecules (to a first approximation) in a liquid from the diameters of these rings, have now been shown to be due to the fact that the molecules were always assumed to be approximately spherical. This assumption is of course only applicable in certain cases, and it is now shown that the abnormal values were due to marked deviations in molecular structure from the spherical shape. The experiments of Katz appear to open a new and promising field of research.

HELIUM IN CANADA.—A comparatively new use of helium, and one that promises to become of very great importance, is its utilisation in the production of artificial atmospheres under which divers and caisson workers carry out their operations. It is anticipated that such atmospheres will permit of much greater depths being reached under water, longer periods being spent without fatigue, and, in the case of tunnel and caisson workers, that the prevention of what is known as 'caisson disease' will be facilitated. Investigations along these lines are being carried out by the United States Bureau of Mines, and accordingly considerable impetus has been given to the helium industry, which thus has other outlets besides that of supplying airships with non-inflammable gas. The Canadian Mines Branch, during the period 1922 to 1926, made a special study of the helium-content of natural gas occurring within the Dominion, and the results of this investigation are now available in a report under the above title by Dr. R. T. Elworthy (No. 679. Ottawa : F. A. Acland. 20 cents). It is significant that Canada is the only source of helium in the British Empire. The report summarises our knowledge of this gas and is particularly valuable for its account of modern methods of recovery ; it includes details of the varied helium-bearing gases (with analyses) in the Dominion and much interesting experimental data. The most important source of supply of this substance discovered is in the natural gas from three small wells at Inglewood, Ontario, which yields as high a percentage of helium as that forming the basis of commercial operations at the well-known plant at Fort Worth, Texas ; leases have been taken up by the Ontario Government in the Inglewood district, and it is anticipated that the National Research Council will lay down an experimental helium extraction plant, providing sufficient gas is available. The natural gas of Alberta, with the exception of Bow Island and Foremost fields, contains little or no helium, which, in view of these enormous resources, is unfortunate. However, if only 0·2 per cent. helium-bearing gas could be treated economically, it is believed that the Dominion could supply about 5,000,000 cubic feet annually.

IRON AND STEEL IN INDIA.—A paper by Richard Mather published in the *Journal of the Royal Society of Arts*, May 13, reveals the rapid advances which have been made during the last twenty years or so in the ferrous industries of India. Although Indian Wootz steel has deservedly possessed the highest reputation for quality for hundreds of years, it has only been during the last decade or two that the initial difficulties associated with the establishment of a heavy iron and steel trade there have been overcome. Now, however, a large portion of the existing Indian demand is satisfied by Indian products, and also a surplus is available for export. This applies to pig-iron rather than steel, and the growth in the exports of this material during the last few years are as follows :

Year.	Tons of pig-iron exported.
1923	181,500
1924	271,000
1925	402,000
1926	315,000

In 1926, Japan took 75 per cent. of this iron and the United States 13 per cent. In the former country Indian iron has become a serious competitor with the home product. With regard to steel, Indian production in 1911 was 10,000 tons ; last year it was 540,000 tons, and it will probably exceed 600,000 tons in the present one. So far as future developments are concerned, Mr. Mather states that "the conclusion may safely be drawn that the Indian steel industry will develop, perhaps fairly rapidly, during the next few years, and that for some time afterwards its growth will depend mainly on the rate at which the demand increases. But for the next few years imports will not diminish to a great extent, unless the consumption declines or remains stationary ; and even in later years there will remain an important market in India for certain kinds of steel." As an example of the value of this industry during the War, it was pointed out in the discussion that the military railways by which the Mesopotamian campaign was carried on, and even the line by which Lord Allenby made his successful attack on Palestine, were constructed of steel from the Tata works.

National Physical Laboratory, Teddington.

INSPECTION BY THE GENERAL BOARD.

ON Friday, June 24, the General Board of the National Physical Laboratory made its annual inspection of the laboratory. A large number of visitors representative of scientific and technical institutions, Government departments, and industrial organisations were present and were received by Sir Ernest Rutherford, president of the Royal Society and chairman of the General Board of the Laboratory, Sir Richard Glazebrook, chairman of the Executive Committee, and Sir Joseph Petavel.

The varied nature of the work of the laboratory was well illustrated by a large number of interesting exhibits.

On the new whirling arm in the Aeronautics Department, measurements were being made of the rolling moments at a steady rate of turning of a model Bristol Fighter aeroplane. With the whirling arm stationary a definite moment about the axis of flight can be impressed on the model by means of a spiral spring situated inside it. The resulting displacement effects a separation of the primary and secondary coils of one of two similar electromagnets, the other of which is mounted in the control room. Their primaries are connected in series while their secondary voltages are opposed, so that the displacement produces an out-of-balance current which is indicated by a galvanometer. The speed of the whirling arm can then be adjusted until the galvanometer deflexion is zero, when the air moment at that speed is equal to the impressed moment.

In one of the wind tunnels an investigation of the conditions under which wing flutter may occur was in progress. Points on a selected chord of the wing section are connected by light spring-controlled wires to pivoted levers carrying small mirrors and by suitable optical arrangements their vibrations are recorded on sensitised paper. Permanent magnified records are thus obtained and the vibrations of the wind under various conditions can be directly compared.

The Engineering Department exhibited apparatus for the electrical integration of wind pressure. The apparatus consists of a number of capsule diaphragms arranged in groups, each of the latter being connected to a Pitot tube. The expansion of any group is magnified by a lever the free end of which carries a brush sliding over a potentiometer wire. For each group a determination is made of the potential difference between the brush and one end of the wire, and by previous calibration the corresponding wind pressure can be derived. The experimental arrangements are such that if a number of units are attached to a structure, the sum of their potential differences is proportional to the mean wind pressure on the structure. Of interest also was a motor trailer equipped for experimental work in connexion with the wear of road surfaces. An adjustable rear axle permits wheels of varying size from 18 inches to 40 inches diameter to be fitted. Motion of the rear springs is transmitted to recording apparatus in the cab by means of a pivoted lever and bowden wire. To the coupling is fitted a traction dynamometer, the motion of which is transmitted to the recording apparatus by oil impulses on a plunger in the cab. Determinations are made of the tractive resistance and spring deflexions of the trailer, and of the horizontal and vertical movements of the road surface when the trailer is made to negotiate obstacles of various sizes.

The Metallurgy Department showed apparatus developed for the preparation of beryllium of high purity with the view of eliminating if possible the lack of ductility hitherto associated with this metal. Iodine and beryllium produced otherwise are introduced by a side tube into a glass vessel in which is sealed a tungsten wire which can be heated electrically. The apparatus is exhausted and heated in a furnace until beryllium iodide is formed. At this point the tungsten wire is heated up until a temperature is reached at which the vapour pressure of the solid beryllium is less than its partial pressure in the gaseous phase, when solid beryllium is deposited on the wire.

A method was also demonstrated of determining the surface tension of molten metals by means of bubbles formed on the ends of two concentric silica tubes, the ends of which are ground in the same horizontal plane, dipping in the metal. The alundum crucible containing the metal and the two tubes are surrounded by an airtight furnace through which hydrogen is passed. By means of a special reservoir and valves, bubbles of hydrogen can be blown on either tube, the pressure required being indicated by a manometer. From these pressures and the dimensions of the orifices the surface tension can be calculated.

In the Metrology Department was exhibited an ingenious method of determining the cross-section of very fine quartz fibres which, owing to diffraction effects, do not lend themselves to direct measurement by projection methods. The fibre is mounted horizontally and can be loaded at its mid-point with small milligram riders. A magnified image of the fibre is projected on to a screen, and from the length and displacement of this image under different loads its extension and the forces acting along its axis can be computed. From these data and the known value of Young's modulus for quartz, the cross-section of the fibre can be readily determined.

Of interest also was a sensitive tilting level for the accurate testing of surface plates. Two fixed horizontal rods, on which the level can slide, bridge the specimen, and the level is racked down until its ball feet rest on a parallel block placed on the surface and moved to successive positions. An image of the bubble thrown on a scale by a semi-silvered glass plate indicates any departure from flatness, which can be computed from the radius of curvature of the level and the size of the block to one hundred thousandth of an inch.

For work in connexion with the international temperature scale a new valve-controlled high-frequency furnace capable of melting up to two kilograms of palladium by the eddy currents generated in the metal has been installed in the Physics Department. The oscillating circuit containing the furnace is included in the anode circuit of two air-cooled silica valves connected in parallel and each dissipating 8 kilowatts. The furnace can be exhausted and temperatures are measured by means of an optical pyrometer.

For gas analysis an apparatus utilising high frequency vibrations has been developed. A piezo-electric quartz crystal maintained in vibration by an oscillatory circuit is used to generate high-frequency sound waves in the gas mixture and stationary waves are formed by means of a movable reflector. When

the reflector is identified with a node, resonance occurs between the gas and the crystal, which manifests itself by a large increase in the current in the maintaining circuit after the manner described by Pierce. Measurement of the wave-length then affords a measure of the composition of the gas mixture.

A demonstration was given of the determination of flame temperatures by spectrum line reversal. An image of the bead of a Pointolite lamp was focussed through a flame on to the slit of a spectroscope. When sodium was introduced into the flame the sodium lines were visible either as bright or dark lines superimposed on a continuous spectrum according as the flame temperature was greater or less than that of the bead. By careful adjustment of the temperature of the latter the sodium lines could be made to disappear. The temperature of the flame was then determined by measuring that of the bead with an optical pyrometer.

In the Optics Division a photo-electric spectrophotometer of general utility was exhibited, and its use for the measurement of ultra-violet absorption was demonstrated. Two monochromators in series are utilised to effect spectroscopic purification of the light from a mercury vapour lamp. The radiation then passes into a photo-electric cell fitted with a quartz window, and the photo-electric current can be measured by either a Lindemann or a Compton electrometer.

In the Electrotechnics Department was to be seen a non-reactive high resistance for use in high voltage alternating current work involving the measurement of very small power factors. Essentially it consists of a number of vertical glass tubes through which tap water can flow, arranged in parallel, and so disposed that two of them which carry the current to be measured are encircled by the remainder. The latter screen the inner tubes, thereby reducing their capacity to earth and the consequent phase error in the current.

The Electrical Standards Division showed new apparatus for building up standard telephonic frequencies. Between the prongs of a tuning-fork controlled by a seconds pendulum is an iron-cored bobbin which is included in the anode circuit of a multivibrator of the same frequency as the fork. By means of a selector circuit loosely coupled to the multivibrator, successive harmonics of the impulse can be picked off.

In the Photometry Division experiments were in progress to determine the effect of a glaring source of light on the ability of the eye to detect brightness differences. An observer seated in a totally enclosed cabinet views a field of uniform brightness except for a circular central spot the brightness of which can be varied until it is no longer visible to the observer. Under glare conditions a circular spot of very high brightness is included in the field. The least difference of brightness detectable with and without glare can then be determined.

The Wireless Division exhibited an installation for investigating the distribution of current in a vertical cage aerial and for determining whether its variation is sinusoidal under transmitting and receiving conditions. Small ammeters are fixed at convenient intervals inside the aerial in order not to affect the capacity of the latter and are viewed from the ground by means of a telescope.

At intervals during the inspection, demonstrations were given in the William Froude Tank to indicate the manner in which measurements are made of the characteristics and behaviour of model sea-going vessels.

The Edinburgh Meeting of the Society of Chemical Industry.

A DISTINCT biochemical tendency was noticeable in the contributions brought before the annual meeting of the Society of Chemical Industry, held at Edinburgh on July 4-9 at the invitation of the Edinburgh and East of Scotland Section of the Society. In his interesting presidential address, entitled "Chemistry in the Progress of Medicine," Mr. F. H. Carr stressed the importance of a close co-operation between academic laboratories, research institutions, and industrial establishments in the search for new remedial agents, and of an equally effective liaison between the chemist, the physiologist, and the physician in elucidating the relation between chemical constitution and therapeutic properties. The body hormones are to be regarded as ideal specific drugs, the detailed study of which should do much to illuminate this problem.

Although many such agents are undergoing investigation at the present time, it can be claimed only in two or three instances that the hormone has been isolated as a pure chemical individual. Adrenaline, the active principle of the suprarenal gland which plays an important part in regulating the blood pressure, has been synthesised both in the laboratory and the factory. Recently also, a similar advance has been made by Harington and Barger in the artificial preparation of thyroxine of the thyroid gland; 5 mgm. to 10 mgm. of this perfectly definite substance may increase the metabolic rate of the human body by so much as 45 per cent. over a period of 14 days. Histamine, another fully characterised substance which has been shown to influence the circulation and respiration, is also apparently produced for functional purposes in the body.

It is possible that such substances are altered and elaborated in various ways in the body before being able to exert the physiological effects which are attributed to them. In general, although the action of a therapeutic agent is probably determined by its chemical constitution, the body mechanism plays an important part in the resultant chemical changes. It appears that the most effective chemotherapeutic agents act through the formation of a depôt from which they are automatically released as required: depôt formation, mechanism of release, and activity in great dilution are indicated as the likely desiderata of chemotherapeutic compounds.

"Most of the bacterial and parasitic diseases, as well as others due to defective functioning, await chemotherapeutic investigation. Chemotherapy is but one of the frontiers of scientific medicine, but it may well prove to be the most important. Certainly this will be so if, in the end, we learn how to stimulate at will the chemical processes of bodily defence, and thus to meet every eventuality, or to prepare substances comparable in activity and specificity with diphtheria antitoxin. Progress lies in the direction of biochemistry and more effective working contact between individuals in chemistry, bacteriology, physiology, and clinical medicine. We need to multiply a hundred times discoveries like those relating to the oxidation and reduction phenomena in the tissues, to the constitution of glutathione and of thyroxine. As these results become known, and with the fuller development of experimental technique, we need bold hypotheses like that of Ehrlich so as to open up new avenues of thought and work."

At a joint meeting with the Biochemical Society

a discussion was held on "The Physiological and Industrial Aspects of the Chemistry of Carbohydrates." Recent work on structural relationships in the carbohydrate group was reviewed in papers contributed by Prof. W. N. Haworth and Prof. A. R. Ling. Dr. C. G. Lambie, in dealing with the question of the intermediary metabolism of carbohydrates, advocated the view that dihydroxyacetone may be a possible common term in the metabolic transformations of carbohydrates, fats, and proteins; an assumed equilibrium of the form glucose $\rightleftharpoons$ dihydroxyacetone, favoured in the forward direction by the presence of insulin, would then explain many of the observed facts of normal and pathological metabolism, including the phenomena of diabetes.

The industrial importance of carbohydrates was emphasised in a paper by Drs. C. J. J. Fox and L. Hall, in which certain recent developments in the cellulose industries were outlined. Despite the present enormous production of artificial silk, it is considered that the further applications of this material are almost unlimited. The rapidly growing demand for wood in industry renders imperative a considered study of forest economics and the adoption of a policy of afforestation which will maintain an adequate supply of this indispensable raw commodity. Of cellulose derivatives the acetate is practically non-inflammable and has other advantages over the nitrate, but it has not yet attained the level of quality and price which would enable it to displace the nitrate in the manufacture of films, etc. The study of the bacterial decomposition of cellulose by methane producers, hydrogen producers, denitrifiers, and thermophilic species has recently been renewed with the object of bringing such processes under productive control. A further paper, on "Some Aspects of the Manufacture of Fibrous Celluloses," was read by Dr. J. L. A. Macdonald before the Chemical Engineering Group of the Society.

A wide field of industrial chemistry was surveyed by the Society's medallist, Col. G. P. Pollitt, in his lecture on "The Development of the Synthetic Nitrogen Industry in Great Britain." The decline in the utilisation of fixed nitrogen which immediately followed the War has been followed by a rapid recovery. In 1926 the world's consumption of nitrogen was 1,250,000 tons, the production having been approximately doubled since 1921. At the present rate of increase of population, and with no alteration in methods of farming, a food shortage is to be anticipated before the end of the present century. As a consequence of the necessity for increasing the output per unit of agricultural land, the nitrogen industry will become one of the most important manufactures, ranking with coal, steel, and shipbuilding. For economic reasons, synthetic nitrogen is gradually replacing Chile saltpetre and by-product ammonia; but such a replacement was rendered possible only through the development in Germany of the Haber-Bosch process. In Great Britain the technique of high-pressure operations has now been mastered, and there is no necessity for this country to continue indefinitely the importation of fixed nitrogen.

Among other important processes which there is a strong promise of developing in order to render Great Britain less dependent on imported raw materials are the production of liquid fuel by the hydrogenation of coal, of synthetic methanol from water-gas, and of acetylene and acetic acid from coke-oven gas. In the past there has been a tendency for an undue proportion of the most able men in Great Britain to neglect industry and to enter the services, the law, and other non-productive professions. Provided that in the future our industries have, as in Germany, the first call on the brains of the country, there is every reason to anticipate that Great Britain will continue to lead in the world's industrial development.

Prof. J. Read's lecture on "Natural Sources of Energy in Australia" afforded an appropriate indication of the world-wide interests of the Society of Chemical Industry, which has a strong membership in the Dominions and in the United States. Australia possesses a surprising variety of power resources, located mainly in the eastern coastal zone. The most important of these are black coal, brown coal, and water power; in addition there are relatively unimportant occurrences of natural petroleum (Papua), natural gas (Queensland), and kerosene shale (New South Wales). For the present the vast deposits of brown coal near Melbourne are to be utilised solely by direct combustion of the raw material. Under the auspices of the State Electricity Commission of Victoria the first section of a power-house, with a present capacity of 50,000 kw., has been erected at Yallourn; it is proposed eventually to raise the capacity to 150,000 kw., and to interconnect the brown-coal power system with the Sugarloaf-Rubicon and Kiewa River hydro-electric schemes. The consequent generation of cheap electric power, light, and heat should lead to a steady industrial expansion in this area. Hydro-electric power is being rapidly developed, particularly in Tasmania, more than 500,000 h.p. having been located and surveyed in the island. A total amount of 75,000 h.p. is now available from the Great Lake and Shannon River schemes, and factories for the production of electrolytic zinc, carbide, etc., have been established in the vicinity of Hobart.

The Universities of Edinburgh, St. Andrews, and Aberdeen, which lie within the area embraced by the local section of the Society, were officially represented at the meeting, and Dr. Kurt Meyer attended on behalf of the German Chemical Society. Prof. A. W. C. Menzies conveyed an invitation from the American Section to hold the annual meeting for 1928 in New York, and this was unanimously accepted.

University and Educational Intelligence.

CAMBRIDGE.—J. A. Ratcliffe, Stokes student of Pembroke College and formerly research student of Sidney Sussex College, has been elected fellow of Sidney Sussex College and University demonstrator in physics. J. A. Steers, St. Catharine's College, has been appointed University lecturer in geography, and E. G. Dymond, St. John's College, University demonstrator in physics.

After some delay, the deeds executed by the late Mr. W. W. Rouse Ball of Trinity College, by which various sums were to be paid to the University, are being completed, and two sums of £25,000 each will be received for the foundation of professorships in mathematics and modern English law, and a further sum of £10,000, of which the income is to be available for the University Library.

MANCHESTER.—Dr. H. B. Maitland has been appointed professor of bacteriology and director of the Department of Bacteriology and Preventive Medicine in succession to Prof. W. W. C. Topley. Prof. Maitland graduated in medicine and surgery in the University of Toronto in 1916 and obtained the degree of M.D. by thesis in 1922. He remained at Toronto as lecturer in bacteriology and later as associate

professor until 1924. Early in 1925 he was appointed to assist in research upon foot and mouth disease, later taking charge of the investigations, and he has since joined the staff of the Lister Institute.

Dr. A. J. Bradley has been elected to an honorary research fellowship in physics.

AT the annual Commencement Exercises held at Yale University, Newhaven, U.S.A., on June 22, among those upon whom the honorary degree of Doctor of Science was conferred was Sir James Colquhoun Irvine, Principal and Vice-Chancellor of the University of St. Andrews.

ANOTHER series (the sixth) of "Methods and Problems of Medical Education" has been issued by the Rockefeller Foundation. Twenty-eight institutions or special departments of institutions are dealt with in this series; it includes medical libraries and departments of anatomy, physiology, pathology, embryology, neurology, tropical medicine, physicotherapeutics, and others. An interesting article on the value of visual methods in education and methods of projection is contributed by Prof. Jacobj of Tübingen. Details of the staffs, salaries, wages, and cost of upkeep, and methods of instruction are given in most instances, together with plans and illustrations of the institutions and laboratories.

THE first report of the English committee dealing with the same portion of the terms of reference as are dealt with in its first report by the Committee on Education and Industry in Scotland, namely, ". . . . particular reference to the adequacy of the arrangements for enabling young persons to enter into and retain suitable employment," was published at the end of last year (see NATURE, Jan. 8, p. 69). Necessarily, and obviously, the two committees have been closely in touch with each other. Among the recommendations common to both are: closer co-operation between juvenile employment committees and juvenile advisory committees; the appointment of qualified officers and the provision of suitable premises for choice of employment; a national advisory council for juvenile employment; the increase of information as to industrial conditions available to juveniles and parents; provision of public money for the purpose of a scheme of juvenile unemployment centres; legislation to cover the provision of working certificates. Both committees have seen quite clearly that between the ages of fourteen and sixteen years, "boys and girls are most impressionable, and irretrievable damage can be effected by enforced idleness." Yet during this very period there is a gap in public supervision, since the age of entry into unemployment insurance is sixteen years. Two remedies present themselves immediately: the raising of the school leaving age, and the lowering of the age of entry into unemployment insurance. With regard to the first, the English committee appeared overwhelmed by the evidence against raising the school leaving age, and became correspondingly vague: "the change, *if made* [our italics], should be made for educational and social rather than industrial reasons." The Scottish committee is much more vigorous. "Due notice should be given by the Scottish Education Department, as soon as it may be found financially practicable, of the appointed day for the raising of the school leaving age to 15 years. . . . When, but not before, the school leaving age is raised to 15 years, the age of entry into unemployment insurance should be lowered to 15 years."

Calendar of Discovery and Invention.

July 17, 1850.—The earliest photographs of stars were those of Castor and Vega obtained on July 17, 1850, with the refractor at Cambridge, Mass., by Whipple under the direction of W. C. Bond.

July 18, 1774.—The first experiments in Great Britain for determining the mean density of the earth were made by Maskelyne in Perthshire, who on July 18, 1774, wrote to Dr. Lind: "From the observatory on the south side of Schiehallien . . . I am now ready to begin making observations . . . whenever the weather will permit." The results of Maskelyne's observations worked out by Hutton gave the value 4·481. The experiment cost the Royal Society £597: 16*s*.

July 19, 1846.—One of the many students of Liebig at Giessen was Frank Buckland, who, writing on July 19, 1846, gave his routine thus: "7.30-8.30, chemistry; 9-10, German with Dr. Adrian; 10-11, laboratory; 11-1, Liebig's lecture; 1-2.30, dinner. After dinner I occupy myself with chemistry in the laboratory, or German, as the case may be, till about 6 or 7. If ever there was a place to work in it is Giessen. The people never think of leaving off work till 6 or 7; whereas at Oxford the books are shut up at the latest at 2 o'clock."

July 20, 1854.—Liebig retired from Giessen in 1854. The English chemists, headed by Graham, sent him a testimonial "Commemorative of their profound and unalterable regard." Acknowledging the gift from Munich on July 20, 1854, Liebig began his letter: "The man of science generally knows of no other reward for the time he has devoted to the discovery of truth and to the investigation of the laws of Nature's powers, than the mental satisfaction which springs from the consciousness of having, to the best of his ability, contributed his part towards the advancement of human happiness and human welfare; for toils like this, attended as they are with so many difficulties and sacrifices, and with such mental effort and fatigue, cannot be priced in the market or sold —cannot be performed to order or turned into money. . . . If I have laboured for the period of almost a human life in promoting the progress of chemistry . . . I gratefully acknowledge that I have received in return all that a man could justly aim at."

July 21, 1820.—It was between July 15 and July 20, 1820, that Oersted made his remarkable discovery of electro-magnetism, the results being made known to the world in a circular letter in Latin, dated July 21, 1820: "Experimenta circa effectionem conflictus electrici in acum magneticam." Oersted's discovery was the result of a long search for a connexion between electricity and magnetism.

July 21, 1914.—Working at Lick Observatory, Nicholson, on July 21, 1914, discovered photographically the ninth satellite of Jupiter, which, like the eighth satellite, revolves around the planet in an opposite direction to the other seven.

July 23, 1849.—On this day Fizeau communicated to the Paris Academy of Sciences the results of his determination of the velocity of light by measuring the time taken for light to travel between Suresnes and Montmartre, a distance of 28,334 feet.

July 23, 1847.—Among the important contributions to the early work on the new theories of the conservation of energy and the mechanical equivalent of heat was the memoir of Helmholtz, "Über die Erhaltung der Kraft," read to the Physical Society of Berlin on July 23, 1847. The paper was, however, refused admission to Poggendorf's *Annalen*, and among the older members of the Physical Society, Karl Jacobi was the only supporter of the views of Helmholtz. E. C. S.

Societies and Academies.

LONDON.

Royal Society,[1] June 30.—C. Chree and J. M. Stagg: Recurrence phenomena in terrestrial magnetism. Making use of the daily international character figures for 1906 to 1925 issued from De Bilt, an attempt is made to enlarge our knowledge of the 27-day interval in terrestrial magnetism. Assuming magnetic disturbance to be caused by some kind of electrical discharge from the sun, if sunspots were the sole or principal source of the discharge, we should expect the interval to be longer in years of high than in years of low spot latitude. No recognisable difference is, however, found. In opposition to results obtained by Dr. Deslandres, no trace is found of periods which are submultiples of 27 days. On the other hand, days which follow from 4 to 6 days after a very *quiet* day prove to have a greater than average chance of being highly disturbed days.

S. Chapman: On certain average characteristics of world-wide magnetic disturbance. The average characteristics of slight magnetic disturbance in the middle belt of the earth, between northern and southern latitudes of 50° or 60°, are similar to those of intense disturbance (magnetic storms) in the same region.

G. I. Taylor: The distortion of crystals of aluminium under compression (Part ii.). Changes in orientation of crystal axes during compression of a disc cut from a single crystal of aluminium are in accordance with the prediction made on the assumption that the crystal slips as determined by distortion measurements. As with tensile test pieces, the crystal axes always take a position where two possible planes of slip are symmetrically disposed in relation to the stress, but the orientation is different. After the axes have taken the symmetrical position, they remain there, even when distortion is very great. Distortion during the period when the crystal axes remain in the symmetrical position is due to slipping on two symmetrically disposed planes of slip.

G. I. Taylor: The distortion of crystals of aluminium under compression (Part iii.). Several experiments were devised to find out whether it is possible to measure the internal stresses in a compressed disc. The relationship between shear stress and amount of shear is found for tensile and for compression specimens, when slipping is confined to one plane. The experimental results in the two cases are identical. The fact that the component of force normal to plane of slip is a pressure in one case and a tension in the other makes no measurable difference to resistance to slipping for given amount of slip. During double slipping, resistance to shear increases more rapidly for a given total amount of slipping than when all slip is confined to one plane. Resistance to shear goes on increasing up to the greatest amounts of distortion used.

Prof. J. C. McLennan, H. J. C. Ireton, and K. Thomson: The luminescence of solid nitrogen under cathode ray bombardment. The phosphorescence bands N_2 (5230 Å.U.) and N_4 (5945 Å.U.) have complex structures, the former having eight and the latter three components. The moment of inertia of the molecular system involved in the phosphorescence of solid nitrogen is 3×10^{-40}. The group of bands N_1 near 5577 Å.U. originate in a modification of nitrogen different from that involved in the production of the bands N_2 and N_4.

E. T. Paris: On the reflexion of sound from a porous surface. The 'acoustical admittance per unit area' can be measured experimentally by means of the 'stationary-wave' apparatus for testing sound-absorption, and when it is known, the coefficient of absorption (for the particular wave-length at which the admittance has been measured) can be calculated by a simple formula for any angle of incidence. For an 'acoustic plaster' there is a large variation of absorption with change of angle of incidence, the coefficient increasing from 0·28 at normal incidence to 0·76 at about 83° and then falling to zero at grazing incidence. Heavy absorption at very oblique incidence appears to be characteristic of plasters of this kind.

C. J. Smith: A new differential dilatometer for the determination of volume changes during solidification. The dilatometer has two bulbs immersed in a thermostat, the change of volume of the substance contained in one bulb being compared with that of a corresponding volume of nitrogen in the other. The difference of pressure of the nitrogen in the two bulbs is measured by withdrawing a known volume of mercury from a small reservoir attached to the appropriate side of the dilatometer. The advantage over other dilatometers used for the same purpose lies in the possibility of obtaining definite and steady conditions of temperature.

R. C. Johnson and H. G. Jenkins: The band spectra of silicon fluoride. Some eight band systems or groups—all except one new—are recorded and attributed to silicon fluoride. Two band systems attributed to a fluoride of sulphur were encountered in the experimental work. To two of the band systems of silicon fluoride, named α and β, have been assigned vibrational quantum numbers. A third, the γ system, is shown to be related, and a fourth system has been partially analysed. The heat of dissociation of the FSi-SiF molecule is of the order of 5 volts or 116000 calories.

T. W. Wormell: Currents carried by point-discharges beneath thunderclouds and showers. Upward currents were found generally greater than downward currents. The maximum value attained during a shower by the discharge current from the single point, which was at a height of about 8 metres, was frequently between 1 and 10 microamp. The net quantity of positive electricity discharged during a shower was commonly of the order 10^{-2} coulomb. The total net transfer of positive electricity from the point during 8 months was $0{\cdot}17_3$ coulomb, the quantities passing upward and downward being $0{\cdot}25_5$ coulomb and $0{\cdot}08_2$ coulomb respectively. The transfer of electricity observed is thus opposite in direction to the normal ionisation current of fine weather, and also to the convection current carried by precipitation. In the case of several showers, the phenomena observed consisted of a downward current as the cloud approached, a large upward current beneath the centre of the shower, and a downward current towards the end of the shower. The distribution of electric field below the cloud suggests that in these cases the cumulo-nimbus cloud was bipolar, with upper charge positive, and lower charge negative.

A. M. Taylor and E. K. Rideal: The effective moment of the sulphur complex. The absorption spectrum of sulphur has been examined in the infra-red between 1μ and 14μ. The chief maxima occur at 7·7μ and 11·9μ, and the form of curve is the same for rhombic, prismatic, liquid and plastic varieties, the maxima being very little shifted from one modification to another. The depth of the absorption band at 11·9μ is somewhat remarkable, in view of the absence of charged ions in the element. The 'effective charge' on the vibrating particles in sulphur is about 0·7 electron, indicating an interatomic linkage which approximates to one of hetero-

[1] Continued from p. 66.

polar character. Assuming the group S_2 to have an electric moment, a structure is suggested for the larger group S_{16}, and the electric moment of the group S_2 is calculated. The value agrees with that determined from the infra-red spectrum.

(*To be continued.*)

PARIS.

Academy of Sciences, June 7.—Ch. **Depéret**: An attempt at the Pliocene history of the Seine basin.—Edouard **Imbeaux**: The great Artesian basins of Russia in Europe.—Léon W. **Cohen**: The non-equivalence of the definitions of dimensions of Menger and Urysohn.—Gr. **Fichtenholz**: Suites of harmonic functions.—Henri **Chrétien**: Panoramic kinematography by means of ordinary apparatus.—R. de **Mallemann**: The general molecular theory of rotatory power.—P. **Bonet-Maury**: The vaporisation of polonium. The polonium preparation is carried on a ribbon of nickel, the latter being heated electrically to a known temperature. Just above this is placed a copper vessel containing liquid air and the volatilised polonium is completely deposited on this cooled surface. This apparatus has been used to determine the law according to which the volatilised atoms of polonium are distributed in space when the heating is carried out in a vacuum.—F. **Blondel**: The structure of the ensemble of the south-east of French Indo-China.

BRUSSELS.

Royal Academy of Belgium, Jan. 8.—Octave **Dony** and Francis **Meunier**: The electrolysis of the insoluble compounds of the alkaline earths and, in particular, of barium carbonate. A comparative study of the conditions of electrolysis of barium carbonate in suspension in a solution of chlorate or perchlorate of the same metal, in the case where the two electrodes are separated by a diaphragm (Siemens and Halske method), and in the case where the use of a diaphragm is replaced by that of a mercury cathode. The conditions of yield are found to be more favourable in the latter method.—Th. **De Donder**: The extremals described by electrons and electrified particles.—F. **Dacos**: The specific inductive power of phosphorescent substances. Experiments are described showing that for a series of preparations of calcium sulphide containing an increasing proportion of impurity (bismuth) the specific inductive capacity of the various substances as well as the intensity of the light emitted by the phosphorescence follow an analogous law. It has also been shown that the dielectric constant of a phosphorescent substance remains invariable whatever the illumination to which it may be submitted.—E. **Dahy**: A birational involutive transformation of the plane.—M. **Barzin** and A. **Errera**: The logic of M. Brouwer.—R. **Moens**: Some experiments on the electrodeless discharge with maintained waves.

Feb. 5.—Th. **De Donder**: Extremals described by electrons and electrified particles. (Second communication.)—P. **Swings**: The quasi-elliptic orbits, Riemann potentials, and central forces.

GENEVA.

Society of Physics and Natural History, May 5.—L. **Reverdin**: Study of the fauna of the station of Sumpf (Zoug), bronze age. The author has identified 298 bony remains belonging to 11 species in addition to man, amongst which he gives a description of ox, sheep, and dog, the last represented by two kinds, the dog of the bronze period and that of the peat period. The fauna corresponds with that of Alpenquai, at Zurich.—R. **Chodat**: Two new algæ in the flora of the Lake of Geneva. The author has observed in the water of the lake in large quantities a new species of Pandorina and a new Erueigenia, not before noted in spite of twenty-five years of careful research. It is a rare case of epidemic stocking in a lake basin in floral equilibrium.—H. **Lagotala**: Contribution to the study of the ancient strands of the Mediterranean. A strand 8 or 9 metres high is visible at Cavalaire (Var., France). It is marked by holes due to molluscs and corresponds well to the lines of strands pointed out by Depéret, Caziot, and others.

WASHINGTON.

National Academy of Sciences (*Proc.*, Vol. 13, No. 4, April).—J. L. **Walsh**: On the expansion of harmonic functions in terms of harmonic polynomials.—B. P. **Gerasimovič**: On the correction to Saha's formula for small deviations from thermodynamic equilibrium. The applications of ionisation theories in astrophysics assume that the layers in which spectral lines arise are in thermodynamic equilibrium. This can give only approximate results. The correction for small deviations from equilibrium is calculated. For the sun, it is nearly unity because the 'boundary' temperature (Schwarzschild) does not differ from the temperature measured spectrophotometrically; for some of the stars showing emission lines it may be of importance.—Worth H. **Rodebush**: Chemical constants and absolute entropy. Using the specific heats at low temperatures, the vapour pressures at low temperatures, and the specific heats of the liquid metals, the entropies of potassium and sodium vapours at 298° K and 1 atmosphere are found to be 38·2 and 36·7 respectively. These values suggest that the thermodynamic probability of a system is a definite number and justifies the concept of absolute entropy.—Richard C. **Tolman**, Don M. **Yost**, and Roscoe G. **Dickinson**: On chemical activation by collisions. In discussing activation by molecular collisions, the amount of energy available is generally only slightly in excess of that required for activation. This entails the unlikely effect that practically all the energy after a collision passes into one of the colliding structures. Further, the hypothesis leads to very large values for the de-activational diameters, and also to the use of different diameters for activational and de-activational collisions.—Alfred C. **Robertson**: A case of negative catalysis in a homogeneous system. Vanadic acid (ammonium vanadate + acetic acid) greatly diminishes the rate of decomposition of hydrogen peroxide by potassium dichromate. It is suggested that the intermediate perchromic acid is converted into the less reactive pervanadic acid, thereby decreasing the total rate of decomposition.—T. H. **Gronwall**: On the determination of the apparent diameters of the ions in the Debye-Hückel theory of strong electrolytes.—Joseph W. **Ellis**: New infra-red absorption bands of methane. Five new bands at and between $\lambda 1{\cdot}15\ \mu$ and $\lambda 1{\cdot}80\ \mu$ were observed. Certain bands at and between $\lambda 1{\cdot}15\ \mu$ and $\lambda 7{\cdot}67\ \mu$ seem to be associated with the C–H linkage.—Ernest O. **Lawrence** and J. W. **Beams**: On the nature of light. By passing light from a zinc spark gap through a Nicol prism, a double Kerr cell consisting of two sets of parallel brass plates in carbon disulphide and oriented at right angles to each other and at 45° with respect to the electric vector of the polarised light, and finally through another Nicol prism 'crossed' with respect to the first, it was possible to obtain short 'segments' of light of variable length. The effect of these pulses was measured by a potassium photo-cell. Such segments might include fractions of light quanta, which would be unable to eject an electron photo-electrically; also, the time taken by the 'segment' to pass over an electron might be less than the time required to eject an electron. Thus, the photo-electric current would be small or zero. The results

show that light quanta, as generally understood, are less than 3 cm. long, and that an electron absorbs a light quantum in less than 10^{-10} sec.—L. A. **Sommer**: Bands in the extreme ultra-violet spectrum of a helium discharge. Lyman's so-called line at $\lambda 600{\cdot}3 \pm 0{\cdot}6$ appears to be a band corresponding to a transition $1^1S - 2^1S$ in the helium molecule.—W. N. **Birchby**: White-light interference fringes with a thick glass plate in one path (Part 2).—G. W. **Stewart** and Roger M. **Morrow**: Molecular space array in liquid primary normal alcohols: the cybotactic state. The X-ray circular diffraction haloes in these alcohols show that one distance observed increases by approximately 1·54 Å.U. with each CH_2 group added to the chain, while another distance, varying from 4·6 Å.U. for lauryl to 3·8 Å.U. for methyl, seems to be due to the separation of the molecules perpendicular to the chain. The results indicate a space array permitting of molecular mobility in the liquid which is termed 'cybotaxis.'—Carl **Barus**: Pinhole probe measurements with massive cylindrical air columns.—Jared Kirtland **Morse**: Atomic lattices and atomic dimensions. Models of cubic and hexagonal lattices can be built up using a modified cubic atom concept, and possible atomic radii are calculated. One striking result is that the atomic radius of the carbon atom in diamond is 0·77 Å.U. while in graphite it is 0·75 Å.U., and both lattices consists of cubes having one corner in common.—Paul S. **Epstein**: The magnetic dipole in undulatory mechanics.—R. A. **Brink** and C. R. **Burnham**: Nucleus and cytoplasm in relation to differential pollen-tube growth. 'Sugary' maize plants bear a lower proportion of 'waxy' seeds than plants carrying the dominant 'non-sugary' factor. Recognising two stages of growth in the pollen-tube, dependent respectively on (1) the food reserves of the pollen grain, and (2) on food materials supplied by the tissues of the pistil, a differential rate of growth is found in the first stage.—J. T. **Buchholz** and A. F. **Blakeslee**: Abnormalities in pollen-tube growth in Datura due to the gene 'tricarpel.' Many of the pollen-tubes from pollen carrying the 'tricarpel' gene burst at their tips and the protoplasm is extruded, leading to a deficiency in 'tricarpel' individuals in crosses.—M. **Demerec**: Magenta-alpha—a third frequently mutating character in *Drosophila virilis*.—Dontcho **Kostoff**: Pollen-tube growth in *Lythrum salicaria*. Pollen-tube growth in fertile pollinations is accelerated in the later stages in contrast with that occurring in unfertile pollinations.—William **Hovgaard**: Bending of a quasi-ellipsoidal shell with special reference to rigid airships. Two deformations other than simple bending are involved: (*a*) a downward movement of the framework due to shearing deflexions of the whole ship; (*b*) a deformation of the transverse frames due to unequal loading.—H. Walter **Leavitt** and John W. **Gowen**: Influence of iron content on mortar strength. The tensile strength of mortar (after both 7-day and 28-day periods) increases with increasing iron content in the sand used; compressional strength is unaffected.

Diary of Societies.

SATURDAY, JULY 16.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Eastern District Meeting) (at Guildhall, Cambridge), at 2.

TUESDAY, JULY 19.

ROYAL SOCIETY OF MEDICINE, at 5.30.—General Meeting.

SATURDAY, JULY 23.

PHYSIOLOGICAL SOCIETY (in Physiological Laboratory, University, Edinburgh).

CONGRESS.

JULY 19 TO 22.

BRITISH MEDICAL ASSOCIATION (at Edinburgh).

Tuesday, July 19, at 8 P.M.—Sir Robert Philip: Presidential Address.

Wednesday, July 20 (in McEwan Hall), at 8 P.M.—Lister Centenary Celebration, presided over by the Earl of Balfour, and addresses by Sir W. Watson Cheyne, Bart., Prof. Tuffier, Prof. H. Cushing, and Dr. J. Stewart.

Wednesday, July 20.—Discussion: The Results of Insulin Therapy in Diabetes Mellitus.—Discussion: Tuberculosis of the Kidney.—W. Rankin: The Treatment of Acute Osteomyelitis by Primary Diaphysectomy.—Discussion: The Relation of Pregnancy to General Diseases.—Discussion: Growth in its Pathological Relations.—Discussion: Clinical Methods of Administration and Therapeutic Uses of Oxygen.—Prof. J. A. Gunn: Expectorants.—Discussion: Acute Pneumonia in Early Childhood.—Discussion: Chronic Sepsis as a Cause of Mental Disorder.—Discussion: The Tics and Allied Conditions.—Discussion: Optic Neuritis.—Discussion: Neurological and Mechanical Factors underlying Immobility of the Vocal Cords; their Diagnosis, Prognosis, and Principles of Treatment.—N. Patterson: Some Diseases Affecting the Thyro-glossal Tract.—Dr. D. H. Ballon: The Study of Bronchopulmonary and Pleural Lesions by the Bronchoscopic Method with the Aid of Iodised Oil (Lipiodol).—Discussion: Should all Public Health Administration—Municipal, School, Factory, etc.—be concentrated under a Single Department, and the Immediate Control in each Executive Area be vested in a Single Individual?—Discussions: Amœbic Dysentery; Some Problems of Malaria Prophylaxis.—Discussions: X-Rays in the Diagnosis of Intrathoracic Growth; X-Rays and Radium in the Treatment of Carcinoma of the Breast.

Thursday, July 21.—Discussion: The Treatment of Acute Lobar Pneumonia.—Dr. D. H. Ballon: The Value of the Bronchoscopic Injection of Lipiodol in the Diagnosis and Treatment of Tuberculosis, Lung Abscess, and Bronchiectasis.—The Place of Surgery in the Treatment of Toxic Goitre.—Sir Almroth E. Wright: The Rational Treatment of Infected Wounds.—Discussion: The Hygiene of Menstruation in Adolescents.—Discussion: Immunity.—Discussion: The Therapeutic Uses of Calcium Salts.—Discussion: Acute Intestinal Obstruction in Infancy and Childhood.—Discussion: Epidemic Encephalitis.—Miss I. C. Mann: Some Aspects of the Comparative Development of the Retina.—Sir W. T. Lister: Some Points in Connexion with Detachment of the Retina.—W. C. Souter: Spontaneous Reattachment of Detached Retina.—Sir Arnold Lawson: Value of Antiseptics in Modern Ophthalmic Surgery.—F. H. Diggle: Relationship between Lacrymal Obstruction and Nasal Disease.—H. M. Traquair: Incidence of Tobacco Amblyopia in Edinburgh and District.—A. H. H. Sinclair: Remarks on Intracapsular Extraction of Cataract, and Demonstration.—Discussion: Otosclerosis.—Dr. S. Young: Radiography in Mastoid Disease.—Dr. A. J. Wright: To what Extent does the Removal of Tonsils and Adenoids prevent Ear Disease.—Discussion: What Duties has the State in Relation to the Nation's Food Supply regarding Research, Instruction of Parents, Maintenance of Supplies, and Cooking Facilities?—Dr. W. E. Cooke, Sir Thomas Oliver and Prof. S. McDonald: Pulmonary Asbestosis.—Discussion: The Structure and Function of the Spleen.—Prof. P. T. Herring: The Pineal Gland.—Prof. D. M. Lyon and Dr. W. Robson: Cystinuria.—Dr. J. C. Bramwell: Form of the Pulse Wave.—Prof. J. A. MacWilliam and Prof. G. S. Melvin: Optimal Rhythm in the Mammalian Heart and the Action of the Cardiac Nerves.—Dr. C. Reid: The Mechanism of Voluntary Muscular Fatigue.—Prof. H. E. Roaf: The Quantitative Measurement of Defects in Colour Vision.—Prof. B. A. McSwiney: Structure and Movements of the Cardia.—Discussion: The Influence of Internal Secretions on Sex Characters.—Discussion: Immunity.—Discussion: The Uses and Limitations of Ultra-Violet Radiations in Dermatology.—Dr. H. C. G. Semon: The Value of Krysolgan in Lupus Erythematosus.—Dr. G. B. Dowling: The Treatment of Tinea Capitis with Thallium Acetate.—Discussions: Alcohol and the Motorist.—The Teaching of Forensic Medicine.

Friday, July 22.—Discussion: The Pathology and Treatment of Pernicious Anæmia.—Dr. A. Blackhall-Morison: Coronary Angina Pectoris.—Discussion: Chronic Appendicitis.—A. McLennan: Burns.—Dr. F. A. E. Crew: The Effect upon the Sex Ratio of Conception Early and Late in Relation to the Œstrous Cycle of the Rat.—Dr. D. A. Miller: Failed Forceps Cases.—Dr. D. Dougal: The Clinical Features of Ectopic Pregnancy.—Dr. B. Solomons: Some Points in the Technique of the Low Segment Cæsarean Operation.—Prof. W. F. Shaw: Uterine Fibroids after the Menopause.—Discussion: Aspects and Problems of Comparative Medicine.—Discussion: The Action and Uses of Ovarian Extracts.—Discussion: Therapeutic Modification of the Diet in Infancy; what can be achieved by it?—Discussion: Points in the Lunacy Commission (England) Report—(*a*) Are the existing safeguards against wrongful detention adequate? (*b*) How far is judicial intervention necessary in the process of certification? (*c*) What additional facilities are required for early treatment?—Discussion: Chemical Changes accompanying Muscular Activity.—Prof. J. Mellanby: Bile as the Alimentary Stimulus for Pancreatic Secretion:—Prof. J. Tait: Natural Arrest of Hæmorrhage from a Wound.—Dr. H. W. Davies and Prof. B. A. McSwiney: Circulation Rate.—Prof. R. J. S. McDowall: Physiological Considerations in High Blood Pressure.—Dr. C. R. Harington: The Constitution of Thyroxine.—Discussion: Hæmolysis.—Discussion: Aspects and Problems of Comparative Medicine.—Discussions: Radiology and Diagnosis of Intrathoracic Tuberculosis from the Point of View of Specialist and Practitioner; Pathology of the Tuberculosis of Childhood and its Bearing on Clinical Work; Interrelation of Physician and Surgeon in Regard to Non-pulmonary Tuberculosis.—Discussion: The Value of Routine Examination of the Cerebro-spinal Fluid with Regard to (*a*) More Accurate Knowledge, (*b*) Prognosis, (*c*) Treatment.—Discussions: The Employment of 'Polar-Body' Developing Strains of the Gonococcus in the Treatment of Gonococcal Infection; The Place of Bismuth in the Treatment of Syphilis.—Discussion: The Historic Evolution of Disease.—Dr. G. M. Cullen: World Epidemics and their Relationship in Cause and Effect to Social Conditions.—Miss M. C. Buer: The Effect of Early Industrialism upon the Health of the Community.—Prof. A. J. Clark: The Historical Aspects of Quackery.—Prof. W. J. Dilling: The Methods of Introduction of Drugs.—Discussion: The Future Relationship of Municipalities to the Voluntary Hospitals of this Country.