THURSDAY, MAY 8, 1913.

EXPLOSIVES AND PHYSICAL CHEMISTRY.

Explosives: a Synoptic and Critical Treatment of the Literature of the subject as gathered from Various Sources. By Dr. H. Brunswig. Translated and annotated by Dr. Charles E. Munroe and Dr. Alton L. Kibler. Pp. xv+350. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1912.) Price 12*s*. 6*d*. net.

IN this volume Dr. Brunswig attempts to direct the study of explosives from the largely empirical methods of the past into the more definite fields of exact physical chemistry, in which the nature, causes of explosion, and the controlling conditions governing such phenomena naturally fall. For this purpose he has collected the well-known facts (and in many instances those frequently overlooked) and arranged them in a systematic manner.

The earlier sections deal with the general character of explosive reactions, their velocity, pressure, and temperature conditions, the character of the gases evolved, explosion by influence, &c. Judging by most of the literature on the subject, the physico-chemical bearing of these important matters is seldom considered, and Dr. Brunswig's earlier chapters certainly emphasise the necessity which exists for their receiving more consideration, if progress is to be made. As the author points out, "the days of purely empirical progress in the technology of explosives are numbered."

Some comparisons of the energy content of explosives (expressed as the heat of combustion) with ordinary fuels are of interest. While 1 kilogram of liquid petroleum develops 12,000 calories, and average coal about 8000 calories, dynamite (with 25 per cent. kieselguhr) only develops 1300 calories. "Explosives are only technically valuable because they liberate all their energy in a very short space of time." The actual utilisation of this energy, according to the author, by no means compares favourably with that in a high-class engine, such as the Diesel type. The efficiency of such engines is given as 32 per cent. (37 would be a better figure), whilst with most explosives the available energy is calculated to be only 15 to 20 per cent. of the theoretical.

The misleading relative value of explosives of widely different character which may be deduced simply from the heat of combustion, or the product of the gaseous volume and temperature attained (the characteristic product, or potential energy), is evident from the following figures, from tables in the book, when explosive gelatine is taken as 100.

	Comparative value	
	On calories available	On gas volume × temperature
Nitroglycerin ...	... 96 ...	... 97
Guncotton ...	... 66 ...	... 81
Picric acid ...	... 49 ...	... 61
Black powder ...	... 41 ...	... 17
Mercury fulminate	... 25 ...	... 11

As the author points out, such misleading figures—which place, for example, mercury fulminate below powder—are due to the omission of the velocity with which the reactions take place. In this connection it should be mentioned that in Noble's classical work with modern smokeless powders, this reaction velocity would not be greatly different for the various explosives he dealt with, and the relative potential energy figures would be unaffected.

The second portion of the book, dealing with the characteristics and manufacture of the principal explosives, will convey little fresh information to those already somewhat familiar with the subject. Dr. Brunswig says that he has "refrained from mentioning other material which has become known to him through personal relation with the technique of explosives," and pleads "the restraining influence of industrial discretion," where contradiction exists between literature and personal knowledge of the facts.

In the list of important propellants, brown prismatic powder and amide powder appear as "great-gun powders," and ordinary black powder as a musket powder. It would be of interest to learn who is still employing them for these purposes. Again, M.D. cordite is classed as a musket powder, but is not included in the big-gun powders.

Erosion is one of the most important questions relating to propellant explosives. The author quotes Sivy's statement that one-third of a kilogram of iron is lost with every shot from an efficient 28 cm. gun. The reader might, however, find difficulty in deciding on the primary cause. In one place it is stated that the percentage of nitroglycerin originally present in the earlier ballistites and cordites was reduced (a change intended solely to reduce erosion) because the explosive contained too much nitrogen. It must not be inferred that the true reason for erosion, the high temperatures resulting from the high proportion of carbon dioxide formed, is overlooked, but this primary

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cause is certainly confused by other ambiguous statements.

Some interesting results of experiments on the liability of metals to erosion may be quoted. They were carried out in an American steel works by firing a heavy charge in a shell, the base of which was formed of the metal under test with a 4 mm. hole bored through. Martin, tungsten, and nickel steels offered about the same resistance to erosion, 20 per cent. nickel steel was much more easily attacked, whilst manganese bronze failed to stand the action of the highly heated gases.

There are several points of interest in relation to the safety of explosives deserving of mention. In view of the extensive investigations and introduction of new methods of testing the liability of mining explosives to cause ignition of methane-air and coal dust-air mixtures, Mallard and le Chatelier's early observation that a methane-air mixture requires ten seconds to ignite when conducted through a porcelain tube at 650–660° C. is worthy of being recalled. The influence of the duration of the flame, on which Bichel has laid great emphasis, is in such circumstances apparent.

With propellant explosives the unexplained effect which gelatinisation of nitrocelluloses has in decreasing the stability of the finished product, as compared with the ungelatinised parent substance, affords opportunity for speculation and research. Here an apparently simple physical change, leading to consolidation, seemingly unconnected with any chemical change, induces a marked increase in the liability to spontaneous chemical decomposition.

The disaster on the French battleship *Iéna* is but an instance of such decomposition leading to grave consequences. The B smokeless powder, which was credited with being the initial cause, consisted of two parts of insoluble nitrocellulose and one part of soluble, gelatinised by an ether–alcohol mixture. The temperature of the magazine where the 10 cm. cartridges were stored which first fired was extraordinarily high with the refrigerating appliances out of action—estimated between 50° and 60° C. The marked acceleration of decomposition of such powders with rise of temperature is one of their striking features.

The book should be generally welcome as an addition to the already extensive literature on explosives, for, in those parts outside the purely practical, the subject is viewed from an unaccustomed point of view, and different aspects from the orthodox are always valuable. Further, the excellent references and index of authors add appreciably to its value.

J. S. S. B.

NEW BOOKS ON PHYSIOLOGY.

(1) *Human Physiology.* By Prof. Luigi Luciani. Translated by Frances A. Welby. Edited by Dr. M. Camis. With a preface by Prof. J. N. Langley, F.R.S. In four volumes. Vol. ii.: Internal Secretion—Digestion—Excretion—The Skin. Pp. viii + 558. (London: Macmillan and Co., Ltd., 1913.) Price 18*s*. net.

(2) *Le Problème Physiologique du Sommeil.* By Henri Piéron. Pp. xv + 520. (Paris: Masson et Cie., 1913.) Price 10 francs.

(3) *The Chemical Constitution of the Proteins.* By Dr. R. H. A. Plimmer. Part ii.: Synthesis, &c. Second edition. Pp. xii + 107. (London: Longmans, Green and Co., 1913.) Price 3*s*. 6*d*. net.

(1) THE important character of Prof. Luciani's text-book was well recognised by English readers when the translation of the first volume made its appearance. The second volume, which has just been issued, confirms this impression. The subject-matter is treated, as a rule, in an interesting way, pros and cons on disputed points are discussed intelligently, and the work of past researchers, though in the main chiefly interesting to the historian, is presented with great fulness and lucidity. The book will prove a valuable asset to the professed physiologist and to the advanced student.

For the average or junior student one may say at once that the work is scarcely likely to benefit him much. It assumes he already knows almost as much as its veteran author, and the multiplicity of the authorities quoted and the divergent views expressed by them will only lead him into a quagmire of confusion.

The book will be especially welcome, as it brings to the knowledge of English-speaking workers some idea of the energy and fertility of their Italian colleagues. It is naturally these who are most largely quoted. At the same time the preponderance given to Italian work and thought has its disadvantages, especially as one so often notices the omission of important investigations carried out in other countries. This leads in many cases to a very imperfect presentment of certain problems, and in such instances the subject-matter is consequently not complete or up to date. This is especially noticeable in cases where chemistry has played a part in the elucidation of physiological mysteries. Prof. Luciani is a man of great erudition and boundless industry, but the chemical side of physiology is evidently not his strong point.

His account of the physiology of the suprarenal body could not have been written in a more interesting manner, but beyond the mere mention in a parenthesis of the epoch-making work of Schäfer and Oliver, there is nothing to indicate that it was these workers who founded our knowledge of the physiology of this organ. Adrenaline is referred to as a chemical substance of known composition, but there is no description of its constitution, nor of the success which has attended the efforts which have been made to synthesise it.

The account given of the pituitary is similarly marred by the entire omission of Herring's and Howell's researches, which have thrown so much light on its development, structure, and functions.

Nussbaum's work on the kidney is mentioned and dismissed with a shrug because Adami failed to confirm some of his statements. We are not told that Adami subsequently withdrew most of his criticisms, nor of the important recent development of the Nussbaum method in this country, which has shown that this particular means of investigation has proved to be a sheet-anchor in our conception of the mechanism of the renal organs.

So also in the discussion on the absorption of proteins the author's knowledge seems to have stopped short at an epoch when it was believed that proteose and peptones were absorbed as such, and we have many pages devoted to an antiquated description of how these are re-synthesised in the intestinal wall into the blood-proteins. The work of Fischer, Abderhalden, and a host of American workers is passed by without a reference.

Such examples might be multiplied almost to weariness. It would therefore be advisable that if advanced students take this book as their guide it would be well for them not to rely exclusively upon it. They will derive both pleasure and profit from its study, but if they desire the latest and most accurate account of modern views they should supplement it with reading other books which deal rather with the present than with the past.

(2) Dr. Piéron's book on sleep is of quite a different character, for it only treats of one small corner of physiology, and yet he has contrived to write a volume on this subject almost equal in length to the one we have just considered. It, however, resembles Prof. Luciani's in its wealth of references. Some sixty pages are devoted to bibliography alone. This indicates how much has been written, but it also shows how little we really know. If physiologists had satisfactorily solved the intimate meaning of sleep, there would be no need of so much discussion and printer's ink, and the subject might have been discussed in as many lines as there are pages devoted to it. It is only fair to say, however, that the book is a singularly interesting one, and the subject is discussed with that admirable clearness which distinguishes the writings of most French authors. Of all the numerous theories advanced, some chemical, some circulatory, some histological, some psychological, and so forth, the author most inclines to the so-called inhibition hypothesis. The book is entitled a physiological problem, but many pathological or quasi-pathological states are included; thus we have chapters devoted to coma, unconsciousness produced by drugs and other means, fatigue, hypnosis, and others. It will therefore appeal to the students of pathology and medicine as well as to those who make physiology their life-work.

(3) The third book on our list, that by Dr. Plimmer on protein synthesis, is the second edition of a work which has already been favourably noticed in these columns. The mere necessity of a second edition of such a highly technical work is no mean testimony to its excellence. So rapid have been the recent advances in knowledge on this question that the book is very largely a new one, and it is thoroughly up to date. To peruse the original memoirs on which the book is founded is a task which would deter many authors, and certainly the majority of readers. The useful summary Dr. Plimmer has given will relieve the latter class from undertaking such a labour. It would be damning the book with faint praise to say that it is interesting; it is far too technical and packed with facts and formulæ to make it light reading, but to those who want to know the recent developments in one of the most important of the problems of the day to which either chemists or biologists can apply themselves, the book will prove a veritable godsend.

W. D. H.

THE GAS TURBINE AND OTHER ENGINES.

(1) *The Gas Turbine.* By H. Holzwarth. Translated by A. P. Chalkley. Pp. viii + 140. (London: C. Griffin and Co., Ltd., 1912.) Price 7*s.* 6*d.* net.

(2) *A Primer of the Internal Combustion Engine.* By H. E. Wimperis. Pp. xiii + 143. (London: Constable and Co., Ltd., 1912.) Price 2*s.* 6*d.* net.

(3) *Vapours for Heat Engines.* Including Considerations Relating to the Use of Fluids other than Steam for Power Generation. By Prof. W. D. Ennis. Pp. v + 78. (London: Constable and Co., Ltd., 1912.) Price 6*s.* net.

(1) ENGINEERS interested in this very difficult problem are much indebted to Mr. Holzwarth for his ingenuity, to Mr. Junghaus for his support, and to both for their liberality

in making public the results of their labours in this direction up to the present. Though the book is but a small volume of 140 pages, the matter is greatly condensed, and will demand close attention for its full significance to be appreciated.

The essential unit of the Holzwarth gas turbine consists of a combustion chamber into which gas, or hydrocarbon vapour, and air are delivered at a small pressure by a suitable pump through mechanically operated inlet valves; ignition is by high-tension magneto, and the resulting high temperature and pressure combustion products then discharge through a spring-controlled flap valve, *via* a nozzle, to the rotor vanes; having passed the rotor, the gases enter an exhaust pipe, wherein a partial vacuum is constantly maintained by an exhauster. Very shortly after ignition the flap valve is slowly closed by mechanical means, time being permitted for a gust of scavenging air to pass through, thus cleansing and filling the combustion chamber in readiness for the next working charge of vapour, and cooling the nozzle and rotor vanes. The action is thus intermittent, and the design involves three valves in each unit, together with charging and exhausting pumps. In the actual turbine several such units are arranged symmetrically around a turbine wheel or rotor, the continuous speed of which is preserved by the successive impulses thereby imparted to its vanes. As fuels, petrol, kerosene, gas oils, benzol, and even tar oil may be satisfactorily employed.

The book is divided into four sections, in the first of which a theory of the gas turbine is exhibited mathematically by aid of analysis and of entropy diagrams; much of this part is of the nature of a summary of formulæ and results, and cannot be fully appreciated without much reference to other works; moreover, partly on account of difficulties of analysis, but largely from imperfection of the physical data, some of the conclusions reached are of a very conjectural character, and may require substantial qualification after a more extended practical experience. The author considers in detail the several operations of charging, compression, ignition, combustion, expansion, and scavenging; he concludes that the intermittent action used, with the lowest possible temperature of charge prior to ignition, and the largest possible nozzle opening, is essential to economy, and is conveniently realisable in actual design. Data relative to compression are still wanting, and the investigation given proceeds largely upon assumptions suggested by experience and general knowledge; in the Holzwarth combustion unit it is not practicable to compress to any extent before ignition, but the author is persuaded that satisfactory turbine efficiencies are attainable at much lower compressions than are usual in reciprocating engines.

An interesting section of the work is that dealing with the utilisation of the exhaust heat; by aid of a "regenerator," sufficient heat is said to be recoverable to work the charging and exhausting apparatus.

The construction and details of the actual turbine are described, and the text is illustrated by many well-drawn and clearly executed figures. The gas turbine is as yet in its infancy, and it would be unfair at the present time to compare it with the modern reciprocating high-efficiency engine; in the last section of the book test results are given, together with copious diagrams and tables. Progress is continuing, and further experimentation is needed, and will be carried out by the able author and his business colleague.

The translator is to be congratulated on his work; the text is in such good and clear English as to betray no suggestion of its German origin. The book is well printed and illustrated, and from all points of view is a welcome and valuable addition to the literature of the problem.

(2) This is an excellent elementary text-book on the internal combustion engine, with special reference to the small petrol engine, and forms a suitable introduction to the larger work by the author on the same subject; though succinctly presented, the matter is never obscure. A brief historical notice is succeeded by an account of the leading facts of the theory of heat and the fundamental formulæ of the ordinary theory of perfect gases. The desirable feature appears of a limited use of easy differentials, the several steps of the reasoning being given in full so that the student should experience no difficulty in following the argument to its conclusion; that nebulous quality, entropy, is also dealt with intelligibly, and a useful account is given of indicators and indicator diagrams. The difficult subject of explosion pressures is treated in the light of the results obtained by the Gaseous Explosions Committee, the variability of specific heat with temperature being suitably emphasised. This is followed by descriptions and large sectional views of actual typical engines, including the Diesel and semi-Diesel types, together with illustrations and an account of uncooled and cooled pistons and valves, and a short note on Aëro engines.

Chapter vi. treats more fully of fuels, both liquid and gaseous, including alcohol and benzol, and the principle of the gas producer; next some engine details, notably ignition and carburation, are shortly described; finally, a chapter is devoted to the testing of engines, and reference is made to the author's accelerometer; we should like to have found a more detailed account of this very ingenious and useful instrument. Examples are introduced in various portions of the work for the student's exercise on points of theory, and answers to many of these are given at the end of the work, which concludes with a useful index. Both in matter and style the book is much better than many of the small elementary treatises that have already appeared, while the printing and illustrations leave nothing to be desired. Altogether this forms an attractive and useful little work which will prove of real assistance to the student in the earlier portions of his course.

(3) In this tract of 78 pages are conveniently collected data as to the physical properties of special interest to the engineer of several liquid substances, including alcohol, chloroform, carbon tetrachloride, ether, ammonia, sulphur dioxide, acetone, and carbon disulphide, together with steam tables. The collection should prove useful for purposes of reference; the author uses British thermal units and Fahrenheit degrees of temperature, and his figures will thus be immediately available to the great majority of British engineers to whom it is still difficult to think in metric and centigrade units, notwithstanding the theoretical advantages claimed for the metric system.

In appendix i. the formula for chloroform ($CHCl_3$) is incorrectly given as C_2HO_3, and "carbon chloride" is used for carbon *tetra*chloride; as there are several carbon chlorides it seems desirable to distinguish clearly which is referred to.

The work is well got up, and contains numerous tables and diagrams relative to the substances dealt with, together with a discussion of the limits of efficiency attainable theoretically with the several liquid fuels considered.

OUR BOOKSHELF.

Percentage Compass for Navigators, Surveyors, and Travellers. By J. C. Fergusson. (London: Longmans, Green and Co., n.d.) Price, unmounted, 2*s*. 6*d*. net; mounted on linen, 3*s*. 6*d*. net.

MR. FERGUSSON has apparently just discovered what everyone knew before, viz., that at the angle of 45° the natural sine is equal to the natural cosine, or the one is 100 per cent. of the other, and, being obsessed with the idea that the one great object in life is to work out percentages, he has taken the trouble to find the values of the natural cosines when the natural sine has any percentage from 1 to 100 to those natural cosines. He then divides the compass circle into octants, and each octant into 100 unequal parts, or percentages, and states that by the use of these percentages Traverse tables are no longer required.

What Mr. Fergusson has really done is to make a new Traverse table where the natural cosine, arranged in percentages in a circle outside the compass, has to be multiplied by the percentage course steered to obtain the natural sine.

At present both natural cosine (diff. of latitude) and natural sine (departure) can be obtained from the ordinary Traverse tables for every degree of the compass and for any radius between 1 and 300.

Not only does Mr. Fergusson give a roundabout way of obtaining a result which can be readily extracted from the Traverse tables, but he also seems to think that the natural cosines and sines on a circle, the zero of which points to the magnetic north, will give the difference of latitude and departure by utilising the percentages of the octants on a compass card marked by his method. These, it is scarcely necessary to point out, can only be ascertained when the zero of the circle points to the true north, or each course steered has been corrected for the magnetic variation and any local disturbance caused by a vessel's magnetism.

An Essay on Hasheesh. Including Observations and Experiments. By Victor Robinson. Pp. 83. (New York: "Medical Review of Reviews," 1912.) Price 50 cents.

IT is difficult to regard this booklet as a serious contribution to medical literature. It consists of about four score small, narrow pages, about half of which are occupied by an account of the hallucinations and rhapsodies experienced by the author when under the influence of the drug *Cannabis sativa.* What the precise value of these observations is it is impossible to discover. It is no more practicable to subject them to rational or systematic analysis than to attempt to find reason or method in the incoherent ravings of delirium. The particular manifestations induced by Indian hemp must, of course, largely depend upon idiosyncrasy, temperament, antecedent and accidental conditions, and a host of predetermining and fortuitous causes, and must therefore vary from individual to individual and differ, too, in different circumstances even in the same individual.

The only valuable section of the book is the short digest of the little that is known from prior work concerning the therapeutics and chemistry of hasheesh.

Life and Evolution. By F. W. Headley. Pp. xx+272. Second edition. (London: Duckworth and Co., 1913.) Price 5*s*. net.

THE present does not differ greatly from the first edition, which was reviewed in the issue of NATURE for March 7, 1907 (vol. lxxv., p. 434). Mr. Headley has re-written a few pages, corrected occasional inaccuracies, and replaced several unsatisfactory illustrations by better. He has also, in the light of new facts which have become available since the book appeared first, modified some of his views.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Proposed Tropical University.

THE proposal to create a tropical university which has been put forward in the columns of NATURE and elsewhere is one which requires careful scrutiny and calls for a clear appreciation of the real issues involved.

It seems at least open to question whether the advocates of the scheme really contemplate a new university, or whether they are not rather thinking of a college or institute of university rank, the work of which should be somewhat intimately associated with the promotion of the material prosperity of the great agricultural interests that are growing up in the tropics. Such a college, in addition to the function of inducting men into the various branches of tropical agriculture, should serve, if properly staffed and organised, as a centre for the dissemination of current information on matters pertaining to the industrial needs of the community, in so far as agricultural problems are concerned. For this purpose it is essential that facilities for field and other experiments should be fully provided, and if the site were suitably chosen the college would prove an invaluable training ground, not only for the population resident within its immediate geographical area, but for others also, and especially perhaps for Europeans, about to engage in agriculture in any part of the tropics. Various places have been suggested as possible sites, and there is much to be said in favour of the West Indian proposal. Easy access from Europe, as well as the variety of soil, climate, vegetable products, &c., are all points in its favour, whilst the fact that no British institution of the kind desired exists in that region is a defect which would thus be repaired. Furthermore, the possibility of securing a considerable range of advantages within a relatively small geographical area is of itself a distinct gain, for it could be more economically worked than a similar institute in a large continental area, where things are on a larger scale, quite apart from limitations imposed by a continental climate, which cannot be ignored.

Accepting for the moment the desirability of founding a college of the kind indicated, the danger that lurks in the scheme would almost certainly be found, in practice, to consist in a desire to see immediate results which would be convertible into a cash value by the planters. In order to ensure success, it is absolutely essential that a wise and far-sighted policy should guide the destiny of the institute. Agricultural problems, and especially tropical problems, are seldom simple, and while immediate practical objects need not, and should not, be lost sight of, the college would fail to justify its creation if it were to exist for these purposes alone. It must, while not neglecting the practical training of students in tropical agriculture, also include within itself, as a vitally essential part, a body of first-rate scientific investigators and teachers, who will be able to seize upon problems and work them out. There must be no attempt to limit their work to the economic questions of the moment, for in cramping the spirit of investigation lies the way of throttling material progress.

Such a staff would, of course, cost money, and often the return might seem to be slow in coming, but it is impossible to over-estimate its importance. Indeed, unless a proper staff can be provided, the scheme is not worth pursuing, for the most that could then be hoped for would be a mere technical institute —a sort of edition *in parvo* of current planting practice, veneered over by a fallacious appearance of scientific equipment.

Now an institute such as is here foreshadowed would greatly gain by connection with leading institutions in this country. Science is growing apace, and particularly those branches of it which especially touch on agriculture. And, however able the staff, it could not hope to escape from the disadvantages inherent in a separation from the main clearing-houses of scientific thought. Some sort of association, then, with home institutions, such as the University of Cambridge and the Imperial College of Science and Technology, for example, could not fail to be of advantage to all concerned. An association of this kind ought to be a real and not a merely nominal one, for only in this sense could it serve any useful purpose and provide for an interchange of knowledge and for the stimulation of ideas. Arrangements might perhaps be made for enabling suitable students of the college to visit this country and be received for a time in the home institutions, and *vice versâ*.

Such a college, conceived and maintained on generous lines, would develop into a valuable asset to the Empire, and would exert a powerful influence in furthering the interests and objects of tropical agriculture within it.

But the question of an insular tropical *university* is a very different one. There are perhaps already more than enough universities, and it is difficult to see how it would be possible to justify the foundation of another in the manner that has been suggested, —quite apart from the very considerable outlay that would be necessarily involved.

Moreover, a centre of real university learning, and still less of culture, can scarcely be created by the stroke of an administrative pen, and it would, in any event, be compelled to seek its justification in the existence of a population large enough and able in other respects to utilise the advantages the university ought to be in a position to confer. And it seems open to inquire whether a mere fraction of the financial resources which would be needed for the more ambitious project might not amply suffice to enable everyone of marked ability to enter an existing university elsewhere, if he (or she) were otherwise unable to do so. There would be many disadvantages inseparable from a small insular university, and it is scarcely necessary to dwell on them here. For the present it may suffice to remark that a second-rate university is not worth its upkeep, whilst a properly staffed and equipped one would demand very considerable funds, and not only so, but other claims, difficult to meet, would also have to be satisfied.

The further one reflects on the matter the weaker does the case for the establishment of the university, and the stronger the claims for the foundation of an agricultural college, appear. Almost all the arguments which can be urged against the first proposition can be used in support of the latter. But it may be that after all a substantial agreement already prevails amongst the majority of those who are advocating the scheme, and that an agricultural college of university rank is really what is desired.

J. B. F.

The Mountains and their Roots.

IN NATURE of February 27, p. 703, you honoured me with a review of my recent paper on the origin of the Himalaya Mountains. During thirty years of residence in these mountains I have continually been confronted by the geodetic problems which they present. The highest geological authorities express doubts as to how mountains have been upraised, and geological theorists differ widely.

In my recent paper I suggested, with diffidence, the hypothesis that the long belt of Indus-Ganges alluvial plains was concealing a deep crack in the subcrustal shell of the solid earth, and that the Himalaya mountains had been crumpled up by the opening of this crack in the solid globe.

When a large mass of heated rock, or ore, or glass is cooling, its surface is apt to crack; we never see the core of any such mass shrink away from the outer shell and leave the outer shell too large and unsupported, as is often assumed to be happening in the case of the earth.

Are geologists quite sure that the earth's outer shell has not been cracking, and that the cracks are not hidden from our sight by silt? Would not the cracking of a solid globe provide a sufficient mechanical force to elevate mountains?

The earth's rotation is slowing down; the equatorial protuberance of rock is constantly straining to move polewards.

Throughout the whole length of the Indus-Ganges belt of plains earthquakes are frequently occurring, and what can be causing these earthquakes, if not the splitting asunder of the solid globe beneath?

At both extremities of the Indus-Ganges belt deep narrow submarine cañons exist extending far out to sea; they are known to sailors as "swatches." What are these swatches, if not the surface indications of a subcrustal crack?

In the review in NATURE my hypothesis is dismissed without any specific objection to it being raised. I am not wedded to it, and I should welcome its dismissal, if I thereby learnt its errors. But I am disappointed to see it rejected merely because my critic has himself accepted the "floating crust" hypothesis.

The reviewer has accepted as true the hypothesis of the Rev. Osmond Fisher. According to this hypothesis the solid crust of the earth is of limited thickness and floats upon a liquid magma of greater density. This assumption of a liquid substratum appears to me to be opposed to the views of the great majority of geological writers. So far as I am able to judge, the weight of the evidence seems largely in favour of a solid globe.

Furthermore, Mr. Fisher has to assume that as the central core of the earth cools down, the outer crust is left unsupported owing to the core's contraction ("Geology of India," R. D. Oldham, p. 471). This assumption of a cooling core contracting away from its shell seems to me to be more difficult to justify than the assumption of a cooling shell becoming too small for its core.

But let me descend from these great assumptions to actual geodetic figures.

Mr. Fisher assumes that the crust floats in the dense liquid, just as ice floats in water. Each mountain rising from the upper surface of the crust has a corresponding protuberance extending downwards from the lower side of the crust. The buoyancy of a protuberance suffices to support the weight of the corresponding mountain above it.

If h=height of a mountain, and if d=depth to which its protuberant root extends downwards into the liquid, then, according to Fisher, $d=9{\cdot}6\times h$.

Now let me apply this hypothesis to the mountains of India. All these mountains are assumed to be buoyed by subcrustal protuberances of lower density than the magma, but the protuberances extend downwards to different depths, which are proportional to the several mountain heights.

Mountain	Height of mountain above crust = h Miles	Depth of protuberance below crust = d. Miles
Tibet plateau	3	29
Himalayan range	4	38
Vindhyas	0·6	5

Let us suppose a plumb-line to be suspended near the foot of a mountain, and let us suppose that the mass of this mountain is compensated by a deficiency of density underlying it below the crust. If that deficiency of density be wholly concentrated near sea-level, it will entirely compensate the attraction of the mountain mass, and the plumb-line will hang vertically. But if that deficiency of density be distributed to a great vertical depth, it will not compensate the mountain's attraction, first, because of its greater distance in depth from the plumb-line, and secondly, because its resultant action is more inclined to the horizontal.

If a mountain (Himalayan) is four miles high, and if its protuberance extends downwards to a depth of thirty-eight miles, the geodetic observer would report:—"There is distinct evidence of compensation, but the compensation is by no means complete."

If, however, a mountain (Vindhyan) is 0·6 mile high, its compensation would take place within five miles of the crust, and the observer would report:—"The compensation is here more complete than in the case of the higher mountain."

Similarly a pendulum observer at a station (Himalayan) two miles high will (according to the Fisher hypothesis) not find the same degree of compensation as he will at a station (Vindhyan) half a mile high. The underlying deficiency of density will in each case have a retarding effect on the pendulum, but at the Himalayan station the deficiency reaches downwards nineteen miles into the liquid, whilst at the Vindhyan station the deficiency only extends five miles downwards.

According, then, to the "floating-crust" hypothesis our plumb-line and pendulum observers should find the attraction of small mountains more completely compensated than the attraction of high mountains. But what are the results of actual observations? Both the pendulum and plumb-line observers find the attraction of the Himalayas to be largely compensated, whilst the Vindhyan mountains are not compensated at all. Actual results of observation are in direct opposition to the "floating-crust" hypothesis.

Mr. Hayford has stated that the "floating-crust" hypothesis is not true for the United States of America ("Figure of the Earth and Isostasy," p. 164), and in my opinion the evidence is sufficient to show that this hypothesis is not true for India.

S. G. BURRARD.

Surveyor-General's Office, Dehra Dun, March 29.

As an officer of the Survey of India, employed for many years in determining deflections of the plumb-line and variations in the intensity of gravity, I was interested to find in the article which appeared under this heading in NATURE (No. 2261, vol. xc., February (27) reference to the hypothesis suggested in 1904 by the Rev. O. Fisher as to the nature of mountain compensation, and the statement that this hypothesis goes far to explain the deflections of the plumb-line observed at the foot of the Himalayas and in the Gangetic plain. The article states that, according to Mr. Fisher's hypothesis, "the crust is of uniform density, the isostatic compensation being obtained by a variation in thickness," and that, on this hypothesis, Mr. Fisher "finds that the attraction of the visible range combined with the negative attraction of the downward protuberance should give a northerly deflection of about 24″ at the foot of the hills, of about 2″ at sixty miles away, and a southerly deflection of about 2″ at the farther edge of the plains. These results appear to be in very fair accord with the observations. . . ."

This statement is liable to convey a wrong impression. We are given to understand that the effects of the visible mountain mass and the downward protuberance are sufficient to explain the observed phenomena. The facts stated below will show how far this is correct. In addition, the article referred to makes no mention of an important feature of the Rev. O. Fisher's hypothesis. We are not told that part of the deficiency of mass which compensates the visible mountain range is supposed to be, not under the range, but under the plains. Mr. Fisher's hypothesis is not one of simple isostatic compensation, but involves the horizontal displacement of part of the compensating deficiency.

Mr. Fisher's investigations were published in *The Phil Mag.* of 1904, in an article which your reviewer suggests has been overlooked by Col. Burrard in his paper, "The Origin of the Himalaya Mountains: a Consideration of the Geodetic Evidence." As regards the overlooking of Fisher's investigation, it will be sufficient to point out that it was included, at Col. Burrard's own request, as an appendix to Professional Volume xviii., "Astronomical Latitudes and Deflections of the Plumb Line," published by the Survey of India in 1906. Also on p. 5 of Col. Burrard's paper under reference, we find the hypothesis of horizontal displacement of compensation discussed and rejected.

Before discussing Fisher's investigation, let me state the facts that require explanation. At the eastern end of the Himalayas are found northerly deflections of 46″, at a point about five miles north of the foot of the slope, and of 1″ at a meridional distance of twenty miles south of the slope. The variation of deflection in the twenty-five miles is 45″. In the central Himalayan region we find 38″ north at a few miles north of the foot of the slope and 5″ south at a meridional distance to the south of 112 miles, the variation here being 43″ in 112 miles. In the western Himalayas, in the meridian of Dehra Dun, deflections occur of 31″ north at the foot of the hills, and of 1″ north at a meridional distance of fifty-six miles. Here the deflections change by 30″ in fifty-six miles.

Thus, in a strip of country from thirty to 100 miles wide, lying immediately at the foot of the Himalayan slope, there is found a very rapid variation in the deflection of the plumb-line in the meridian. But while the variation is large, the average deflection over this tract is small, rather less than 20″ north. The observed variation of deflection is greater than that due to the visible Himalayan mass considered entirely uncompensated, and it might seem that we must admit this complete want of compensation of the hills in combination with a deficiency under the plains. Here, however, we are opposed by the evidence of the deflections themselves. Though we find that the observed variations of deflection are greater than if compensation did not exist, the observed deflections themselves are much smaller.

Now, Mr. Fisher, in his paper of 1904, investigated the deflections at three points on the meridian of Kalianpur. One of these lies at the foot of the Himalayan slope, and Mr. Fisher correctly takes Dehra Dun as representing this point. A second point, sixty miles from the slope, is represented by Kaliana, while the third point is 293 miles from the foot of the slope. This point is considered to represent Kalianpur. Kalianpur, however, is about 420 miles, measured on the meridian, south of Dehra Dun. The point 293 miles from the foot of the slope corresponds more nearly with a point between Usira and Kesri.

The observed phenomena which Mr. Fisher had before him were a change of deflection, amounting to 30″, in the sixty miles between Dehra Dun and Kaliana, and an average deflection in this interval of 16″; a change of 43″ between Dehra Dun and Kesri, with an average deflection of 16″.

Considering Fisher's investigation first from the mathematical point of view, we find that the theoretical plumb-line deflections are calculated for three points only, while his formulæ involve several unknowns, thickness of crust, crustal density, ratio of crustal to subcrustal density, the degree of compensation which, taken into consideration with the ratio of densities, determines the depth of the mountain root, the deficiency of mass underlying the plains and the area over which this is distributed. Obviously more than one set of suitably adjusted values of these unknowns will bring the formulæ into accord with the observed facts. The agreement, if such agreement did exist, of Fisher's calculated quantities with the observed deflections would be interesting, but it would not prove the correctness of his hypothesis.

Mr. Fisher calculated the theoretical deflections on two hypotheses, neglecting the effects of sphericity. In the first the visible mountain range is compensated by a deficiency of mass vertically below it. The results of this calculation are exhibited on p. 17 of *The Phil. Mag.* for January, 1904. The theoretical change of deflection over the sixty-mile interval is found to be 15·5″ in a plane at right angles to the range, or about 12″ in the meridian, with an average deflection of about 6·5″ in the meridian. These calculated quantities of 12″ and 6·5″ correspond to the observed 30″ and 16″. In calculating the effect at 293 miles from the slope, evidently an error has crept into Mr. Fisher's computations. The residual deflection is stated to be away from the mountain range. This is an impossibility where sphericity is neglected. The positive attraction of the visible mass and the negative attraction of the compensating root only become equal at an infinite distance from the mass. In a later paper, dated April, 1904, other figures are given for the deflection at the south of the plains, making the theoretical difference between deflections at the foot of the slope and at the south edge of the plains about 17″, with an average deflection of 10″ against the observed 43″ and 16″.

It is evident that "the attraction of the visible range, combined with the negative attraction of the downward protuberance," fails to give theoretical effects in accord with the observations.

Mr. Fisher then modified his first hypothesis, and it is this modification that has been lost sight of by the reviewer of Col. Burrard's paper. Mr. Fisher now supposes the mountain mass not supported solely by the root immediately beneath it, but partly by the effect of the crust below the Siwalik rock of the plains being depressed by 15,000 ft. into the substratum. A third factor is thus brought into operation, namely a deficiency of mass underlying the plains. It is true it may be claimed that the deficiency is considered as part of the isostatic compensation of the visible Himalayan mass, and that Fisher's system does not introduce a third entity, but merely implies an irregular distribution of compensating masses. The whole deficiency equivalent to the surface excess, instead of lying directly below the latter, is, in part, displaced horizontally to below the plains. But the elimination of part of the deficiency below the visible range has the effect of altering the variation between deflections at the foot of the slope and at the south edge of the plain by only 2″, whereas the differential effect of this deficiency of mass, when transferred to the subcrust under the plains, is 8″. The significant fact is not so much the reduction of deficiency below the mountain range as the location of a deficiency under the plains between the foot of the slope and the southern station of observation. In Fisher's hypothesis this is the important feature which brings about a more rapid variation of deflections than follows from the assumption of simple compensation.

The results of the calculation upon the second hypothesis give 20″ as the variation of deflection between Dehra Dun and Kaliana, with an average deflection of 12″, against the observed 30″ and 16″. The calculated variation and average deflection for the interval between the foot of the hills and the southern edge of the plains are, respectively, 24″ and 10″, the observed values being 43″ and 16″. The differences between Fisher's quantities, based on the second hypothesis, and those observed, approach, on an average, 35 per cent. of the observed values.

Both hypotheses, that of simple and that of general compensation, fail to give results in accord with observation, when Fisher's numerical values are used. In his second hypothesis his assumption of a three-mile depression of the crust is inadequate. As pointed out by Col. Burrard in his paper, to explain Himalayan deflections by a hidden synclinal, we must assume the latter to be seventy to eighty miles wide and six miles deep under Siliguri, seven miles south of the foot of the slope, and two miles deep under Jaljaiguri, thirteen miles south of Siliguri, the rock composing the synclinal basin to have a density of 2·7, and the sediment filling the synclinal to have a density of 1·9. As Col. Burrard says, it is doubtful whether the density of sediment, when under a pressure of a vertical column six miles high, would remain as small as 1·9; any increase in its value will require the depth of the supposed synclinal to be increased.

In connection with Fisher's investigation, there is an interesting point. Putting aside his computed figures, we see that both he and Burrard agree in considering that the observed facts cannot be explained by only the visible Himalayan mass and its vertically underlying root. Both investigators are forced to conclude the existence of a third factor, a source of negative attraction under the plains at the foot of the hills. Fisher prefers to adopt the idea of deficiency extending under a relatively wide belt of the crust due to the depression of the latter into the liquid substratum, the outer surface of this depressed tract being brought up to sea-level by the deposition of the Siwalik beds and alluvium. This hypothesis leads to the assumption of very doubtful values of some of the unknown quantities, as has been shown above. Burrard's hypothesis differs from Fisher's in that he would localise the deficiency in a rift in the crust subsequently filled in by deposits.

H. M. COWIE.

Dehra Dun, U.P., India, April 3.

SURELY Col. Burrard and Major Cowie have misread the review; it did not dismiss Col. Burrard's speculations, but pointed out that he had himself dismissed, with what appeared to be inadequate examination, an hypothesis which seemed fully capable of explaining the facts. The sentence which has elicited their letters was intended to refer solely to the memoir under review, and had no application to other publications by the same author. The memoir did not, in fact, contain any detailed investigation of an hypothesis which, if tested numerically and in its completeness, appears to be at least as capable of affording an explanation of the facts as that propounded by Col. Burrard. The reviewer may point out that the limited amount of space at his disposal compelled the omission of reference to many points of which he was well aware, and had fully considered, but in view of the publication of these letters he may be permitted to amplify the argument of the paragraph in the review which has called them forth.

Mr. Fisher's investigation assumes an isostasy by flotation, and, what is an almost inevitable consequence, that the flotation is not confined to the area of the range, but that, as an iceberg has generally an under-water extension helping to support the visible mass, so the lighter "crust" under the plains is borne down into the denser "substratum" or "subcrust" by the weight of the mountain range. This interpretation is in accord with the evidence of the pendulum, which shows that the defect of gravity under the mountains is continued under the plain, and only gradually decreases with increasing distance from the range; it is also in accord with conclusions drawn by the Geological Survey long before the observations of variations in the force of gravity and of deflection of the plumb-line in the neighbourhood of the foot of the hills were published, and the constants used by Mr. Fisher, so far as they are special to the Himalayas, were taken from these reports.

According to the hypothesis, a station near the edge of the hills, such as Kurseong, would be affected (1) by the positive attraction of the visible masses; (2) the negative attraction of the "root" or downward thickening of the "crust" into the "substratum"; (3) by the negative attraction of the submerged portion of the "crust" under the plains, replacing denser "substratum"; and (4)—though Mr. Fisher did not separately consider this—by the negative attraction of the alluvial deposit of the plain, the mean density of which is less than that of average rock. Of these (1) is the same whatever hypothesis of isostasy is adopted; (2), it appears from Mr. Hayford's investigation of the effect of an isostasy produced by compensation limited to a ten-mile stratum, between twenty-five and thirty-five miles depth from the surface, would somewhat increase the deflection at a station situated on the edge of the hills (*e.g.* Kurseong), and make but little alteration at a station twenty or thirty miles out in the plain (*e.g.* Jalpaiguri); (3) and (4) would both produce their maximum effect at a station situated like Kurseong, and have comparatively little influence at one situated like Jalpaiguri. Here we have three separate corrections, all working in the same direction, and all attaining their maximum at the same station, and it is not inconceivable that together they might afford an explanation of the peculiarities noticed by Col. Burrard.

It is obviously useless, at the present stage of our knowledge, to enter into detailed calculations of an imaginary range, but some approximate calculations made by the reviewer indicate that the increase in the difference of deflection as between Kurseong and Jalpaiguri due to (2) would be of the order of 4″, to (3) of the order of 8″, and to (4) of not less than 9″, or a total increase in the calculated difference of deflections amounting to more than 21″, as compared with Col. Burrard's unexplained anomaly of 30″. These figures have no value, except as indicating that there is another hypothesis, besides that of the "rift," which would account for a change in the amount of deflection near the foot of the range, of the same character and order of magnitude as that actually observed.

It must be added that this explanation can only be taken as applying to the Himalayas; the conditions in the Vindhya are entirely different and require to be considered apart.

THE REVIEWER.

PIANOFORTE TOUCH.

When the editor of *Popular Mechanics* submitted a list of modern inventions to a referendum to select the "seven principal wonders of the modern world," the piano-player and player-piano were conspicuous by their absence from the long collection, although they possess quite as many features of scientific interest as many of the inventions actually submitted. These mechanisms have, moreover, failed, for some not very obvious reason, to form the subject of discussion in scientific and technical journals where frequent mention is made of such proprietary inventions as motor cars, gramophones, kinematographs and the like. Yet a number of subjects for scientific discussion may be suggested in connection with piano-players. The psychologist, for example, will notice that after a very little experience the performer does not consciously move his regulator to play faster or slower; but he unconsciously plays the notes at the exact instants that he thinks of them quite as much as if he were striking the keys with his fingers.

The attempt to compare pneumatic playing with finger playing in the matter of "touch" lands us in a very difficult problem of dynamical acoustics which has not received so much attention as it deserves from physicists. We are told that the piano-player cannot reproduce the clear singing *pianissimo* of the finger pianist, that there is a certain element wanting which only the human fingers can supply. What is this element? A piano-player can be played as softly or as loud as is desired, it allows full use of the pedals, and a slight jerk of the time lever enables the performer to "linger on a note" as well as an ordinary pianist. But still, we are told, the "touch" is not the same, and if a few notes are played from the music roll and then played with fingers, a certain difference in the quality of the tone often appears noticeable.

Now the quality of a note, apart from its actual loudness, depends on the relative intensity of the fundamental tone and its several harmonics, and we are thus led to inquire into the question how far the harmonics of a pianoforte note are capable of being intensified or reduced independently of the fundamental tone.

It is obvious that great differences in quality are produced by the use of the loud pedal, and the old-fashioned soft pedal which shifted the hammer off one of the strings and caused a softer part of the hammer to strike the others had an equal effect; moreover, the singing qualities and delicate harmonics are quite destroyed by shutting up a piano and covering it with ornaments. But even when other conditions are kept constant, differences are noticeable according to whether the same note is struck with a sharp blow or a heavy pressure, and we are thus led to the important question: *Are the intensities of the fundamental tone and its harmonics functions of one variable only, or are they functions of two or more variables?*

Now upon this point I find that a great disagreement of opinion exists. Many piano-makers in this country hold to the single-variable hypothesis on the ground that when the hammer is striking the strings it is disconnected from the keys; if this were not the case the note would be "blocked." On this hypothesis the striking velocity of the hammer constitutes the single independent variable. The single-variable theory is not inconsistent with the possibility that the character of a note may vary according to its loudness; this only requires that the intensities of the various components shall be different functions of the same variable instead of being multiples of the same function.

Other people will tell us that if it were possible to produce differences in the quality of a pianoforte note, they would be too small to be appreciable.

In Germany, on the other hand, I am informed that great importance is attached by teachers of the pianoforte to differences in the manner of applying pressure to the keys. During the small interval of time that the key is being depressed, this pressure is an arbitrary function of the time, or, if preferred, of the displacement, the form of the function depending on the action of the fingers and in particular on their elasticity, and the German method distinctly assumes the existence of a relationship between the form of this function and the quality of the note sounded.

Neither Helmholtz's nor Kaufmann's theories afford an explanation of the "two-variable" hypothesis. I believe other papers have been published dealing with this question, both experimentally and theoretically, and I hope the present article will be the means of eliciting information on the subject. It is evident that such investigations have not become widely known among physicists. From the point of view of applied mathematics, the difficulty of the problem consists in finding fundamental assumptions which lead to the desired conclusions, and are at the same time consistent with the structural conditions as they exist in the pianoforte. Two possible explanations suggest themselves:—

1. Although the hammer is at a slight distance from the wires in its position of *equilibrium*, it may still be acted on by some impressed force while touching the string, owing to the elasticity of the connections.

2. The stem of the hammer is flexible and capable of independent vibration, so that the circumstances of the impact may depend on the bending set up in projecting the hammer.

I am now investigating the equations of motion based on these two alternative assumptions, but the problem is a very difficult one, and it seems desirable to obtain further experimental evidence before any final conclusions can be reached.

For some time past I have obtained results with a piano-player which exhibit conspicuous discrepancies from what one would expect on the single-variable theory, and a good deal of care has been exercised in ascertaining that these effects are not due to mere imagination. My experiments have been so far directed towards the question as to how far differences of dynamical touch can be made to produce effects that can be noticed by an ear not specially trained to observe them. The apparatus used in these experiments consists of a horizontal lever fixed in front of a piano-player of the usual standard type; the short arm of this lever is connected by a wire passing over pulleys, or by some other connection, with the small auxiliary bellows of the player, and acts directly on it, the usual spring being removed. The lever carries a sliding weight by which the collapsing tension of the bellows can be regulated. When the bellows collapses it closes a kind of throttle valve in the mechanism, thus cutting the air off and producing an action similar to that effected by a short sharp impulse applied to the pianoforte keys. By increasing the load, by shifting the weight towards the end FF, a heavier sustained pressure is produced.

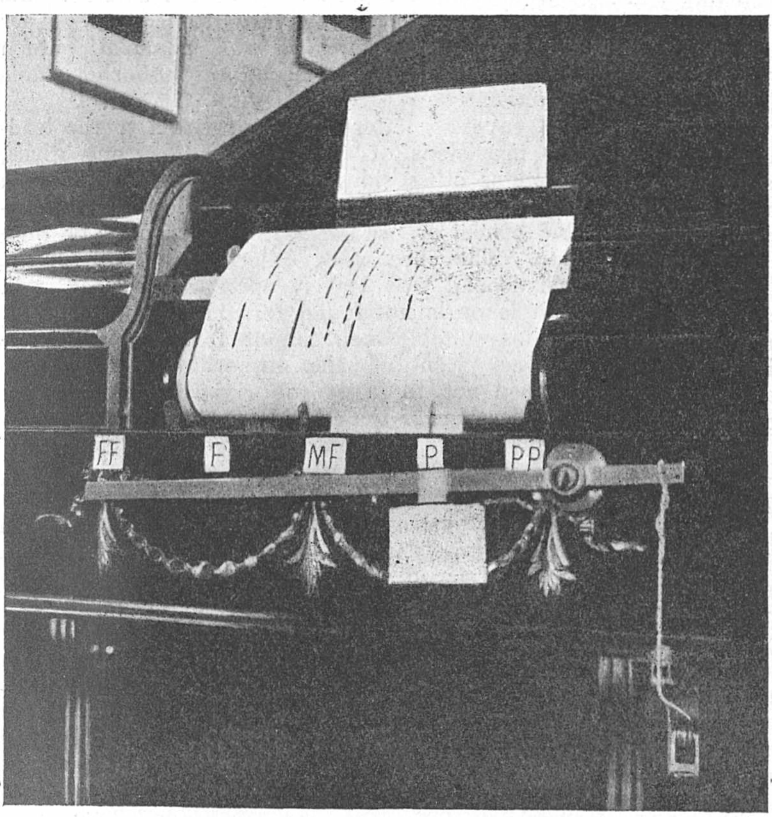

FIG. 1.—Apparatus (provisionally protected) for controlling the touch of a piano-player.

When the same passage is played first with the weight at PP and then with it at FF, a noticeable difference is observed. The loudness can be made about the same in both cases by suitably altering the pressure on the pedals, but in the former position the result is a brilliant "metallic" effect in which the treble notes stand out conspicuously, while in the latter position soft, mellow tones are produced in which the bass notes predominate.

The differentiation between bass and treble parts of chords is not necessarily inconsistent with the single-variable theory, since the hammers are of different mass in different parts of the scale, and therefore undergo different accelerations when the same variable force is applied to them. This dynamical differentiation is more satisfactory than the popular mechanical arrangement for controlling the two halves of the keyboard, as it involves no hard and fast dividing line.

In a passage involving chords it is impossible to separate the effects due to differences between the notes of a chord from any possible differences between the harmonics of the notes, and therefore it is necessary to choose a solo passage in order to effect a decisive test. I have shown such tests to a good many people; a few notice either no differences or only very slight differences. On the other hand, it is very surprising to find how many people notice conspicuous differences, and those who are most successful in detecting them are often people with no ear for music and no previous musical training. In most cases I ask them to describe what they observe without previously preparing them. It is thus evident that the dynamical effects dependent on these differences of touch, so far from being negligible, must have a marked influence on the impressions formed by a large proportion of both the musical and unmusical people who attend a first-class pianoforte recital.

Something more than merely sliding a weight is necessary to approximate to the rendering of a good pianist, who can vary his action on the keys from one note to the other. To effect the same result the lever must be controlled by hand as well, being pressed or jerked from above or below practically in an unlimited variety of ways. An almost infinitesimal touch of the finger will often cause a particular note to ring out brilliantly. In the commercial player the performer has to depend mainly for these effects on his feet. Now not only are feet much less sensitive than fingers, but the effects are so modified by the elasticity of the various springs that these latter have a predominating influence in governing the touch, and a considerable effort on the part of the performer often produces only a slight difference in the result.

A remarkable instance of how a trifling cause may greatly modify pianoforte tones was shown in a recent demonstration at the Physical Society, when the effects were observed to be rather loud and harsh. In this case a copper wire was used for the connection between the lever and bellows instead of one of steel. On trying the copper connection at home the effects were identical with those shown at the Imperial College.

In this country little attention is paid to pianoforte touch, owing, probably, to the use of boxed-up pianos covered with jangling ornaments, when sufficient volume of sound has to be obtained by violently hammering the keys and bobbing down the pedals through harmonics and discords. Moreover, the average pianoforte pupil has too much to do with learning execution to trouble about "touch," and very few professionals produce variations in the quality of their notes at all approaching the possible maximum. It is not surprising, therefore, to find widespread belief in the single-variable theory. At the same time, I do not consider it possible to overlook the numerous results of independent observation which are inconsistent with that theory.

It is much to be hoped that the increasing popularity of the player-piano will lead to increased interest in the more scientific aspects of piano-playing.

The explanation of the acoustical effects produced by the modern pianoforte is probably a dynamical problem of considerable complexity, depending on a number of causes, many of which have hitherto been neglected. It is important that not only should attention be directed to any investigations bearing on the matter which have commonly been overlooked, but that further experiments should be carried on with the object of better localising the apparent discrepancy which exists between theory and observation.

G. H. BRYAN.

AGRICULTURAL EDUCATION.

FOR many years past technical education of a more or less efficient kind has been provided for the majority of our leading industries, but for some reason or other our greatest industry of all, and that on which indirectly all the others depend, has been left with scarcely any provision at all. It may be that this is due to the fact that agriculture is the nurseling of one Government Department and education of another, and that under our rigid red-tape-bound system, agriculture has no dealings with education. It gives peculiar pleasure, therefore, to note that this system shows signs of amendment, and one of the firstfruits of reform is seen in a memorandum recently issued by the Board of Agriculture and Fisheries to local authorities in England and Wales offering grants from the newly-established development fund towards the furtherance of technical instruction in agriculture and horticulture.

The grants promised are intended to aid (1) in the establishment of advisory councils to be set up in each county or group of counties for the purpose of reviewing, governing, and co-ordinating or initiating schemes for providing higher agricultural education and educational experiments in connection therewith; (2) in the provision and maintenance of buildings and lands for farm schools and farm institutes, at which young agriculturists and others whose daily business is connected with the land may obtain scientific and practical instruction in the technicalities of their art. At each of these schools and institutes it is intended that a highly efficient staff shall be maintained to give short courses of instruction in summer and winter suited to the requirements of the district, also to conduct experimental and research work, and to which agriculturists can apply for advice in cases of difficulty. The grants for farm schools and institutes may be partly annual where new or additional work is being undertaken.

Somewhat stringent conditions are laid down for the administration of the grants to prevent their being applied to the relief of the ratepayers in those districts where such work has already been begun, but that these districts may not be discouraged, the proportion of the grant to the actual expenditure may vary from 50 to 75 per cent., having regard to the financial burden hitherto undertaken by each local authority in this direction.

A covering letter directs attention to the leading provisions of the memorandum, and gives, amongst other things, the Board's ideas with regard to the appointment and duties of a responsible official or organiser in each county or division. The success or otherwise of the scheme will depend very largely upon whether the right man is or is not found for this important post, and as suitable men cannot at the present time be very plentiful, the authorities will be well advised not to insist too rigidly on the paper qualifications of the candidates, but to judge each on his merits, past performances, and experience in agricultural education and organisation.

The scheme outlined contains the germ of an excellent system, but its success or failure will depend largely upon the skill and tact with which it is developed. When the curricula and atmosphere of our rural elementary and secondary schools have been reformed so as to complete the scheme, and the inherent prejudices of the farming community have been overcome, we may hope for a good return for the money spent, but we must not look for abundance of fruit before the tree has had time to take root and expand its branches. Progress will doubtless be slow, and much patience, skill, and trouble will have to be expended before a crop may be looked for.

WILLIAM ALDRIDGE.

NOTES.

AT the meeting of the Linnean Society on May 1 Prof. Hermann von Vöchting was elected a foreign member, and the president announced that it had been decided to award the Linnean medal to Prof. Adolf Engler.

THE council of the Manchester Literary and Philosophical Society has nominated Sir Thomas H. Holland, K.C.I.E., F.R.S., to represent the society at the twelfth International Congress of Geology, to be held in Toronto in August next.

A MESSAGE from the Wellington correspondent of *The Times* on May 1 says:—Miss Procter's mission to New Zealand to urge the establishment of a solar physics observatory has been successful. Mr. Cawthron, a citizen of Nelson, has offered to give the 10,000*l.* to 12,000*l.* which is estimated to be the sum required.

THE annual autumn meeting of the Institute of Metals will this year, under the presidency of Prof. A. K. Huntington, be held on the Continent, for the first time since the institute's formation in 1908. It will take place in connection with the Ghent International Exhibition, the dates fixed being ugust 28–30. Among many important papers to be communicated will be the report of the corrosion committee.

AT a meeting of the Mansion House Committee of the Captain Scott Fund on Monday, May 5, the Lord Mayor announced that the combined funds, including that of *The Daily Telegraph*, amounted to 56,129*l.*, of which 12,493*l.* had been assigned for supplementing the Government provision for the relatives, 1848*l.* towards discharging the liabilities incurred by the expedition and the publication of the scientific results, and 6112*l.* for a memorial, leaving the allocation of the balance, 35,675*l.*, to the discretion of the committee. A committee was appointed to consider and report upon the form the memorial should take.

As announced already, a joint meeting of the Institution of Electrical Engineers with the Société Internationale des Electriciens will be held in Paris on May 21–24. The following papers will be discussed at the meeting:—High-tension continuous-current traction, M. Gratzmuller; single-phase traction, M. Latour; the electrification schemes of the Chemin de Fer du Midi, M. Jullian; the electrification of the Paris suburban lines of the State Railway, A. N. Mazen; railway electrification problems in the United States, H. Parodi; petrol-electric motor trains, J. B. Damoiseau; long-distance transmission of electric energy (continuous current), J. S. Highfield; long-distance transmission of electric energy (three-phase current), M. Leblanc; automatic telephony: application of mechanical devices to the assistance of manual operating in telephone exchanges, W. Slingo.

THE Historical Medical Museum, organised by Mr. Henry S. Wellcome, which is to be opened in London towards the end of June next, will include some objects of particular interest. An important exhibit in the science section will be a large collection of the original apparatus used by Galvani in making his first experiments in galvanism in the eighteenth century. Other exhibits will be a collection of votive offerings for health, ancient microscopes, and optical instruments, amulets and charms connected with English folk medicine, early medical medals and coins from the Græco-Roman period, and early manuscripts and medical books.

ARCHÆOLOGISTS will welcome the announcement that the famous prehistoric camp, known as Maiden Castle—Maidun meaning "Hill of Strength"—near Dorchester, has been, at the suggestion of the King, purchased by the Duchy of Cornwall, and will now be carefully preserved. The camp dates from Celtic times, and formed a shelter for cattle during tribal raids rather than a military fortress. Water was supplied from a Neolithic dew-pond on the summit of the plateau, and the palisading kept at bay wolves and other enemies, while the cattle were left in charge of a few women and children. The cunningly arranged entrances to the camp supply a remarkable example of primitive methods of defence.

AT the annual general meeting of the Marine Biological Association of the United Kingdom, held in the rooms of the Royal Society on April 30, the following officers and members of council were elected for the year:—*President,* Sir Ray Lankester; *Chairman of Council,* Dr. A. E. Shipley; *Hon. Treasurer,* Major J. A. Travers; *Members of Council,* E. T. Browne, L. W. Byrne, Dr. W. T. Calman, Prof. H. J. Fleure, Prof. F. W. Gamble, Sir Eustace Gurney, Commander Campbell Hepworth, Prof. J. P. Hill, E. W. L. Holt, Prof. E. W. MacBride, H. G. Maurice, Dr. E. Schuster, G. W. Smith, Prof. D'Arcy W. Thompson; *Hon. Secretary,* Dr. E. J. Allen. The following governors are also members of council:—G. P. Bidder, the Earl of Portsmouth, Sir Richard Martin, the Hon. N. C. Rothschild, Prof. G. C. Bourne, Dr. A. E. Shipley, Prof. W. A. Herdman.

AT the annual general meeting of the Institution of Civil Engineers, held on Tuesday, April 29, the result of the ballot for the election of officers was declared as follows:—*President,* A. G. Lyster; *Vice-Presidents,* B. H. Blyth, J. Strain, G. R. Jebb, A. Ross; *other Members of Council,* J. A. F. Aspinall, J. A. Brodie, W. B. Bryan, Col. R. E. B. Crompton, C.B., J. M. Dobson, Sir H. F. Donaldson, K.C.B., E. B. Ellington, W. H. Ellis, W. Ferguson, Sir Maurice Fitzmaurice, C.M.G., Sir J. P. Griffith, Dr. C. A. Harrison, W. Hunter, H. E. Jones, Sir Thomas Matthews, Dr. W. H. Maw, C. L. Morgan, B. Mott, A. M. Tippett, Sir Philip Watts, K.C.B., W. B. Worthington, Dr. Dugald Clerk, F.R.S., R. S. Highet, Dr. E. Hopkinson, F. Palmer, and H. N. Ruttan.

THE annual meeting of the Iron and Steel Institute was held on May 1–2, when the Bessemer gold medal for 1913 was presented to Mr. Adolphe Greiner by the president, Mr. Arthur Cooper. In making the presentation, the president said Mr. Greiner was in 1864 appointed chemical engineer, and in 1887 general director of the steel works of Messrs. John Cockerill, Seraing, Belgium. He was responsible for the introduction into Belgian iron and steel practice of the basic processes, and has been to the front in the utilisation of blast furnace and coke oven gas. The Andrew Carnegie gold medal for 1912 was presented to Dr. J. Newton Friend. The annual dinner was held on the evening of May 1. Mr. R. Elliot-Cooper, president of the Institution of Civil Engineers, spoke of the importance of the work of standardisation of materials, in which the institute has been engaged. Sir Alexander Henderson in the course of a speech remarked that science has done more for the iron and steel industry than for any other. The president of the institute said the growth of the iron and steel industry is seen in the fact that during the life of the institute the production of steel has grown from 600,000 to 60,000,000 tons per annum.

IT would appear from the recent annual report of the Decimal Association that the General Medical Council has announced that all measures and weights in the new British Pharmacopœia, including those referring to dosage, will be in the metric system, and that in order to facilitate the use of the work by medical men, the equivalents for dosage will also be given in the Imperial system. Further progress is also reported in connection with the adoption of the metric carat of 200 milligrams as an international unit for the sale of diamonds and precious stones. Owing, no doubt, to the steady advance made by this unit on the Continent, the views of the trade in this country with respect to it appear to have undergone considerable change recently, and to be now generally in favour of the legalisation of the metric carat. It is confidently expected that steps will be taken very shortly by the Government to issue an Order in Council legalising the metric carat, as well as a series of multiples and submultiples of that unit. The effect of this legislation will be to render the present arbitrary and unrecognised carat illegal and to bring the weights and balances used by merchants and dealers for the sale of precious stones by weight under the purview of the local inspectors of weights and measures. A law has recently been passed in Belgium making the use of the metric carat obligatory in that country, and it is anticipated that a similar step will be taken at an early date in the United States, and possibly also in Russia.

WE understand that the Easter vacation season, just concluded, at the Port Erin Biological Station, has probably, taken all round, been the most successful one yet held. The number of senior students and of post-graduate researchers at work in the institution during March and April was above sixty. *Amphidinium operculatum,* the minute brown dinoflagellate which was found for the first time in Britain at Port Erin a couple of years ago, and has kept on occurring since from time to time in vast quantities, was present in abundance during the greater part of April, and was the subject of some interesting experiments and observations. The marine plankton was abundant during the greater part of the vacation, and the catches showed, early in April, the spring diatoms making their appearance in great numbers—at first round the coast on both east and west sides of the island; and not appearing out at sea (*e.g.* at the five-mile station) until a week or so later. Unusually large quantities of floating fish eggs seemed to be present in the tow-nets out at sea (the species have not yet been identified, nor the exact numbers in the hauls estimated), and the results in the fish hatchery attached to the biological station have been exceptionally favourable. The hatching work is still in progress, spawning is not quite finished, so final figures cannot yet be given, but it looks as if this year might be a record one in fish-hatching. By April 24 more than eight and a half millions of plaice eggs had passed into the hatching boxes, and above seven millions of hatched fry had been distributed out at sea.

AT a meeting of the Society of Engineers (Incorporated), held on Monday, May 5, a paper on tidal waters as a source of power was read by Mr. C. A. Battiscombe, the object of the paper being to direct attention generally to the commercial possibilities of hydro-electric installations in the British Isles, more particularly with regard to the use of the tides. After some introductory remarks in reference to tidal intervals and the range of neap tides, the author pointed out that in this connection the head of water available for actuating turbines cannot exceed one-third of the range of minimum tides. An outline was given of the arrangements proposed for the constant maintenance of a working head, by means of a chamber for the turbines, connected by valves to the tidal way and to three reservoirs in which the tidal water may be impounded. It was claimed that the utilisation of the tides for power purposes presents few engineering difficulties so far as principles are concerned, but that the real difficulty lies in the question of cost, and therefore in the choice of the site and in the design of the structural details. The author concluded by insisting on the importance of regarding the supply of fuel as a matter that concerns the whole nation: that the demand for combustible fuel is continually increasing, and that coal being practically the only fuel found in England, it would be mere folly to neglect any other available source of energy whereby the present rate of consumption of coal may be sensibly reduced. It was submitted that not only can the tides be utilised as a constant source of power, but that, taken in conjunction with the power that could be derived from fresh-water rivers, their utilisation would be a great gain to the commercial and industrial interests of the United Kingdom.

THE majority of the papers read before the first International Eugenics Congress, held in London in July, 1912, were published at the beginning of the congress in a volume entitled "Problems in Eugenics." Some, however, were received too late to be included therein, and these, together with a report of the discussions which took place at the congress and the speeches which were delivered at the inaugural banquet, have now been published in a supplementary volume ("Problems in Eugenics," vol. ii.; London: The Eugenics Education Society, 1913, pp. 196). In the preface Major Leonard Darwin directs attention to the fact that an international eugenics committee has been established on a permanent basis as a result of the congress. The primary object of this committee, which will meet in Paris next August, is to settle questions connected with the future assembly of eugenics congresses, but it is hoped that it may also fulfil the useful function of a clearing-house for information on eugenic matters.

THOSE who are prepared to accept the view that many, or all, megalithic monuments were designed for the purpose of astronomical observations will be interested in an elaborate paper by Dr. Marcel Baudouin, entitled "Le siège d'observation de Chergiroux à l'Ile d'Yeu (Vendée)," published in vol. iii., sixth series, parts 5 and 6, of the *Bulletins et Mémoires de la Société d'Anthropologie de Paris* for

1912. The learned author has discussed the question with much care and learning, and though some may still hesitate to accept his conclusions, his communication deserves the attention of all who are interested in the astronomical aspect of megalithic monuments.

The attention of students of African ethnology may be invited to an important paper, "Notes on the Geographical Distribution of the Hottentot and Bantu in South Africa," by Mr. W. H. Tooke, published in part v., vol. ii., of Records of the Albany Museum of Grahamstown. The cradle of the Hottentot race he believes to have been the region now occupied by the Hamitic tribes—Berbers, Gallas, Somali, and Masai. But there are mixed races containing negro, Semitic, and Caucasian elements, and the problem remains whether any of these tribes are derived from a prototype of which the Hottentot is evidently, from close conformity to persistence of type, the present representative. He groups the Bantu into four divisions—inland, including the Makalanga and the Bechwana; coastal, the Baronga or Tekeza, and the Zulu-Xosa or Zulu-Kaffir. The movements of these groups are intricate and obscure, but the information collected by Mr. Tooke will help towards a scientific solution of these tangled problems. The importance of the study of stone implements in the same region was urged in his lecture, delivered on February 29, before the African Society by Prof. Henry Balfour, on the earliest inhabitants of South Africa.

To the April number of *The Geological Magazine* Mr. R. B. Newton contributes a note on the fossils in the Pennant collection, recently presented to the British Museum (Natural History) by Lord and Lady Denbigh. These include about a thousand specimens, some of which were described and figured by Pennant himself. A selection has been placed on exhibition in the geological department.

The extent to which the native fauna is disappearing in Victoria may be inferred from the following paragraph relating to the Darby district in the March number of *The Victorian Naturalist*:—"Only a few years ago the koalas, or native bears, were numerous, and could be seen here at any time. Wallabies, dingoes, and the introduced hog-deer were also common, but are now replaced by the fox."

In the Bulletin of the American Museum of Natural History, vol. xxxii., art. 2, Mr. R. J. Coles records a method of obtaining embryos of large rays. Having observed that female rays appeared to have expelled their embryos in their struggles when taken in nets, the author resorted to the plan of jumping into the water as a seine containing a ray was drawn into the shallows, stabbing the fish with a knife in the back of the head, and then holding on to the knife-handle with one hand, and plugging the vent with the other. The fish was then dragged ashore, when the young would be ejected on the sand. The author then describes, with illustrations, the embryos of several species, and also adduces evidence to show that there is a regular northward summer migration of certain tropical species of rays along the Atlantic coast of North America.

In an article on the late Prof. Alpheus Hyatt and his principles of research, published in the April number of *The American Naturalist*, Dr. R. T. Jackson emphasises the importance of these researches in respect to the phylogeny and mutual relationships of invertebrates. Stages in development, more especially post-embryonic, were a favourite subject with Hyatt, who inculcated the law that the development of the individual is an epitome of that of its group. He also insisted on the importance of a due recognition of parallelism in development, and originated the theory of acceleration of development, as well as directing attention to senile degenerate development. In conclusion, the biographer expresses the belief that in the future "Hyatt will be looked on as the master-mind who pointed out the methods by which to ascertain the true phylogenetic relations of invertebrate organic forms."

The first part of vol. cv. of the *Zeitschrift für wissenschaftliche Zoologie* contains three papers of considerable interest to embryologists. The first, by Theodor Baumeister, deals with some early stages in the development of the hedgehog. As this animal is sometimes regarded as the oldest living mammal it has already received a large amount of attention at the hands of embryologists, but the present memoir serves to fill an important gap in our knowledge. The second, by Eva Krüger, treats of the reproduction and gametogenesis of the nematode *Rhabditis aberrans*, n. sp., while the development of a more familiar nematode, the well-known fresh-water form, *Gordius aquaticus*, claims the attention of N. Th. Meyer. The segmentation of the egg in the species last-named has been worked out in detail, and the figures are sufficiently convincing. The process of gastrulation, however, appears to take place in a very remarkable manner. The mesenchyme is stated to be formed by an early unipolar immigration, while the alimentary canal arises from two opposite invaginations which meet and fuse together to form a tube, the hinder of the two forming both midgut and proctodæum. The proboscis arises as a second invagination of the anterior end. The author himself appears not quite to be convinced as to the correctness of his account of the formation of the alimentary canal.

Among the most recent publications of the Department of Applied Statistics, University College, London, is an investigation into the mortality of the tuberculous after sanatorium and tuberculin treatment, by Mr. W. Palin Elderton and Mr. Sidney J. Perry. The data from which they worked consisted of records of 3000 cases from the Adirondack Cottage Sanitarium, provided by Dr. Lawrason Brown, of smaller numbers from Scottish sanatoria, provided by Dr. Rest and Dr. Guy, and of particulars of cases dating from 1845 to 1870, from the case books of Dr. Austin Flint, which serve as a guide to the mortality of the consumptive in America in pre-sanatorium days. The most interesting of the conclusions arrived at is stated by the authors as follows:—"There is no evidence in the mortality shown from the data before us to prove that tuberculin as compared with ordinary sanatorium treatment appreciably lengthens the life of the consumptive. If the use of tuberculin had the very marked results claimed by some of its supporters we should have anticipated more definite evidence of its effect on mortality."

A recent memoir by Capt. R. T. Wells on dysentery in Haziribagh Central Jail (Scientific Memoirs by Officers of the Medical and Sanitary Departments of the Government of India, No. 52) contains a number of important data bearing on the question of the relation of amœbæ to the causation of dysentery. From this, as well as from other recent investigations, it is very clear that great care must be taken to distinguish clearly between harmless contamination-amœbæ and the pathogenic amœbæ which are the true cause of the disease. Contamination-amœbæ can be cultivated from fæces, tap-water, and other materials by planting them on Musgrave's medium; their cysts are air-borne, and readily gain access to fæces or specimens of pus, however carefully collected, or to any material planted on Musgrave's medium contained in Petri dishes. The true dysenteric amœbæ differ in their microscopic characters from the contamination-amœbæ, and they do not live more than a few hours after discharge from the body, whether transferred to Musgrave's medium or not. The failure to distinguish between these two types of amœbæ has led in many cases to very erroneous conclusions being drawn.

To *Symons's Meteorological Magazine* for April Mr. R. C. Mossman contributes the second of his interesting papers upon Southern Hemisphere seasonal correlations, showing that in the month of May a pronounced opposition exists between the barometric pressure at Stykkisholm, Iceland, lat. 65° N., and Laurie Island, South Orkneys, lat. 61° S. The corrected mean pressure at these two places for the month in question, for the years 1902–11, was respectively 29·91 and 29·32 in. An examination of the barometric data at other places shows that in South America, south of about lat. 47°, the pressure departures are in harmony with those at South Orkneys and South Georgia; but data from intertropical and other regions, *e.g.* the Azores, United States, &c., show indefinite results. The author therefrom concludes "that the dominating factor influencing these May pressure variations in the North and South Atlantic is to be found in the polar regions." As to why the striking differences obtain only in the month of May no explanation is offered. Some interesting notes are also made relating to the variations of wind circulation accompanying the differences of pressure in the extreme South and far North Atlantic.

The February number of *Lĕss* (*The Forest*) contains articles on the influence of forests on the soil, climate, salubrity, &c., questions already much discussed, and on the modifications caused by man in the distribution of birds. Some birds frequent human habitations to build nests on house roofs, or to obtain food, especially in winter. Wading birds have been driven away by the draining of marshes, and the destruction of woods has deprived certain species of their natural nesting-places, while the fields and meadows which have taken their place have attracted other species. Instances are given of the effect of these changes in Russia.

During the solar eclipse of April 17, 1912, determinations of magnetic declination were made by a number of observers in order to detect any direct action of the eclipse on the magnetic state of the earth. The general verdict was that the effect, if it existed at all, was very small. Dr. S. Kalinowski, of Warsaw, however, directed attention in the October, 1912, number of *Terrestrial Magnetism* to the decided difference in the declination curves obtained by him during the eclipse, and at the same hours on the preceding and following days. The normal increase in the westerly declination was replaced by a small decrease followed by a rather rapid increase. Dr. Kalinowski pointed out that the same effect was exhibited in a less marked degree in the curves obtained at Beuthen, but that the Potsdam curves did not show it. In a letter to the editor of *Terrestrial Magnetism*, published in the March, 1913, number, Dr. S. van Dijk states that the curves obtained during the eclipse at De Bilt, Holland, show an effect of the same character as that found by Dr. Kalinowski.

Messrs. Williams and Norgate inform us that in the advertisement of some of the volumes in the Home University Library, announced in last week's issue, "An Introduction to Mathematics" was, through an oversight, attributed to the Hon. B. Russell in place of Mr. A. N. Whitehead, F.R.S. The volume is correctly advertised in the present issue.

OUR ASTRONOMICAL COLUMN.

The Spectra of Nova Geminorum.—In the publications of the Allegheny Observatory of the University of Pittsburg (vol. iii., No. 3) Mr. F. C. Jordan gives a description of eighteen spectrograms of Nova Geminorum (No. 2). The first of the series of photographs was secured on March 16, when the bright lines were strongly developed on the plate, and the absorption lines a little less so, and the last on April 14, when no absorption lines were detected at all. The author gives tables of the wave-lengths determined, and a series of intensity curves. He mentions the curious fact that with regard to the H and K absorption lines the weighted means of the velocities deduced from them yield a curve which follows to some extent the light variations of the nova, the velocities being positive when the star is brighter and negative when it is fainter. Mr. Jordan suggests that it would be very desirable to examine the velocity determinations from plates secured at other observatories, and for this and other points of view he would place all the plates he secured at the disposal of any astronomer or institution that may decide to undertake such a discussion.

Another paper of importance in connection with this nova is that printed in the Monthly Notices of the R.A.S. (vol. lxxiii., No. 5, p. 380). The authors, Prof. H. F. Newall and Mr. F. J. Stratton, describe a detailed study they have made of the spectrum of the nova on March 15, and they come to the conclusion that the absorption lines are for the most part identical with the lines in α Cygni, and to a small percentage in γ Cygni; or, in other words, the nova spectrum of that date was an enhanced-line spectrum. The authors refer to the previous work of Sir Norman Lockyer at South Kensington, who showed that in the case of Nova Persei its bright-line spectrum was composed for the most part of α Cygni, or enhanced lines. Thus the origins of most of the nova lines at this stage of its history will now be considered as more definitely settled. The paper is accompanied by an excellent plate showing the nova spectrum and comparison spectra.

RADIAL VELOCITIES OF STARS WITH THE PRISMATIC CAMERA.—Some time ago Prof. E. C. Pickering suggested a means of determining the radial velocities of stars from prismatic camera photographs by inserting in the optical train a medium which produced a sharp absorption line in the stellar spectrum. Mr. R. W. Wood found out that the absorption line of neodymchloride at λ4273 A.U. in a weak solution was of prominent sharpness. Prof. Schwarzschild has now used this filter in connection with an objective prism, the instrument being a Zeiss triplet of 150 mm. aperture and 1494 mm. focal length, and a prism of the same aperture giving a dispersion from Hγ to K of 10·3 mm. He placed the cell a few millimetres in front of the photographic plate, the former being about 8 mm. in thickness, and containing a weak solution, the proportion being 1 to 6. In *Astr. Nachr.*, No. 4646, he gives an account of the results he secured, using the star α Coronæ borealis, the spectrum of which is not very favourable for the research, as the lines are hazy, though the orbit is well known. At least four spectra near each other were taken on the plate, and photographs were secured on eighteen evenings. Prof. Schwarzschild describes in detail the methods of measurement and reduction, and states that the probable error of the mean of six spectra in an evening is ±5·7 km./sec., and the probable error of a single spectrum ±13 km./sec. He points out that Mr. Jordan, with a photograph taken with a slit spectroscope, obtained probable errors of 4·2 to 5·5 km./sec., according to the kind of plate used, and Mr. Cannon a value amounting to ±5·4. The observations corroborate Jordan's period of 17·36 days.

METEORITE FROM KANSAS.—A reprint from the Proceedings of the U.S. National Museum (vol. xliv., p. 325) contains an account of a newly found meteorite from near Cullison, Pratt County, Kansas, by George P. Merrill, head curator of geology of the National Museum. The stone is described as having struck the earth in December, 1902, but it was not found until 1911. Mr. Merrill was thus confronted with the doubt as to whether the stone was the one actually seen to fall, but he found that a thin section indicated the meteoritic nature of the stone at once. Besides showing special interest from the diversity of the chondritic forms which it carried, another feature was a somewhat indistinct wavy banding visible only on a polished surface of a section. The paper, besides giving illustrations of the stone as found and polished surfaces, contains chemical and mechanical analyses of the stone, and the following is the composition of the stone in bulk, omitting percentages of substances less than unity:—

	Per cent.		Per cent
Silica	35·30	Soda	1·80
Alumina ...	4·24	Sulphur ...	2·18
Ferrous Iron ...	8·38	Nickel	1·80
Magnesia ...	23·63	Iron	21·27

ROYAL ASTRONOMICAL SOCIETY OF CANADA.—The January–February number of the Journal of the Royal Astronomical Society of Canada (vol. vii., No. 1) contains much interesting reading, and attention is directed especially to two communications. The first is the address of the president of the society, Prof. L. B. Stewart, delivered at the annual meeting, and has for its title, "The Structure of the Universe." In this he brings together most of the more important recent researches relating to this subject, including such investigations as deal with star streams, proper motions of separate groups, absorption in space, &c. The second article is a delightful account of Mr. John A. Brashear's visit to the home of Dr. Thomas Dick, the Christian philosopher and astronomer. Mr. Brashear came over in 1911 for the fifth centenary celebration of St. Andrews University, and after listening to the opening addresses, as he says, "I could not resist the temptation to slip away" and make a visit to Broughty Ferry, near Dundee, the home of Dr. Dick. Mr. Brashear is full of enthusiasm of the reception he received at the hands of the present owners, and brings together some very interesting notes relating to episodes in Dr. Dick's career; numerous illustrations accompany his communication.

THE ERUPTION OF THE KATMAI VOLCANO, ALASKA, ON JUNE 6, 1912.

IN *The National Geographic Magazine* for February of the present year there appears a very interesting account of the eruption of Katmai, in Alaska, which commenced on June 6, 1912. The Katmai Volcano (7500 ft.) is one of ten or twelve more or less active volcanoes known to exist in the Alaskan peninsula, though probably a still greater number occur in the adjoining Alaskan islands. The report is furnished by Mr. G. C. Martin, who was dispatched by the National Geographic Society of Washington to collect information as soon as the news of the eruption arrived by telegraph. This report, which is illustrated by a map and numerous photographs, shows that the outburst resembled in all its main features that of Krakatoa in 1883, though, happily, owing to the very sparse population of the district, the damage done was comparatively small, and no human lives were lost. No lava-streams are recorded as having been seen, but the eruption, which included three outbursts of excessive violence within two days, consisted in the discharge, first of pumice, and afterwards of dust of gradually increasing degrees of fineness. In the sea, twenty miles from the volcano, floating pumice was accumulated to such an extent that men could walk upon it. At Kodiak, 100 miles from the volcano, dust fell, causing complete darkness for sixty hours, and accumulated to a general depth of 10 to 12 in. Roofs were broken down by the weight of this dust, and houses wrecked by the avalanches of it which descended from the hills. Dust was recorded as having fallen 900 miles away, and if vessels had been in those seas it would probably have been noticed much farther off. Probably great changes were produced in the volcano itself, for one observer declared that half the mountain was gone.

This report is followed in the same journal by an article from the pen of Dr. C. G. Abbot, the director of the Astrophysical Observatory of the Smithsonian Institution, Washington. From observations made by himself in Algeria, where he happened to be at the time of the Katmai eruption, and from communications he received from Mount Wilson, in California, Mount Weather, in Virginia, and other localities in different parts of the globe, he infers that a similar world-wide diffusion of the fine volcanic dust took place as was observed in the case of the Krakatoa eruption, and he discusses the question, "Do Volcanic Explosions Affect our Climate?"

THE SPECTROSCOPE IN ORGANIC CHEMISTRY.[1]

SOMEWHAT more than half a century ago, while engaged, with the assistance of Faraday, in preparing experiments for a Friday evening discourse in this institution, Stokes observed that the spectrum of the electric light extended to five or six times the length of the visible spectrum when he employed prisms and lenses of quartz instead of glass. This extension occurs at the violet end of the spectrum, and consists of rays of high refrangibility, to which the eye is insensitive, but which can be made apparent by means of a fluorescent screen.

At the time of this discovery, and in the years immediately following it, attention was being directed to the absorption of light by coloured solutions, and to the possibility of identifying coloured substances by the number and position of the dark bands in the spectrum of light transmitted through their solutions. Stokes saw that by his discovery of the extension of the spectrum beyond the visible region, this method of investigation might be applied to colourless as well as to coloured substances. In a paper communicated to the Royal Society in 1862, he says:—"Having obtained the long spectrum above-mentioned I could not fail to be interested in the manner in which substances—especially pure, but otherwise imperfectly known organic substances—might behave as to their absorption of the rays of high refrangibility." He proceeded, therefore, to study the action of various organic solutions on the ultra-violet rays, and found that the mode of absorption generally was so constant and so characteristic that by this single property many substances could be identified.

While Stokes was engaged in these researches, Prof. William Allen Miller was simultaneously at work in the same field, and Stokes left the further development of the subject in his hands. Miller improved the method of observation by substituting a photographic plate for the fluorescent screen, but he failed to "trace any special connection between the chemical complexity of a substance and its diactinic power." Struck by this fact, W. N. Hartley—now Sir Walter Hartley—commenced a systematic investigation of the whole subject, and it is to his researches, extending over a period of more than thirty years, that we owe, not only most of the knowledge which we now possess of the relation between the structure of organic substances and the action of such substances on the ultra-violet rays, but the elaboration of the convenient and elegant methods by which such investigations are now conducted.

The light derived from an ordinary source of illumination, such as an electric lamp, consists of waves of all degrees of refrangibility, and its spectrum shows a continuous band of colour ranging from red to violet. The limits of this visible spectrum lie between the wave-lengths 7600 and 3900.

If now, instead of the electric light or other ordinary source of illumination, we employ the light emitted by one of the metals when raised to a high temperature, the spectrum is seen to consist of a series of lines of different colours and intensities lying within the same limits as the visible spectrum. But there are rays beyond the red end of the spectrum and rays beyond the violet end which excite no sensation of luminosity in the eye. By allowing the spectrum to fall upon a screen which has been coated with a fluorescent substance, such as sulphate of quinine or a salt of uranium, these rays are rendered visible for a short distance beyond the violet. But it is only when we replace the glass apparatus, with which we have hitherto been working, by a quartz prism and lenses, and substitute a photographic plate for the eye, that the full extent of the spectrum beyond the violet is revealed. This is the ultra-violet region—the region which Stokes opened up to investigation, and it is with the behaviour of organic substances towards the rays of this part of the spectrum that we have mainly to do this evening.

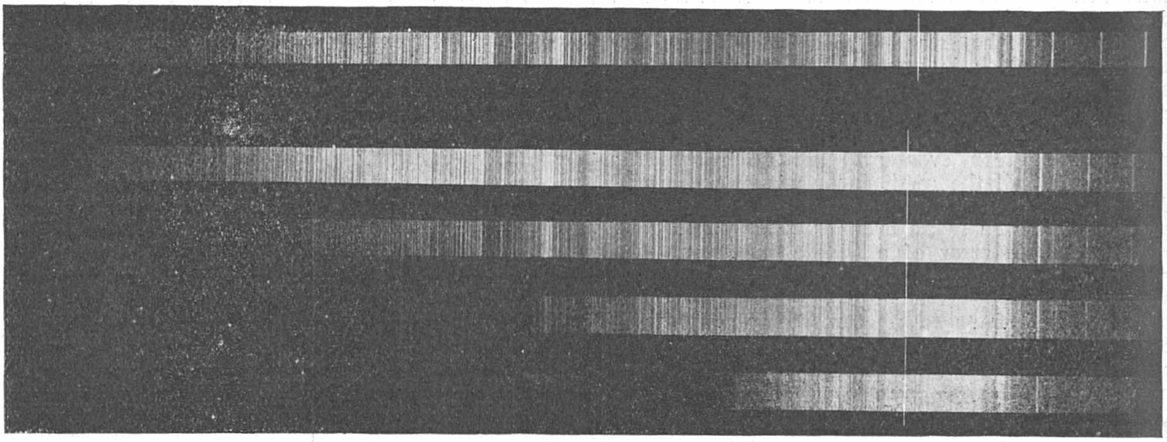

FIG. 1.—1. Spark spectrum of nickel and iron. 2. The same, after the light has passed through quartz 10 mm. thick. 3. Crown glass 0·13 mm. thick. 4. Crown glass 0·33 mm. thick. 5. Window glass 1·62 mm. thick.

When light is transmitted through a coloured solution certain rays are absorbed, and dark bands corresponding to these rays appear in the spectrum. The importance of these bands as a means of distinguishing coloured substances has long been recognised, and, as we have already seen, considerable progress had been made with their study fifty years ago. As the bands in this case are in the visible spectrum, no special means are required for their observation.

But when we extend this method of investigation to colourless substances we are dealing with phenomena which lie hidden from the unaided eye, and our investigations are necessarily carried out with the help of photography.

The instrument employed in the study of absorption spectra consists of a spectroscope in which the eyepiece of the telescope is replaced by a camera. The

[1] From a discourse delivered at the Royal Institution on Friday, April 4, by Dr. J. J. Dobbie, F.R.S.

photographic plate is set at such an angle as to bring all the rays emanating from the source of light into focus at its surface after they have passed through the resolving prism, and for this purpose it is necessary that the plate should have a very slight curvature. The prisms and lenses of the apparatus are made of quartz, which, unlike glass, is readily permeable by the ultra-violet rays (Fig. 1). The source of light usually employed is that obtained by sparking one of the metals, such as iron, or a combination of metals, such as cadmium alloyed with lead and tin. In using the apparatus a photograph is first taken of the spectrum of the source of light. A layer of the substance to be examined, which, if a solid, must be dissolved in a suitable diactinic solvent, such as alcohol or water, is then interposed between the source of light and the slit of the collimator, and another photograph is taken. By comparison of the two photographs it is seen what effect, if any, the substance has had upon the transmission of the light.

When organic substances are examined in this way it is found that some allow light to pass freely through them. Others shorten the spectrum by absorbing the rays at the ultra-violet end to a greater or less extent, and are said to show general absorption. Others, again, possess the remarkable property of absorbing rays of a particular wave-length, thereby producing gaps or bands in the spectrum; these are said to show selective absorption (Fig. 2).

In studying these phenomena in their relation to the chemical characters of a substance, it is of importance to determine not only the extent of the general absorption and the number and position of the absorption bands, but their degree of persistence, *i.e.* the range of concentration within which they are exhibited. It is necessary, therefore, to vary the concentration of the solution or the thickness of the layer so as to cover the whole phenomena of absorption. This is done by simply diluting the solution, or diminishing the thickness of layer, on one hand, until the entire spectrum is transmitted, and on the other by increasing the concentration or the thickness of the layer until no further characteristic absorptive effect is produced. Photographs are taken at each concentration, and a curve is drawn connecting the concentration and the absorption as measured with reference to the lines of the metal employed as a source of light (Fig. 3).

If we now inquire whether the substances which affect light in one or other of the different ways already indicated have themselves anything in common, we find that it is with those which possess the structure characteristic of benzene and its derivatives that the power of absorbing the rays of particular parts of the spectrum is most frequently, although not exclusively, associated.

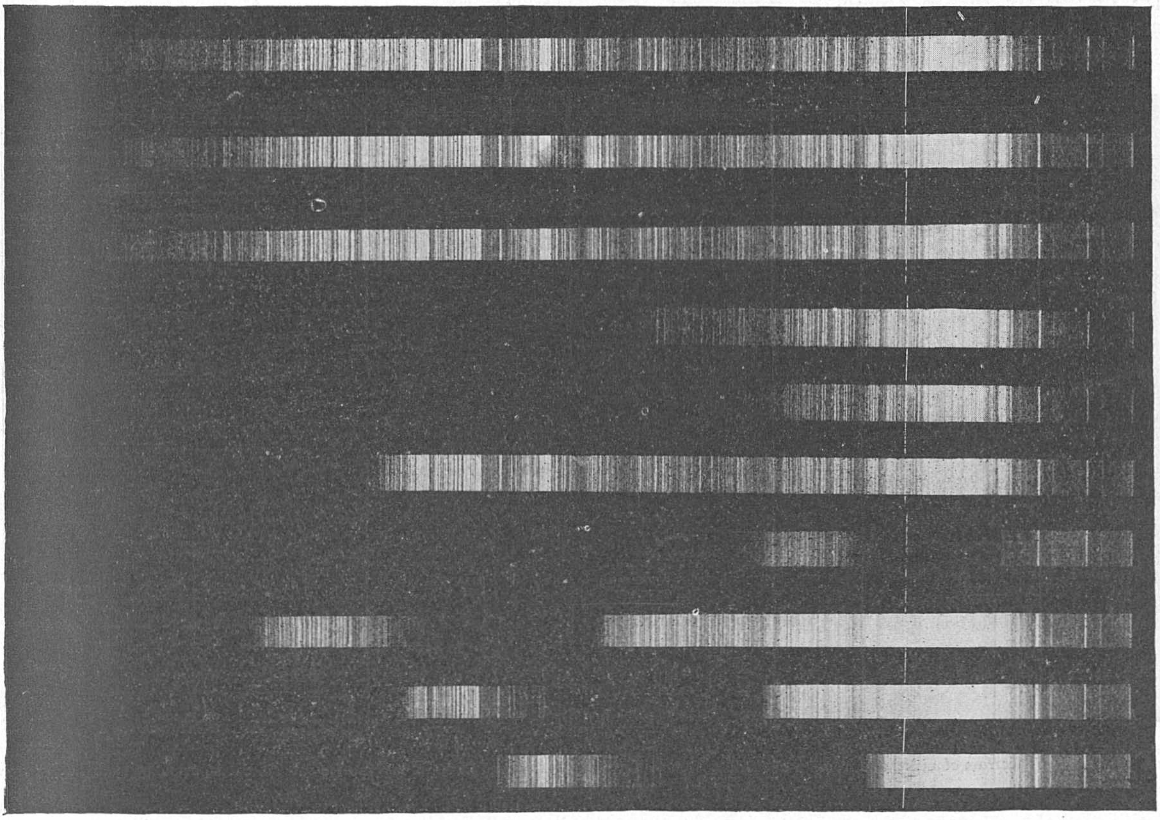

FIG. 2.—1. Spark spectrum of nickel and iron. 2 and 3. The same after the light has passed through water and solution of cane sugar respectively. Alcoholic solutions of (4) pinene, (5) thiophen, (6) citric acid illustrate general absorption, and alcoholic solutions of (7) isatin, (8) phenol (9) salicylic acid, (10) quinine hydrochloride illustrate selective absorption.

Organic compounds, or compounds containing the element carbon, are divided into fatty or aliphatic, in which the carbon atoms are united in an open chain, and cyclic, in which the carbon atoms form a closed chain or ring. Hexane, which is a constituent of liquid paraffin, may be taken as an example of the first class. This substance possesses the formula C_6H_{14}. It is highly diactinic or transparent to the ultra-violet rays, and nearly all compounds belonging to the same division of organic chemistry, such as alcohols sugars, and fatty acids, are either equally transparent to light, or only cut off a portion of the extreme ultra-violet rays of the spectrum.

If we now remove one atom of hydrogen from each of the two end carbon atoms of hexane, these atoms are in a condition to unite directly with each other, thus closing the chain. The substance so formed belongs to the cyclic division of organic compounds. It is known as cyclohexane, and has the formula C_6H_{12}, each carbon atom having two hydrogen atoms attached to it. This substance resembles hexane generally in its chemical properties, and behaves towards light in the same way, that is to say, it is practically diactinic or only cuts off some of the rays of light at the extreme ultra-violet end of the spectrum.

But a wholly different condition is brought about if we suppose one atom of hydrogen removed from each of the six carbon atoms of cyclohexane. One linkage is thus set free in each of the six carbon atoms, and we obtain benzene. How these linkages are actually employed in benzene has never been determined with certainty. Sometimes they are represented as mutually neutralising one another, sometimes as effecting a double link between the alternate pairs of carbon atoms. However this may be, the structure which bears the relation that I have indicated to the structure of hexane and cyclohexane is characteristic of the large group of organic substances of which benzene is the type. It is to this division of the cyclic compounds that the great majority of substances which show selective absorption, *i.e.* produce breaks or dark bands in the spectrum, belong. Here, then, we have a very important and a very general relation between the structure of organic substances and their absorption spectra.

The difference in the behaviour of organic bodies towards the ultra-violet rays, as exemplified in hexane and cyclohexane, on one hand, and benzene on the other, is brought out very clearly when we examine some of their derivatives. If we replace an atom of hydrogen in hexane or cyclohexane by the monovalent group hydroxyl, we get substances belonging to the class of alcohols, and these substances are, like their parent substances, highly diactinic. If, on the other hand, we replace an atom of hydrogen in benzene by the same group we get carbolic acid or phenol, which, like benzene, exercises selective absorption on the ultra-violet rays, but gives a spectrum widely different from that of benzene.

Having dealt with the most general relation that has been observed between the structure of organic substances and their action on the ultra-violet rays, I propose to illustrate some of the more special relations by examples from the phenomena of isomerism. By replacing an atom of hydrogen in carbolic acid or phenol by the nitro-group we obtain three distinct nitrophenols. The ultimate particles or molecules of these nitrophenols are all composed of the same elements—carbon, hydrogen, oxygen, and nitrogen—and of the same number of atoms of each element. Such substances are said to be isomeric, *i.e.* they are made up of equal parts, although they do not possess the same properties. The difference between them lies in the arrangement of the parts relatively to each other; in this case in the position of the nitro-group in relation to the hydroxyl group. On comparing the spectra of the three nitrophenols we find that they differ in quite a marked manner from one another, and afford an illustration of the important general rule that substances which have the same composition but different spectra differ in structure.

It will have been noticed that the substitution of the nitro-group for hydrogen in phenol has the effect of shifting the absorption band nearer to the visible region. One of the three nitrophenols has a yellow colour, and in this case the gap in the spectrum cuts a little way into the violet end of the visible region. By the addition of soda to the solution the colour is changed to red, and on examining the spectrum of this solution we see that the gap now extends far into the visible region. This example will serve to illustrate the close connection that exists between the

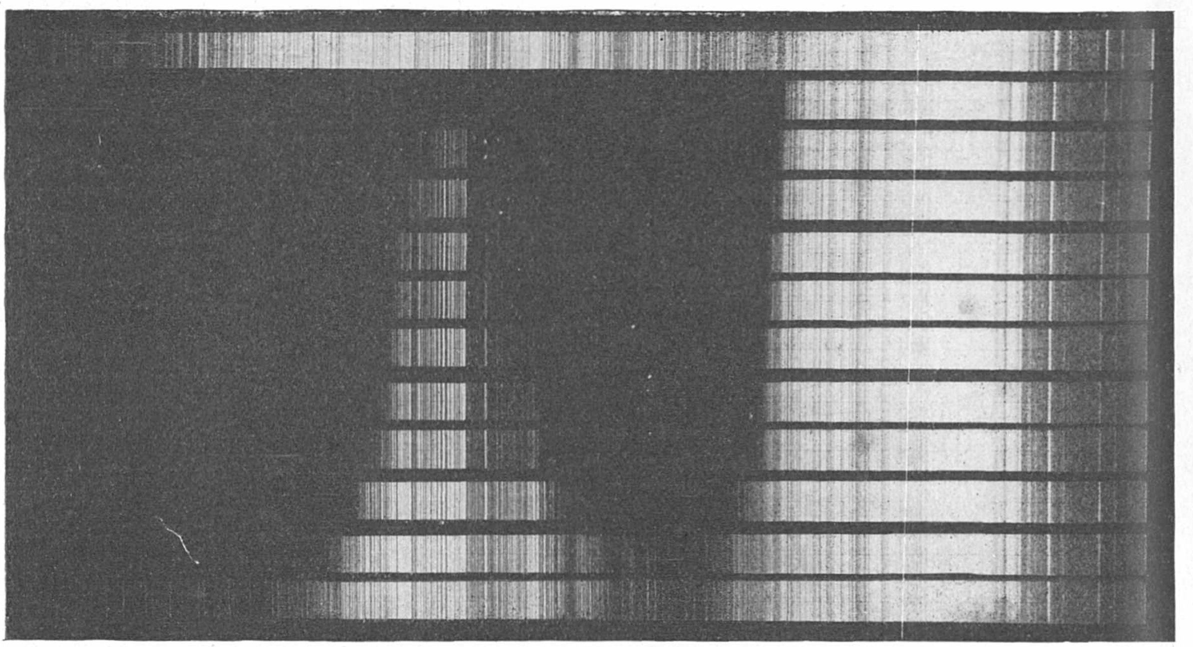

FIG. 3.—1. Spark spectrum of nickel and iron. 2 to 12. The same after light has passed through layers of 0·001 normal solution of salicylic acid from 90 to 4 mm. thick.

study of absorption spectra and the origin of colour, an interesting branch of the subject with which, however, it is impossible for me to deal within the limits of this discourse.

In the nitrophenols we have an example of what is known as structural isomerism, or position isomerism, because the phenomenon depends upon differences in the position or arrangement of the atoms within the molecule—in other words, in the internal structure of the molecule. But it is possible to have two substances of the same composition and structure not identical, but related to one another as an object is to its mirror-image. Substances so related are termed optical-isomers or stereo-isomers. The spectra of isomers of this class, unlike those of structural isomers, do not differ. This leads to an important application of absorption spectra in chemical investigations. If two substances have the same composition but different spectra, we know that they must be structurally different; if, on the other hand, they have the same composition and the same spectra, and yet are not identical, there is a strong probability although not a certainty, that they are optical-isomers.

The study of absorption spectra has proved of special value in the investigation of substances capable of existing in two forms which may pass the one into the other. It is rarely the case that both forms of such substances are stable, and it is often extremely difficult, or altogether impossible, on account of this instability, to determine by the ordinary chemical processes which of the two possible forms the substance as we know it possesses. Such substances, however, frequently give rise to two series of stable isomeric methyl- or ethyl-derivatives, the structure of which can be ascertained by chemical investigation. The parent substance, if not a mixture of the two forms, must correspond in structure with one or other of these derivatives, because it is a well-established fact that the introduction of the methyl- or ethyl-group into a substance in place of an atom of hydrogen does not appreciably alter the spectrum. An example of this is afforded by the three substances isatin, methyl-isatin, and methyl-pseudo-isatin.

The structure of methyl-isatin and of methyl-pseudo-isatin has been determined by chemical methods, but the structure of the parent substance isatin cannot be determined in this way. Is it constituted like methyl-isatin or like methyl-pseudo-isatin? Inspection of the photographs of the spectra of the three substances shows that while there is a wide difference between the spectra of isatin and methyl-isatin, the spectra of isatin and methyl-pseudo-isatin are almost identical, as we should expect them to be on the view that they are constructed alike.

This phenomenon, which is known as tautomerism, is due to the fact that some substances contain an atom of hydrogen, or it may be a hydroxyl group, which readily shifts its position within the molecule, leaving its union with one atom to attach itself to another. Another example of this is afforded by cotarnine, a substance found in opium. The molecule of cotarnine possesses an atom of carbon which is directly combined with an atom of nitrogen, and has also united to it a hydroxyl group. Under the influence of certain reagents the hydroxyl group leaves the carbon atom and attaches itself to the nitrogen atom, but can readily, by an alteration of the conditions, be enticed back again to the carbon atom. The shifting of the position of the hydroxyl group is accompanied by other changes which, however, it is not necessary that we should take into account for our present purpose. In this case both the tautomeric forms are, under certain conditions, stable. The form in which the hydroxyl is attached to the carbon is colourless, while the form in which it is attached to the nitrogen is yellow. The two forms have totally distinct absorption spectra. When one of the forms passes into the other under the influence of the appropriate reagent, the amount of change is proportional to the quantity of reagent added. It is possible, therefore, by taking photographs after the addition of each successive quantity of reagent, to trace the progress of the change through all its phases, and to ascertain how much of each form is present at any time. This is done by comparison with a series of reference plates prepared by photographing mixtures

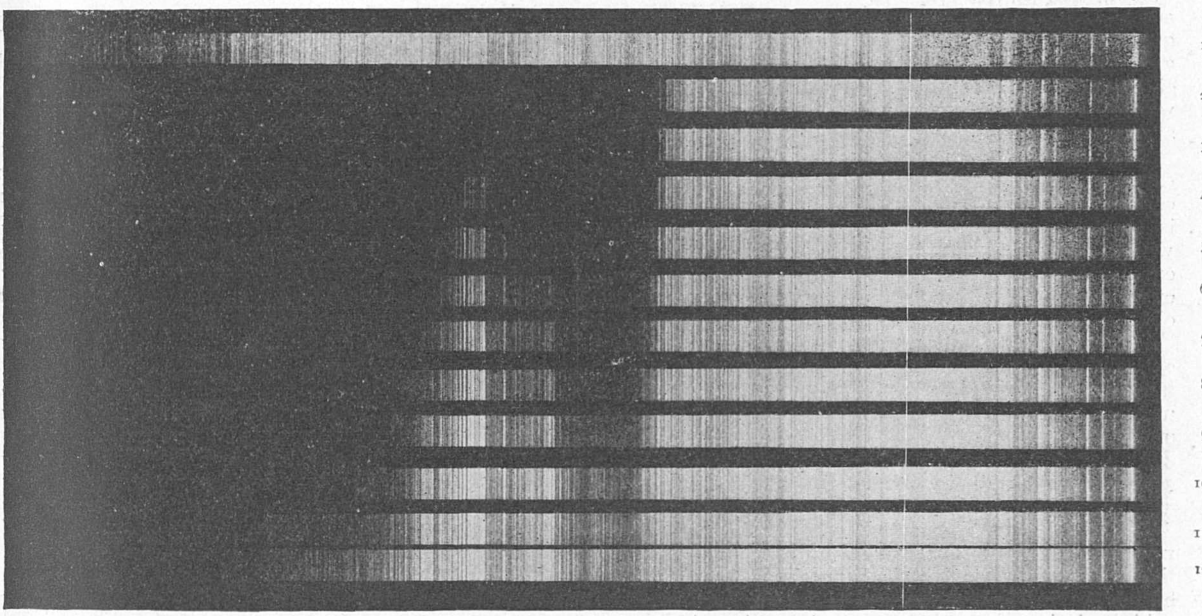

FIG. 4.—1. Spark spectrum of nickel and iron. 2 to 12. The same after the light has passed through layers from 60 to 4 mm. thick of an alcoholic solution of morphine containing $\frac{1}{200}$ grain of the alkaloid.

in various definite proportions of two derivatives of cotarnine which possess the same spectra as the two parent forms.

The study of the absorption spectra of the alkaloids has been applied with success, not only to the investigation of their structure but to their detection and estimation. These substances generally have very characteristic spectra by means of which they can be distinguished with certainty from one another, except when they are homologous or otherwise very closely related structurally. The spectroscopic method may, therefore, be used with great advantage in examinations for the presence of alkaloids to confirm the results obtained by the usual chemical tests. The chemical tests are no doubt as a rule sufficiently distinctive, but considering the gravity of the circumstances in which they have frequently to be applied, it is unnecessary to insist on the value of the confirmatory evidence which can be obtained by the use of the spectroscope.

The minutest quantities of alkaloids can be detected by this means, the method rivalling the colour reactions for the alkaloids in delicacy. Thus, with a quantity of strychnine not exceeding 1/500 of a grain, a clearly defined spectrum of the alkaloid can be obtained. The photograph of morphine already shown was obtained with 1/200 of a grain of the alkaloid, and that of nicotine with 1/100 (Fig. 4).

The use of the spectroscope in the detection and estimation of alkaloids in cases of poisoning possesses certain advantages of the highest importance. One is that the material is not destroyed. The solution which has been employed for the spectroscopic examination can be used afterwards for the chemical examination. Another is that a permanent record is obtained which is always available for reference.

So far my illustrations have been confined almost entirely to colourless substances, because it is in connection with the investigation of such substances that most of the recent advances in the subject have been made.

As my last example, I shall take the case of a coloured substance in which the method has been applied within the last year with marked success.

It will be remembered that considerable uneasiness was caused when it became known some time ago that nitrogen peroxide is sometimes employed to bleach flour. In the course of an inquiry into the subject, it became necessary to determine the nature of the colouring matter naturally present in flour. It was known that many of the yellow and orange pigments so widely distributed throughout the vegetable kingdom are either closely connected or identical with carrotene, the orange colouring matter of carrots, and it had been suggested that the colouring matter of unbleached flour might be identical with, or belong to the same class of colouring matters as, this substance. It was impossible, however, to prove this by the usual chemical methods, because the amount of colouring matter in flour is so minute that its isolation in a pure state, and in sufficient quantity for chemical analysis, was scarcely practicable. Carrotene, however, can be prepared in a pure state, and the happy idea occurred to Dr. Monier Williams, of the Local Government Board, who was conducting the investigation, to photograph its absorption spectrum and compare it with that of the colouring matter of flour, which could easily be obtained in the minute quantity required for this purpose. Inspection of the photographs shows that the spectra are very similar. There cannot, therefore, be any doubt that the colouring matter of flour, if not identical with, is closely allied to, carrotene.

The underlying causes of the relations between chemical structure and absorption spectra have been the subject of much speculation, but it must be confessed that no satisfactory explanation of the phenomena of absorption has yet been formulated, and that the theoretical development of the subject lags behind its practical application.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

On the occasion of the installation of the Duke of Northumberland as Chancellor of Durham University on May 3, honorary degrees of the University were conferred on the following men of science:—*D.C.L.*, Lord Rayleigh; *D.Sc.*, Sir Archibald Geikie, K.C.B., P.R.S., Sir William Ramsay, K.C.B., Sir T. C. Allbutt, K.C.B., Sir J. A. Ewing, K.C.B., Sir William Crookes, O.M.; Sir J. J. Thomson, O.M., and Prof. E. B. Poulton.

In the House of Commons on Monday, May 5, Mr. Asquith, replying to several questions referring to the recent decision of the Convocation of the University of Oxford as to Divinity degrees, said:—"I have for a long time had under consideration the various proposals for the appointment of a Royal Commission or Commissions to inquire into the constitution of, and other matters connected with, the Universities of Oxford and Cambridge. I have reluctantly come to the conclusion that in existing circumstances the setting up of such an inquiry might lead to delay in the prosecution of necessary reforms and is not likely to be productive of fruitful consequences."

The first session of the new University of Western Australia was inaugurated on Monday, March 31, with an address on the place of mathematics and physics in a university education, by Prof. A. D. Ross. About 150 students have enrolled in the faculties of arts, science, engineering, and agriculture. At present the teaching is being carried on under considerable difficulties, as the portion of the temporary buildings which has already been erected does not afford accommodation for laboratory instruction. The work of extending the premises is, however, being pushed on rapidly, and the various science departments should be in a position to carry on their practical work in the third term.

The April number of *The Eugenics Review* is mainly occupied with the report of the Eugenics Education Conference, which took place on March 1, and was reported in Nature of March 6. As a practical outcome of the conference a deputation, having for its object the introduction of teaching of eugenics in training colleges, waited on Mr. Trevelyan, M.P., at the offices of the Board of Education on April 2. The deputation, which included, among others, the president of the Eugenics Education Society, the Dean of St. Paul's, the headmaster of Eton, the principal of Bedford College, and Mr. Nicholls, ex-president of the National Union of Teachers, was sympathetically received by Mr. Trevelyan, who said that the Board of Education recognised the importance of the matter referred to, and would consider carefully the recommendations made by the deputation. From the "Notes" column of the review we learn of the formation on January 29 of the Société Française d'Eugénique. The president of this society is M. Edmond Perrier, the general secretary M. le Dr. Apert, and the treasurer and librarian M. Lucien March. In Italy a eugenics society is in course of formation, and in Denmark, at the instigation of Dr. Soren Hansen, a eugenics section of the Anthropological Committee has been organised. The research committee of the Eugenics Education Society issues an appeal for help (not financial) in a cooperative research recently set on foot, particulars of which may be obtained on application to the chairman of the research committee, Eugenics Education Society, Kingsway House, Kingsway, London, W.C.

AT the annual meeting of the National Education Association, held on May 2, Lord Sheffield made some interesting comparisons between the educational systems of Scotland and England. Supplementary courses are recognised for all schools in Scotland, where, at the end of August, 1911, there were 2056 such courses in 3173 primary schools, and they had 49,497 pupils above twelve years of age in average attendance, out of a total of 783,792 pupils in average attendance. The grants to pupils in these courses amount to more than 4*l*. a head, while in England the grant is 2*l*. a head to pupils in elementary schools. In Scotland 6·3 per cent. of the pupils are under advanced instruction in ordinary schools, or about 30 per cent. of the pupils above twelve years of age in ordinary elementary schools. In England there are no such pupils and no such classes, but there were, in 1911–12, 1,032,000 pupils above twelve years. There are 194 higher grade schools in Scotland, with more than 24,000 pupils in average attendance, or 3·2 per cent. of all the pupils in elementary schools. In 1910–11 there were only forty-seven such schools in England and Wales, with 8852 pupils, or less than one-twentieth of the Scotch proportion. The grants for these schools in Scotland are 2*l*. 10*s*. a head for the first year, 3*l*. 10*s*. for the second year, 4*l*. 10*s*. for the third and further years, all capable of an increase of 10 per cent. for good work. The grants of the English code for higher elementary schools are: first year, 30*s*., second, 45*s*., third, 60*s*., or an average just above 2*l*. a head, and, with the fee grant and aid grant, a total of 3*l*. a head. The assimilation of the English higher elementary schools to the Scotch higher grade schools in all matters could be done by departmental action alone. The Scotch report for 1912–13 shows that more than 95 per cent. of the teachers are certificated, and 68 per cent. trained, and there is one certificated teacher to thirty-nine pupils. In England and Wales there is one certificated teacher to about fifty-two pupils, and in 1911–12 less than 65 per cent. were certificated. The average salaries of teachers certificated are, in Scotland in 1910–11, men, 138*l*., women, 83*l*.; in England, men, 127*l*., women, 92*l*. In Scotland the salaries work out at about 3*l*. per pupil, and in England and Wales at about 2*l*. 17*s*. 4*d*. per pupil. The total cost of board schools in Scotland for school maintenance and interest and repayment of loans is about 4*l*. 16*s*. In England it is between 4*l*. 8*s*. and 4*l*. 10*s*.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 1.—Sir Archibald Geikie, K.C.B., president in the chair.—Prof. E. H. **Griffiths** and Ezer **Griffiths**: The capacity for heat of metals at different temperatures. The thermal capacity, at various temperatures between 0° and 100°, of the following metals has been determined:—Cu, Al, Fe, Zn, Ag, Cd, Sn, and Pb. The work at lower temperatures will be published later. The variation in the thermal capacity can be represented (over the range 0° to 100°) by the following parabolic equations, the difference between the calculated and experimental values in no case exceeding 0·2 per cent. In the large majority of cases the difference is less than 0·1 per cent.

Cu $s=0{\cdot}09088\ (1+0{\cdot}0005341t-0{\cdot}00000048t^2)$,
Al $s=0{\cdot}20957\ (1+0{\cdot}0009161t-0{\cdot}0000017t^2)$,
Fe (ingot) $s=0{\cdot}10452\ (1+0{\cdot}001520t-0{\cdot}00000617t^2)$,
Zn $s=0{\cdot}09176\ (1+0{\cdot}00005605t-0{\cdot}00000178t^2)$,
Ag $s=0{\cdot}05560\ (1+0{\cdot}0003396t-0{\cdot}000000141t^2)$,
Cd $s=0{\cdot}05475\ (1+0{\cdot}000520t-0{\cdot}000000725t^2)$,
Sn $s=0{\cdot}05363\ (1+0{\cdot}0006704t-0{\cdot}000000458t^2)$,
Pb $s=0{\cdot}030196(1+0{\cdot}000400t-0{\cdot}00000036t^2)$,

Many forms of equations were tried, but it was found that the experimental results were more closely represented by the parabolic than by any other form.—A. **Robertson** and G. **Cook**: The transition from the elastic to the plastic state in mild steel. The paper deals with the reduction of stress at the yield point in mild steel. Apparatus for limiting the extension during yield to a value comparable with the elastic extension, and for securing axial loading, are described. Under these conditions twelve specimens were tested, and a reduction of stress of 24 to 36 per cent. observed in eleven, and of 17 per cent. in the other one.—F. P. **Worley**: Studies of the processes operative in solutions. XXVIII., The influence of acids on the rotatory power of cane-sugar, of glucose, and of fructose. Experiments on the hydrolysis of cane-sugar by solutions of benzene-sulphonic acid have confirmed the conclusion previously arrived at from those in which sulphuric acid was used, that the ratio of the negative optical rotation at the completion of hydrolysis to the initial positive rotation increases rapidly as the concentration of the acid is increased. The increase is proportional to the concentration of the acid, and in the case of benzenesulphonic acid amounts to about 20 per cent. when the concentration is increased from zero to twice normal. It has been found that the increase is due entirely to the influence of the acid on the rotatory power of the three sugars, cane-sugar and glucose being made somewhat less dextro-rotatory and lævulose considerably more lævo-rotatory by the presence of the acid.—H. G. J. **Moseley**: The attainment of high potentials by the use of radium. A radio-active substance which emits β-radiation should, when insulated, continue to gain a positive charge until a potential of the order of a million volts is reached. Experiments have been made to test this point. A small bulb containing radium emanation was supported by a quartz rod at the centre of a highly exhausted flask. A disc suspended from a quartz spring in the neck of the flask formed a simple attracted disc electrometer. It was found that a bulb of 9 mm. diameter reached a potential of 160,000 volts in the course of a few minutes. A sudden discharge then occurred through the residual gas in the flask. A bulb of 5 cm. diameter charged up much more slowly: no discharge took place, and the final potential, 110,000 volts, was limited by a leak of electricity along the quartz support.—E. **Marsden** and Dr. T. S. **Taylor**: The decrease in velocity of α particles in passing through matter. The relative velocities of the α particles of radium C before and after passing through foils of various thicknesses have been investigated by means of the deflection caused by a magnetic field. Tables are given showing the results for gold, copper, aluminium, mica, and air.

Linnean Society, April 17. Prof. E. B. Poulton, F.R.S., president, in the chair.—M. P. **Price** and N. D. **Simpson**: Plants collected on the Carruthers-Miller-Price expedition through north-west Mongolia and Chinese Dzungaria.—E. G. **Baker**: Some British varieties of the bee-orchis, *Ophrys apifera*, Huds. In the typical form of the bee-orchis the labellum is broad convex, with a terminal, reflexed appendage, brown-purple, disc spotted with orange-yellow. In 1840 Hegetschweiler, in "Die Flora der Schweiz," described and figured *Ophrys Trollii,* a plant with the middle lobe of the labellum narrow lanceolate, elongated, purplish-red in the centre, gold at the edge, the three outer perianth-lobes lanceolate pointed. The plant came from Winterthur. In this country there appears to be a series of intermediate forms connecting the typical form with *O. Trollii,* some being more nearly allied to the former, some to the latter.—Dr. Hisayoshi **Takeda**: The flora of Shikotan. Shikotan is the southernmost of the Kurile Islands, which are distributed in the form of a chain between Kamtschatka and Yezo, and lies between about 43° 35′ and 50′ N. and 146° 30′ and 55′ E. Its area does not perhaps exceed 140 sq. m. The island is hilly, and some of the hills are covered with forests of conifers and deciduous trees, others with dwarf bamboos—species of Sasa. There are many streams along which bogs and swamps are often well developed. The vegetation of this island has scarcely been touched by human hands, but left in quite a primitive state. The number of the higher plants known to the author is 324, belonging to 213 genera and sixty-two families, of which 245, including eight new species, are new to the flora of this island, while 136 species are not mentioned in Miyabe's "Flora of the Kurile Islands," published in 1890, and also fifty-eight genera and eight families are additions to that publication. Among plants which are common to Shikotan (and also other islands of the Kuriles) and Yezo, or Yezo and Hondo, but not found in Saghalien, there are a number of plants which are distributed over north-eastern Asia, the Aleutian Islands, &c. These plants are believed by the author to have been introduced through the Kurile chain, but not through Saghalien.

Zoological Society, April 22.—Mr. E. T. Newton, F.R.S., in the chair.—Dr. S. F. **Harmer**: The polyzoa of waterworks. An account was given of the serious trouble which had been caused by the occurrence of a rich and varied fauna in the pipes of certain foreign waterworks, notably at Hamburg and Rotterdam. As was first shown by Kraepelin, the polyzoa play a prominent part in the activity of the pipe-fauna, by feeding on diatoms and other microscopic organisms, and serving in their turn as the food of other animals which prey on one another. The nutritive matter rendered available by the presence of enormous numbers of polyzoa is thus in large measure responsible for the existence of other constituents of the fauna, which may include even fishes, such as the eel and the stickleback. The organic material supplied by the disintegration of the polyzoa and other animals is believed to be important for the nutrition of iron-bacteria, which are well known to cause the most serious trouble in waterworks. An account was given of five cases of the occurrence of polyzoa in English waterworks in sufficient numbers to give rise to very serious inconvenience. In one or two of these cases the advice given by Kraepelin, in his paper on the Hamburg pipe-fauna, was being followed, by the introduction of a system of filtration, the principal object of which is to remove the microscopic organisms on which the polyzoa, and ultimately the whole assemblage of animals in the pipes, depend for their nutriment.—A. W. **Waters**: The marine fauna of British East Africa and Zanzibar, from collections made by Cyril Crossland, in the years 1901–2. Bryozoa—Cheilostomata. In the collection dealt with from the neighbourhood of Zanzibar there are seventy-six species or varieties of cheilostomatous bryozoa, almost all being from ten fathoms or under, so that for a shallow-water collection it is very large.—Major J. **Stevenson-Hamilton**: Occurrence of albino examples of the reed-buck (*Cervicapra arundinum*) in the Sabi Reserve, Transvaal. Some interesting notes were also given on the habits and distribution of Sharpe's steenbuck (*Raphiceros sharpei*), which resembles the grysbok much more closely than it resembles the common steenbuck in mode of life, and ranges from Nyasaland to the Transvaal, but gradually dies out to the south-east of that country.

Geological Society, April 23.—Dr. Aubrey Strahan, president, in the chair.—R. H. **Goode**: The fossil flora of the Pembrokeshire portion of the South Wales Coalfield. Of the fifty-three determinable species of fossil plants obtained from the Pembrokeshire portion of the South Wales Coalfield, three are new species. From the palæobotanical evidence it is clear that the so-called "Pennant Grit" of Pembrokeshire cannot be regarded as the equivalent of the Pennant Grit of the main portion of the South Wales Coalfield. Until more plants have been obtained from the so-called "Millstone Grit" of Pembrokeshire, it is impossible to fix definitely the horizon of these beds. However, it is evident that the beds assigned to the Millstone Grit probably belong to the Middle Coal Measures. Thirty-two fossil plants have been obtained from the Middle Coal Measures of Pembrokeshire which have not as yet been recorded from those of the main South Wales Coalfield.—H. **Kay**: The Halesowen Sandstone Series of the southern end of the South Staffordshire Coalfield, and the petrified logs of wood found therein at Witley Colliery, Halesowen (Worcestershire). With an appendix on the structure of a new species of Dadoxylon, by E. A. Newell **Arber**. The Halesowen coal-seam and associated beds of blue clay form a definite intermediate horizon traceable across the coalfield. The area is folded into two anticlines with a deep central syncline ranging south-south-eastwards, and the strata have a south-south-easterly dip. The northern face is let down by a fault repeating the lower beds. Other faults throw southwards, and yet others intersect the anticlines. Mining operations show the existence of a buried anticline with the full Coal-Measure Series. The Witley Colliery railway-cutting shows big logs of petrified wood finely preserved by calcite, and of Upper Carboniferous age. The wood has been examined by Dr. Newell Arber, who finds it to have Araucarian affinities, but of a species new to science. In consequence of its Palæozoic age, it is referred to the genus Dadoxylon. The type of preservation is also new to this horizon in this country, and the discovery of Dadoxylon at Witley constitutes a new record for British Upper Carboniferous rocks.

MANCHESTER.

Literary and Philosophical Society, March 18.—Prof. F. E. Weiss, president, in the chair.—W. H. **Sutcliffe**: A criticism of some modern tendencies in prehistoric anthropology. During the last few years there has been a great revival of interest in the study of Palæolithic man and his instruments in Britain, some of which are of great importance on account of the care and skill with which they have been worked, whilst others appear to be founded on untrustworthy evidence. The author discussed such of these latter as lead to the necessity of demanding a pre-Pleistocene arrival of man in Britain. The Kent plateau eoliths were examined and compared with the chipped flints found by Mr. V. Commont and l'Abbé H. Breuil in the Thanetian beds of north France and those described by Mr. Hazzledine Warren from the undisturbed "clay with flints." It was pointed out that, from our extensive knowledge of the fauna of this formation (Rheims and New Mexico), it is quite certain that no tool-using animal could possibly have been present at this remote time, and that therefore these flints, some of which closely resemble well-made implements, must be of purely natural origin. The "rostro-carinate" flints described by Sir E. Ray Lankester from the Red Crag were next examined, and it was shown that the same type occurs in the ordinary Palæolithic gravel of Hackney Downs. Lankester has also found the same type in the Middle Miocene of Aurillac. It is inconceivable that a human production should have retained exactly the same form throughout this immense period considering the rapidity of evolution of type shown among Palæolithic implements. The "rostro-carinate" flints were found to be not adapted to any likely use, and the conclusion is reached that they cannot be held to give good evidence of the existence of Pliocene man. On examining the age of the Galley Hill and Ipswich skeletons, the extreme improbability of the only two known human remains found in gravel (prior to the recent discovery of the Sussex man) each being a complete skeleton, in view of the very great rarity of even small associated sets of bones of other mammals in the same and similar gravels, was dwelt upon. The Galley Hill skeleton's authenticity depends on the evidence of two witnesses with no geological training, who contradict one another on so fundamental a fact as the nature of the bed in which it lay—one called it mould, the other gravel. As regards the Ipswich man, the author pointed out the impossibility of a human skeleton lying closely contracted on a surface of loose sand resisting the action of a glacier which is supposed to have deposited Boulder Clay over it. The conclusion was reached that both skeletons are merely burials of quite comparatively recent date.

April 8.—Prof. F. E. Weiss, president, in the chair.—W. **Burton**: Note on black pottery from Ashanti and the Gold Coast.—W. **Thomson**: The influence of moisture in the air on metabolism in the body. The author had previously pointed out that metabolism in the lungs (as indicated by the percentage of carbonic acid gas in the exhaled air) took place to a greater extent when breathing dry than when breathing damp air. He now tested this further on the effect of the various alterations in the atmosphere, viz. the combined influence of pressure, temperature, and hygroscopic state of the atmosphere on the carbonic acid gas contained in the exhaled air from the lungs. His experiments showed that some people are more sensitive than others to dry or damp air, but the general result showed that the difference of the carbonic acid gas in the exhaled air, when breathing cold damp air, amounted to about 4 per cent. increase when breathing cold dry air, whilst with warm air the difference showed an increase for the warm dry air of 7·53 per cent.

April 22.—Prof. F. E. Weiss, president, in the chair.—Prof. F. E. **Weiss**: A Tylodendron-like fossil. While agreeing in general external appearance and also to some extent in the structure of the remains of the woody tissues found outside the pith, the latter was remarkable for the considerable development of secretory canals in its thin-walled tissue. The presence of these and other considerations led the author to the conclusion that the pith was more likely to have belonged to a plant of Cycadian than to one of Araucarian affinity.—W. **Robinson**: Some relations between *Puccinia malvacearum*, Mont., and the tissues of its host. The general features of the pustules as shown on petiole, stem, and leaves of the hollyhock (*Althaea rosea*) were described. The relations of the distribution of the fungal mycelium to the starch content of the host were pointed out, and the relations between the haustoria and the individual cells were dealt with. By a series of plasmolysis experiments the haustoria were demonstrated to enter cells which remained living after entry, and they were shown to lie within the protoplasm and to grow towards the nucleus. The results indicate a slow tapping of the resources of living cells by the haustoria, which are able to penetrate the protoplasm in such a way that the cells remain alive for a considerable time.

BOOKS RECEIVED.

Bergens Museum. Aarsberetning for 1912. Pp. 119. (Bergen: J. Griegs Boktrykkeri.)

Uebungsbeispiele aus der unorganischen Experimentalchemie. By H. and W. Biltz. Zweite Auflage. Pp. xi+237. (Leipzig: W. Engelmann.) 8 marks.

Ministry of Finance, Egypt. Survey Department Report on the Work of the Survey Department in 1911. Pp. 76. (Cairo: Government Press.) 10 P.T.

General Index to *The Chemical News*. Vols. i. to c. Pp. iii+712. (London: *Chemical News* Office.) 2*l*.

The People's Books:—The Science of Light. By Dr. P. Phillips. Pp. 92. Gardening. By A. C. Bartlett. Pp. 94. British Birds. By F. B. Kirkman. Pp. iv+96. (London and Edinburgh: T. C. and E. C. Jack.) 6*d*. each.

Malaria, Cause and Control. By Prof. W. B. Herms. Pp. xi+163. (London: Macmillan and Co., Ltd.) 6*s*. 6*d*. net.

Problems in Eugenics. Vol. ii. Report of Proceedings in the First International Eugenics Congress, held at the University of London, July 24 to 30, 1912, together with an Appendix containing those Papers communicated to the Congress not included in vol. i. Pp. 189+index. (London: Eugenics Education Society.)

La Matière. Sa Vie et ses Transformations. By Prof. L. Houllevigue. Pp. xxxii+319. (Paris: A. Colin.) 3.50 francs.

Fortschritte der Mineralogie, Kristallographie, und Petrographie. Edited by Dr. G. Linck. Dritter Band. Pp. 320. (Jena: G. Fischer.) 10 marks.

Manual of Wireless Telegraphy and Telephony. By A. F. Collins. Third edition. Pp. xv+300. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd.) 6*s*. 6*d*. net.

The Theory and Practice of Working Plans (Forest Organisation). By Prof. A. B. Recknagel. Pp. xii+235+vi plates. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd.) 8*s*. 6*d*. net.

Schnee und Eis der Erde. By Prof. H. Wieleitner. Pp. 198+xvi plates. (Leipzig: P. Reclamm, jun.) 1 mark.

Bogen und Pfeil bei den Volkern des Altertums. By E. Bulanda. Pp. vi+136. (Vienna and Leipzig: A. Hölder.) 6.80 marks.

Gouvernement Egyptien. Administration des Arpentages. Catalogue des Invertébrés Fossiles de l'Egypte représentés dans les Collections du Geological Museum au Caire. By R. Fourtau. Pp. 93+vi plates. (Le Caire: Imprimerie Nationale.) 40 P.T.

Religious Beliefs of Scientists. By A. H. Tabrum. New edition. Pp. xxi+309. (London: Hunter and Longhurst.) 2*s*. 6*d*. net.

A Synopsis of the Classification of Insects. By Prof. H. M. Lefroy. Pp. 32. (London: Lamley and Co.) 1*s*. net.

Handbuch der vergleichenden Physiologie. Edited by H. Winterstein. Lief. 32–33. (Jena: G. Fischer.) 5 marks each Lief.

Vorlesungen über allgemeine Histologie. By Prof. A. Gurwitsch. Pp. v+345. (Jena: G. Fischer.) 11 marks.

Photographic Supplement to Stanford's Geological Atlas of Great Britain and Ireland. Arranged and edited by H. B. Woodward, with the cooperation of Miss H. D. Sharpe. Pp. 113. (London: E. Stanford, Ltd.) 4*s*. net.

Die europaeischen Schlangen. By Dr. F. Steinheil. Erstes Heft. 5 plates. (Jena: G. Fischer.) 3 marks.

Memoirs of the Peabody Museum of American Archæology and Ethnology, Harvard University. Vol. vi., A Study of Maya Art: its Subject Matter and Historical Development. By H. J. Spinden. Pp. xxiii+285+29 plates+map. (Cambridge, Mass.: Peabody Museum.)

Monographs of the United States Geological Survey. Vol. li., Cambrian Brachiopoda. By C. D. Walcott. Part i. Text. Pp. 872. Part ii. Plates. Pp. 363+civ plates. (Washington: Government Printing Office.)

Thirty-third Annual Report of the Director of the United States Geological Survey to the Secretary of the Interior. For the Fiscal Year ended June 30, 1912. Pp. 175. (Washington: Government Printing Office.)

United States Geological Survey. Professional Paper 77. Geology and Ore Deposits of the Park City District, Utah. By J. M. Boutwell, with contributions by L. H. Woolsey. Pp. 231+xliv plates. (Washington: Government Printing Office.)

United States Bureau of Entomology. Bulletin No. 91. The Importation into the United States of the Parasites of the Gipsy Moth and the Brown-tail Moth. By L. O. Howard and W. F. Fiske. Pp. 344+xxviii plates. (Washington: Government Printing Office.)

Researches into Induced Cell-Reproduction and Cancer, and other Papers. Vol. iii. By H. C. Ross, J. W. Cropper, E. H. Ross, H. Bayon, W. J. A. Butterfield, E. Jennings, and S. R. Mowlgavkar. (The John Howard McFadden Researches.) Pp. 149. (London: John Murray.) 5*s*. net.

Physikalische Chemie der homogenen und heterogenen Gasreaktionen. By Dr. K. Jellinek. Pp. xiv+844. (Leipzig: S. Hirzel.) 30 marks.

Annual Report of the Board of Scientific Advice for India for the Year 1911–12. Pp. 201. (Calcutta: Superintendent Government Printing, India.) 1*s*. 6*d*.

A Dictionary of English and Folklore-Names of British Birds. By H. K. Swann. Pp. xii+266. (London: Witherby and Co.) 10*s*. net.

DIARY OF SOCIETIES.

THURSDAY, MAY 8.

ROYAL SOCIETY, at 4.30.—The Various Inclinations of the Electrical Axis of the Human Heart: A. D. Waller.—Trypanosome Diseases of Domestic Animals in Nyasaland. III.: *Trypanosoma pecorum*: Surg.-Gen Sir D. Bruce, Major D. Harvey, Major A. E. Hamerton, and Lady Bruce.—The Excystation of *Colpoda cucullis* from its Resting Cysts and the Nature and Properties of the Cyst Membranes: T. Goodey.—The Experimental Hybridisation of Echinoids: C. Shearer, W. de Morgan, and H. M. Fuchs.

CONCRETE INSTITUTE, at 7.30.—Shear and Problems arising therefrom: H. K. Dyson.

FRIDAY, MAY 9.

ROYAL INSTITUTION, at 9.—Life History of a Water Beetle: F. B. Browne.

ROYAL ASTRONOMICAL SOCIETY, at 5.—The Polar Diameter of Saturn and the Minor Axis of the Ring: E. E. Barnard.—Note on the Pressure of Radiation on a Small Reflecting Sphere: J. Proudman.—An Investigation on the Motion of the Stars: C. V. L. Charlier.—The Mode of Propagation of the Sun's Influence in Magnetic Storms: Rev. A. L. Cortie.—The Motions and Distances of the Pleiades and other Groups of Stars: H. C. Plummer.—*Probable Papers*: A Regular Law representing Wolf's Sun-spot Numbers: H. H. Turner.—Preliminary Discussion of the Discordance between the Observed and Predicted Positions of Jupiter's Eighth Satellite: J. Jackson.—Photographic Determination of the Proper Motions of 250 Stars in the Neighbourhood of $\Sigma 443$: A. A. Rambaut.

SATURDAY, MAY 10.

ROYAL INSTITUTION, at 3.—Humphrey Internal Combustion Pumps: H. A. Humphrey.

TUESDAY, MAY 13.

ROYAL INSTITUTION, at 3.—Recent Physiological Inquiries; (3) Ductless Glands and their Dominating Influence: Prof. W. Stirling.

FRIDAY, MAY 16.

ROYAL INSTITUTION, at 9.—The Pygmies of New Guinea: Captain C. G. Rawling.

PHYSICAL SOCIETY, at 8.—Some Experiments to Detect β-rays from Radium A.: Dr. W. Makower and Dr. S. Russ.—Dust Figures: Dr. J. Robinson.

SATURDAY, MAY 17.

ROYAL INSTITUTION, at 3.—Humphrey Internal Combustion Pumps: H. A. Humphrey.

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