



SATURDAY, SEPTEMBER 22, 1934

No. 3386

Vol. 134

CONTENTS

	PAGE
Peace and War in the Air. By F. S. M.	433
Periodicals and Reference. By C. S. S.	435
Algebraic Surfaces. By W. P. M.	437
Ornithology of the Philippines	438
Short Reviews	440
Normal and Abnormal Colour Vision. By Prof. H. E. Roaf	442
Sources of Cheap Electric Power. By Prof. Francis G. Baily	445
Aberdeen Meeting of the British Association	448
Obituary : Sir Thomas Muir, C.M.G., F.R.S. By H. W. T.	449
News and Views	450
Letters to the Editor :	
Spectrum of Chlorophyll.—Dr. J. A. Prins	457
Science and Psychical Research.—Prof. Julian S. Huxley, Dr. F. C. S. Schiller and Prof. E. W. MacBride, F.R.S.	458
Determination of Dipole Moments in Solution.—Dr. F. Fairbrother	458
Cyclic Components of Paraffin Wax.—J. Müller and Dr. S. Pilat	459
Red 'Water-Bloom' in South African Seas.—T. John Hart	459
Phylogenesis of the Stridulating Organ of Locusts.—Dr. Friedrich Zeuner	460
Sensitivity of Dividing and Non-Dividing Cells to Radiation.—F. G. Spear, A. Glücksmann, A. F. W. Hughes and C. W. Wilson	460
Chemical Constitution of Vitamin B ₁ as deduced from Ultra-Violet Absorption Spectra.—Francis F. Heyroth and John R. Loofbourow	461
Structure of the Ionosphere.—Prof. J. Hollingworth	462
Chemical Separation of the Radioactive Element from its Bombarded Isotope in the Fermi Effect.—Dr. Leo Szilard and T. A. Chalmers	462
Activated States in the Spectrum of Copper Hydride.—A. Heimer and T. Heimer	462
Absorption Spectrum of Oxygen at High Pressures and the Existence of O ₄ Molecules.—H. Salow and Dr. W. Steiner	463
Heavy Water and Water of Crystallisation.—Dr. J. Newton Friend	463
Research Items	464
Problems of Freshwater Biology	467
Building Trades Exhibition. By H. E. B.	467
Chemistry of Antigens and Antibodies	468
The First Rhodesian Meteorite	469
University and Educational Intelligence	469
Science News a Century Ago	470
Societies and Academies	470
Forthcoming Events	472
Official Publications Received	472

Editorial and Publishing Offices :

MACMILLAN & CO., LTD.

ST. MARTIN'S STREET, LONDON, W.C.2

Telephone Number : WHITEHALL 8831

Telegraphic Address : PHUSIS, LESQUARE, LONDON

Peace and War in the Air

IT is one of the most tragic facts in the recent development of science that the conquest of the air, which on all grounds should have worked towards the unification of the world and the harmony of mankind, has actually become one of our most threatening dangers. No branch of science is more completely international in its history than aeronautics. Cayley, Lilienthal, the Wrights and Bleriot are a few names out of hundreds, all belonging to different nations, all having contributed something essential to what should be a common good. The air itself is obviously international, having a common constitution, enveloping and moving over us all, and having no possible fixed boundaries or divisions. Nothing, except the sunlight and rays from space, seems so clearly devised by Nature to keep us all together. Yet this heaven-sent unifier is finding in practice almost every possible man-made obstacle to the carrying out of its proper work. Men have used it almost from the first for what is simply murder, the killing, by the easiest wholesale way, of non-combatants—women and children—in the course of war. Moreover, though this practice is solemnly banned at international conferences and by the League of Nations, all the nations go on making their fighting planes so that they may do their destructive work more and more expeditiously. Now it is said that, even in the sphere of civil aviation, so many difficulties are put in the way of co-operation that an international authority is out of the question. In spite of the progress of science, the League of Nations and the extreme economic needs of the world, it is being made more difficult to secure a free passage through the air than free passage at sea.

There is this month, at The Hague, a conference of the International Air Traffic Association, and Mr. G. E. Woods-Humphery, the managing director of Imperial Airways, conscious of the nationalist animus which has been blown into the subject, writes in advance a very moderate article (in *Shell Aviation News*) trying to do a little deflation. Everyone must wish him well, but it is hard indeed to imitate the restraint of his language in speaking of the perversion of a good thing to bad ends by unrestrained rivalry, suspicion and ill-will.

Mr. Woods-Humphery begins by saying that the future of civilisation depends upon moderating this purely national spirit, and points out that the

extreme nationalism of the last decade "has undoubtedly militated against the growth of air transport". Each national reservation or restriction leads to a corresponding reprisal. He sees two ways by which "free passage in time of peace", which is his very modest desideratum, might be secured. The first is the internationalisation of air transport. He dismisses this as a course "much beloved by theorists", but to those having any knowledge of the matter "frankly an impossibility".

It is on this point that one would wish to reason a little with Mr. Woods-Humphery and, if possible, make him a little more hopeful. No one would dream of an international authority being forthwith, or indeed at any time, constituted to take over either the ownership, or the complete control, of the air lines of the world. But in fact, as history shows, that is not how things work. There are plenty of precedents. Our national railway system is one; the International Postal Union is another. In the first, the ownership of the lines rests—with little profit to them at the moment—in the hands of private owners. The State has, however, always retained a general control, and, from the first, passed Acts of Parliament regulating fares, the building of new lines, the protection of travellers against risk, etc. On the whole, while making allowance for the present depression which affects us all, this mixed system must be said to have worked well. British railways appear to serve the country as well—most people would say better—than foreign systems owned and entirely controlled by the State.

The International Postal Union, which has its offices in Berne, and grew up in the middle of the last century, affords an even closer analogy, of how an efficient system may be achieved by methods of gradualness, when different countries are concerned, and without infringing the possessory and self-governing rights of each. In each country an internal system of posts was evolved, mostly in the eighteenth and nineteenth centuries, as national organisations were improved. With us, the most important forward steps were taken in the forties of last century through the intelligent foresight of Sir Rowland Hill. The advantages were so great that the example quickly spread, and from the middle of the century onwards communications began to be set up with the similar organisations abroad on questions of common interest. From 1875, a quinquennial International Postal Congress was held, pledged to uniform actions on such matters as rates, the

transit of letters, etc. This body has permanent offices and its workings are so satisfactory that no one notices them. It should be studied, however, as an example of what can be done with perfect ease when men once recognise the necessity and apply their intelligence with general goodwill to securing it. No one thinks of the international post as a means by which packets of poison-germs could be transmitted to unloved neighbours.

The question of international air transport is more complicated because from the first it has been contemplated that machines used ordinarily for civil purposes should be convertible into war-planes, if need required. It seems that nothing can prevent this, if the devil drives. No written or spoken undertakings would bind the transgressors in time of war. The only feasible way, therefore, of approaching the problem is to build up, seriatim, a system of air transport for pacific purposes, so useful, well fitted together and generally accepted, that it would appear a monstrous perversion of it to murder people from the air. Mr. Woods-Humphery in his article mentions one obvious point to be secured by the earliest agreement possible. We must obtain for aircraft, proceeding on their "lawful occasions", similar facilities as are available for ships at sea. "The latter are free to follow any course which they desire, outside territorial waters" (a quite narrow limit), and are "allowed in territorial waters to pass unhindered to the port of their choice". This seems modest enough, but Mr. Woods-Humphery is willing to accept even a smaller instalment. "Possibly a temporary way (although it is only palliative) to meet the present difficulties would be to allow free passage to foreign air services for the carriage of their own national 'through' traffic."

It is well that attention has been directed to these extraordinary and pestilential obstacles, and that the *Times* recently gave full publicity to them. To obtain, however, so small and obvious a concession must be regarded only a first step to an agreed code of international civil aviation similar to that of the International Postal Union. Possibly the air traffic conference at The Hague will prove the germ of an international body to which the registration and carrying out of the necessary agreements will be entrusted. Other urgent points on which agreement is necessary, in order to secure an efficient and reasonably cheap air service, are the elimination of unnecessarily competing lines. Several of these are to be found in northern countries, notably in Scandinavia. It

should not be difficult to arrange compromises in such cases, which it is to the interest of all Governments to support, as subsidies will only become unnecessary as air transport becomes more popular, and it can only become more popular as those conducting it make their services more convenient by dovetailing the various lines, issuing joint timetables, aiming only at peaceful commercial and scientific purposes, with no *arrière-pensée* of war.

There is much to be done, and science has as great an interest in the matter as international peace. At the time of writing, we have not yet even been assured that the question of the planes of England being allowed to use the airways of France has been satisfactorily settled. It is a pity that flying and the air-post being at present rather a luxury of the rich, it is impossible to arouse the same popular interest in the matter as is now felt in other pacific questions. But it is none the less important for the future, and advance can be made in Mr. Woods-Humphery's spirit, but with more confidence and larger possibilities in mind and a larger objective in view. Science has provided in the aeroplane one of the most potent agents for peace and progress that the world possesses. It must be for the common sense of mankind to use it for its natural end.

F. S. M.

Periodicals and Reference

A World List of Scientific Periodicals published in the Years 1900-1933. Second edition. Pp. xiv+780. (London: Oxford University Press, 1934.) 63s.

WITH its first issue, 1925-27, the "World List" took rank as a notable addition to library resource. It essayed to catalogue the scientific periodicals of the world current at commencement of this century and thence onward to 1921. To each of the periodicals (more than 25,000) of its list it assigned a reference-title individually distinctive. Further, for each of those traceable to any of 150 given representative libraries in the British Isles, the list stated by which of those libraries the periodical was filed. This census of extant periodicals, and of the British intake of them, was undertaken at a significant time. Want of it was being acutely felt. A post-War world in being was making departures fresh. In various directions the recovery of scientific production was almost feverish. Renascent nations newly risen rejoiced to show their virility and culture by contributing to science through channels

natively and linguistically their own. However desirable might be a full inventory of all this activity, it was far from easily compassed. It meant search at sources emanating the world over. Their number proved to be yet greater than had been thought. Nevertheless the difficulties were overcome, and the results justified their undertaking.

Still the stream of scientific publication, far from abating, increases. Especially so its spate of periodicals. These, at recurrent short intervals, as they do, supplying so to say red-hot instalments of science in the making, possess ever wider public appeal and use. More than 5,000 new periodicals have arisen since the "World List's" census twelve years ago. A fresh edition of the List has therefore become urgent. For the production of this, now welcomely before us, the same competent and devoted hands which provided the original have happily, with little change, been available once more. Sir Peter Chalmers Mitchell as chairman, a council of management, an advisory committee, and as editor, Mr. W. A. Smith, of the British Museum, have accomplished the revision and expansion needed. Their public-spirited service, costly in time and labour, has been rendered gratuitously, as though with a generous gesture *labor ipse voluptas* for the end in view.

The present edition is issued as a single volume. It has the improvement that for each periodical, all the given data are brought together in one omnibus entry, already in so far collated for the reader. The total of titles listed is some 10,000 more than in the former issue. Periodicals beginning since that issue are included to end of 1933. In supplying an individually distinctive abbreviated reference-title to each of the 35,000 periodicals listed, the International Code of Abbreviations for Titles of Periodicals (Paris 1930) has been followed. This has not entailed much change from the abbreviations used in the previous edition because the International Code is largely based on the practice of the original edition of the "World List". A standard abbreviation-title of international sanction and use for each periodical has been much wanted. The "World List" now, even more fully than before, provides this international desideratum. A writer of a scientific paper or review can here find it ready to his hand, and editorial management can therefore more stringently insist on its use. Neglect of it confuses citation. The need for it is shown by the co-existence, as given in the "World List" before us, of above 2,000 separate current *Bulletins*, besides *Bultens*, *Bulletinos*, *Bulletinals*, etc., crowding alphabetically toward one like initial abbreviation. *Journals*, too, form a great group scarcely less prone to ambiguity in referencing. The standard

reference-title, besides avoiding ambiguity, gains brevity because it can omit, except in a few cases, the place of imprint. A helpful usage is for each periodical itself to bear on its cover its standard abbreviated reference-title. This is done by publications of the Wistar Institute, the *Journal of Physiology* and some few others.

In this new "World List" the distribution of scientific periodicals as regards their location in the British Isles is traced for 187 representative libraries. For periodicals already listed in the first edition locations additional to those there traced have since then come to light in these libraries, and are now included. The length of 'run' of volumes in the given library is noted, its date of commencement, or, if terminated, when; and whether suspended in the War, or whether the 'run' itself is imperfect. Sequels under change of title are also shown; also titles repeated in a second language; and where a title has been changed at some time from one language to another, both forms of title are quoted though the earlier alone is registered numerically. Some of these data are miniature footnotes to the great page of history itself.

To-day the busy scientific worker is snowed under by periodical literature. There drifts upon him a mass of papers, some for his purpose requiring to be read and others not so requiring. This situation has called forth that other type of periodical, which furnishes classified précis, or 'abstracts' of papers published elsewhere. From the special abstracting periodical the worker gains relief; he gets guidance as to what is actually relevant to his own work. The abstracting periodical, however, has its difficulties. One is that a fringe of relevant papers finds publication in channels which contribute only occasionally to the field to be 'abstracted'. Of such channels some, for example, *Transactions, Memoirs, Proceedings*, etc., of academies, and like bodies dealing fundamentally with science in general, will contain papers of value. This class of channel is active to-day. Its units increase in volume. Their issues, embracing many subjects, may deal but rarely with some particular one. Hence their contribution tends to escape the specialist or reach him late because of its 'fringe' channel. This difficulty the list before us relieves by indexing the extent and the location of the 'fringe' channels the abstracting net must reach if it is to catch fully the relevant literature of the subject. The List serves also any who would themselves control a field 'abstracted', or seek actual access to papers indicated by 'abstract' but not available to hand.

The volume before us shows that for a considerable proportion of the periodicals extant no copy at all, to judge by the 187 representative

libraries addressed, exists in Great Britain. Sometimes this is true of a third or more of the items in a page column. Such deficit of intake of foreign scientific literature must *in toto* amount to more than merely negligible disadvantage to the country. The foreign literature of which the supply seems to stand least in need of expansion is that of Central Europe; outside that the leanness of the intake calls out for remedy. A measure of relief might be effected were libraries in agreement one with another to devote each some margin of income to securing one or more periodicals not taken by the rest. The tale of missing serials could thus be minimised. Each contributory library would secure some items specially or uniquely its own and help in the common cause to remedy a serious defect in the national equipment. The policy could be the more effective in view of the co-operative loan-system between accredited libraries, with the National Central Library as clearing-house. A particular holding of the outlier library once recorded in the "World List", any worker could readily find whether or where the periodical otherwise inaccessible to him is available for him on accredited application.

One feature of library operation which perusal of the List stresses for avoidance is undue overlap of intake. The first edition of the "World List" indicated instances of this. The need to improve the existing intake of foreign periodicals by extending the intake in certain directions indicts unnecessary overlap of intake not only as wasteful, but also as a positive obstacle to progress. This argument applies the more in these days of financial stringency. It is reinforced further by the call to meet some among new periodicals which will come. In all this matter the lure of the long 'run' has undoubtedly been a hindrance to improvement. A *Zeitschrift* or a *Journal* may deteriorate, its price become excessive, a new competitor excel it, or be better representative, etc., and yet reluctance to break a long 'run' immobilise the library against the needful change. Some of the scruples against such freer policy vanish with publication, as in the "World List", of an easily accessible record, notifying such changes to the inquirer. Such notification usefully unfreezes library intake. Indeed, public interests which the "World List" has at heart would be forwarded could there appear, perhaps biennially, an interim supplement recording, as far as concerns the List, changes of intake by the libraries on the List.

The comprehensiveness of the catalogue before us is impressive. The volume received a grant of £1,000 from the Royal Society towards its cost. Science, pure and applied, with a vast range of technology adjunct, commingle throughout its

pages. In deciding as to whether the scope of a given periodical does or does not come under the rubric 'natural science' the List has rightly taken the wide view. Such difficulty is perhaps greatest with sociological items. A debatable omission seems *Philosophy*, the journal of the British Institute of Philosophy. But indeed the List is extraordinarily complete. The whole work earns our grateful acknowledgment and admiration.

C. S. S.

Algebraic Surfaces

Principles of Geometry. By Prof. H. F. Baker. Vol. 6: *Introduction to the Theory of Algebraic Surfaces and Higher Loci.* Pp. ix+308. (Cambridge: At the University Press, 1933.) 17s. 6d. net.

THE book under review is the sixth volume of the "Principles of Geometry" by Prof. H. F. Baker, of St. John's College, Cambridge. As expository treatises of algebraic geometry, these six volumes occupy an unrivalled position within their own field, viewed from the aspect of international scholarship. They begin from the elements of the subject and carry the development forward with a majestic sweep that is without parallel in any other language. A great deal of the subject-matter is abstract, but the author never fails to adduce concrete examples and theorems, so that the faith of the weak is strengthened while that of the strong is never allowed to reach into regions of nebulousness. Prof. Baker is indeed to be congratulated on collecting and correlating this vast field of geometric theory, so that every well-trained mathematician, whether a professional geometer or not, can share in the triumphs and apprehend the conquests of those who make geometrical research their main object in life.

The subject-matter of the first five volumes was indicated when reviewing vol. 5 (NATURE, Feb. 3, 1934, p. 155). Vol. 6 consists of seven chapters. Chap. i deals with "Algebraic Correspondence"; chap. ii with "Schubert's Calculus, Multiple Correspondence"; chap. iii with "Transformation and Involutions for the most part in a Plane"; chap. iv with "Preliminary Properties of Surfaces in Three and Four Dimensions"; chap. v with an "Introduction to the Theory of the Invariants of Birational Transformation of a Surface, particularly in Space of Three Dimensions"; chap. vi with "Surfaces and Primals in Four Dimensions, formulæ for Intersections"; chap. vii with "Illustrative Examples and Particular Theorems".

It will be immediately evident that the whole

of such a vast canvas cannot be passed under review and that only specimen sections can be surveyed. Chap. iv on the preliminary properties of surfaces in three and four dimensions will be found particularly attractive by elementary students of geometry and by more general readers. The introductory paragraph may be quoted *in extenso* :

"We consider an algebraic surface of order n , in ordinary space, in which the co-ordinates are x, y, z, t ; and certain properties of the tangent cone drawn to this surface from an arbitrary point. We suppose, unless the contrary be stated, that the multiple points of the surface consist at most of the points of a double curve, whereon are triple points of the surface, through which pass three sheets of the surface; so that such points are also triple points of the double curve, with tangents not generally lying in a plane. Reasons will be given later for the conclusion that any surface can be birationally transformed to a surface of this character, so that the supposition involves no essential limitation of generality in the surfaces dealt with. At the same time, it is often convenient to suppose that, beside the double curve, the surface considered has isolated multiple points; and this possibility will also be taken into account in some of the results given."

Such problems are then discussed as the number of lines that pass through a given point in space and intersect a given surface in three coincident points. The ordinary tangent plane to a surface intersects the surface in a curve having a node at the point of contact. How many tangent planes pass through a given point in space and have the nodal tangents at the point of contact coincident? Many surfaces have double curves, that is, curves at every point of which the surface is singular and has a plane-pair instead of the usual nodal cone. When the two planes of such a plane-pair become coincident, the point is called a "pinch-point" on the double curve. The properties of 'pinch-points' are studied. If $f(x_0, x_1, x_2, x_3, x_4)=0$ and $\varphi(x_0, x_1, x_2, x_3, x_4)=0$ be two hypersurfaces in space of four dimensions, and if x_4 be eliminated between these two equations, we shall get a surface in space of three dimensions, namely, the projection of the surface of intersection of f and φ from four dimensions into three. Just as the curve of intersection of two surfaces in three dimensions projects in general into a two-dimensional curve with a finite number of double-points, so the above surface in three dimensions, which is the projection of $f=\varphi=0$, will in general have a double-curve. The generalisation of a particular phenomenon to another more extended is a particular feature of the book, and the author never fails to focus the reader's attention on such

generalisations. The algebraic analysis in this chapter is comparatively simple throughout, while the concepts dealt with and the previous knowledge of geometry required are not such as to render the chapter prohibitive to all but experts.

Chap. v, on the invariants of surfaces, is one of the most important in the book. The treatment begins by recapitulating that in the case of a plane curve, a line through an arbitrary point O meets the curve in m points, in w cases of which two consecutive points coincide. The genus of the curve is then $\frac{1}{2}w - m + 1$. This definition is then extended to the case of the points of intersection of the given curve with a pencil of curves. Finally, the question is raised, whether such a process cannot be extended to obtain similar properties for surfaces. The invariants I and w are studied. In this chapter also, a large number of concrete surfaces are studied and their characteristic numbers and invariants are given by way of illustration.

The author's treatment throughout is almost entirely algebraic, and at least one interesting question arises in dealing with geometry in space as with geometry in the plane. Should the teaching of algebraic geometry be almost entirely divorced from the teaching of Abelian integrals? Riemann-Roch's theorem always seems to many a very artificial and difficult theorem from the point of view of algebraic geometry, but it becomes a comparatively easy and natural theorem when the elementary results of Abelian integrals are known. The results of the researches on "Théorie des Fonctions Algébriques de deux variables indépendantes" set forth by Picard and Simart in their treatises with this title are mentioned by Baker, but it is not his intention and it is beyond his professed scope to develop the subject matter of his geometry at length on these lines. The invariants relating to a surface present themselves very sharply defined when these generalised Abelian integrals are studied. It seems relevant at all events to raise the question of a more complete *rapprochement* in general teaching and exposition between geometry and the results of Abelian theory.

"Some books are to be tasted, others to be swallowed, and some few to be chewed and digested," says Bacon's Essays. Every mathematician will have to decide for himself under what category he falls with reference to this book, but it is one of the merits of the book that it forces the reader to a decision. It is a great book and much of it is undeniably difficult. But it is full of information, of vistas, and of glimpses into unpenetrated tracts. It challenges and it grips, and once again Prof. Baker has laid us under a deep debt of obligation.

W. P. M.

Ornithology of the Philippines

The Birds of the Philippine Islands: with Notes on the Mammal Fauna. By the Hon. Masauji Hachisuka. Part 2. Pp. 169-439 + plates 25-39. (London: H. F. and G. Witherby, 1932.) n.p.

THE present, or second part, of the work of the Hon. Masauji Hachisuka on the birds of the Philippines contains the following orders—Columbiformes, Ralliformes, Pygopodiformes, Tubinariformes, Telmatoformes, Archeiformes, Anseriformes and Pelicaniformes. Mr. Hachisuka's Telmatoformes is merely another name for Dr. P. R. Lowe's *Telmatomorphæ*, and the author also adopts the same sub-orders as created by Dr. Lowe for that order. As this embodies the very latest ideas on the subject of the classification of this most difficult group, the author has been wise in accepting for the present the order practically as defined by Dr. Lowe.

At the same time, as Dr. Lowe himself suggests, it is possible that much more remains to be learnt about the intergradation or distinctness of the various groups in the order before systematists can hope for a really final solution of all their difficulties. Two families of birds in especial present many difficulties which have not yet been by any means finally disposed of. In his important article in the *Ibis*, Dr. Lowe pointed out that the curious little family of *Burhinidæ*, or Stone Plovers, showed certain structural characteristics which linked them with the cranes or *Gruidæ*. This, however, even though not *proved*, will probably be generally accepted, but the next family, the *Jacanicæ*, containing those remarkable birds the water pheasants, cannot be finally accepted as belonging to the order without any doubt. Stuart Baker in his recent work on the fauna of India raised this family to the rank of a sub-order by itself, there being undoubtedly many structural characteristics which would seem to bear witness to the very early breaking off of this group from their ancestors, who may or may not have been cranes.

On referring to the author's *Limicolæ*, we find that here again he has relegated Stuart Baker's suggested sub-order *Rostratulæ*, or Painted Snipes, to the rank of a family, possibly quite correctly; but possibly, on the other hand, further examination may prove this to be wrong. As regards the other orders dealt with by the author in this part, there is not very much to be said. The ducks and geese he divides into three sub-families, *Plectroptorinæ*, *Anatinæ* and *Marilinæ*. As regards this last the name should surely be *Nyrocinæ*. There are three genera of diving ducks in the area treated, namely, *Marila*, *Netta* and *Nyroca*. *Marila* was created in 1852-53 (Vögel, "Reich. Nat. Syst.", p. 8), *Netta* in 1829 ("Kaup. Skizz.

Entwick. Nat. Syst.", p. 112), and *Nyroca* in 1822 (Fleming, "Philos. Zool.", vol. 2, p. 260). This last is therefore the earliest generic name of the diving ducks and we believe that it is now generally accepted that the oldest genus should form the basis for the name of the sub-family.

We notice also that in the *Limicola* the author still uses the name *Xenus* for the Terek Sandpiper. This name was resuscitated by Stuart Baker for this bird but the latter himself corrected this in vol. 8 of his "Birds of India", showing that *Xenus* of Kaup 1829 was invalidated by *Xenos* of Rossi 1794, so that we can still use the long accepted name *Terekia*. Possibly the author does not agree with the generally accepted rule that terminals of this nature invalidate the later names. Thus we notice that in dealing with the pigeons he still uses the name *Sphenurus* of Swainson, 1837, though most systematists consider that this cannot be used as Lichtenstein used the name *Sphenura* in 1920 for a very different genus. *Sphenocercus* of Gray ("List Gen. Birds", p. 57, 1840) must be used.

In some cases we also notice the author retains spelling now generally discarded. Thus *Gorsachius* (Bonaparte, "Consp. Av.", 2, p. 138) was certainly published after April 1855 and therefore *Gorsakius* (Gray, "Gen. and Subgen. Birds", p. 114), which was published on April 9, 1855, should be used.

The format, of course, continues the same as that employed by the author in Part I. He thus first gives the scientific and trivial English names, Japanese names, then references and distribution; next, a very full description and some brief notes, the latter including habits and nidification. These notes, we must admit, we should like to have seen a little fuller, whilst in some cases the descriptions might perhaps have been somewhat abridged. After dealing with genus or species, the author then gives an excellent summary of allied families and their ranges, an addition to the work which must have entailed an immense amount of research and trouble but which is of great value. On the whole, the author freely accepts genera though he reduces a good many names to synonyms and certainly cannot be accused of being a wholesale splitter. He has, however, frequently been ruthless in refusing to accept sub-species as definable, especially when he does not consider their stability proved for any given area. On the other hand, in a few cases he accepts a greater number of races than we ourselves would recognise, as for example those of the common moorhen.

The keys given to families and species are good, but we suggest that in some cases they refer to points which are scarcely diagnostic, as, for example, the fact that the males of *Rostratula* perform the duties of incubation. Such biological facts, though of the greatest interest and possibly

giving a lead to diagnosis, cannot be said in such instances to constitute in themselves diagnoses, by which it would be possible to differentiate either species or groups of species. We are glad to see, on the other hand, that considerable stress is placed on colour, colour-pattern and the plumage of the young, characters to which Lowe has constantly referred in his work on the *Limicola* and which are only too often neglected by modern systematists.

A work on a scale so great as the present one will naturally contain a certain number of points on which all systematists will not agree. These, however, cannot be termed wrong, being merely matters of opinion. The reviewer would certainly not agree to the Rednecked Phalarope and the Grey Phalarope being assigned to the same genus, but would place the former in a separate genus, *Lobipes*, easily distinguished by its slender cylindrical bill. Again, the author gives full specific rank to *Sterna longipennis*, yet the reviewer holds this to be nothing but a sub-species of our common tern, *Sterna hirundo*, being as the author himself says, indistinguishable from it except by its black bill, while it does not overlap in geographical distribution with any other race of that bird.

Considering the work as a whole, we can only congratulate the author on its excellence and completeness. Every work of this nature merely forms a basis for future work. Macgregor's "Hand-list of the Birds of the Philippines" appeared in 1926 and since then merely additional notes by the same author and a few odd notes by other ornithologists have appeared from time to time in different publications. The present work brings all our information on this group of islands completely up to date and gives in a compact form not only the results of the author's own work but also the collated information from various sources, rendering it comparatively easy for systematists, biologists and field naturalists to continue on their own especial lines of work.

The make-up of the book is all that can be desired. Misprints and slips are extraordinarily few, but there is one of the latter to which we would direct attention on p. 309, where on lines 9 and 11 the author refers to the difference between the "Fantail Snipe" and the common snipe, presumably meaning the Pintail Snipe and the common snipe. The book is illustrated with charming colour plates by Japanese artists and still more charming black-and-white plates, on each of which three or more photographs are given of various groups of birds, their surroundings or of their breeding grounds, nests and eggs. The book will form not only a welcome, but also an indispensable addition to the library of everyone working on ornithology whether on Palæartic or Oriental forms of bird life.

Short Reviews

Principles of Animal Biology. By Prof. A. Franklin Shull, with the collaboration of Prof. George R. Larue and Alexander G. Ruthven. (McGraw-Hill Publications in the Zoölogical Sciences.) Fourth edition. Pp. xiv+400. (New York and London: McGraw-Hill Book Co., Inc., 1934.) 21s. net.

PROF. SHULL'S book is deservedly popular in the United States, and has passed through three editions since it first appeared in 1920. The present (fourth) edition has been thoroughly revised and contains up-to-date material upon which an interesting and instructive introductory course of zoology might very well be built. The content of the subject of zoology has undergone great changes during the last twenty years or so, and it no longer consists largely of studies of structure, a hunt for anatomical comparisons and the making of new species. It is rather the study of function and behaviour which is the present growing point of the subject. The science has in fact become very largely experimental, and in the teaching of zoology changes in the content of courses and in the method of presenting the material have been gradually appearing. In the United States these changes seem to have taken place more rapidly than in Great Britain, and Prof. Shull's book is evidently the outcome of considerable thought and teaching experience.

The book begins with a sketch of the history of biology, proceeds to consider living matter, cells and unicellular and multicellular constitution. Then follows a series of chapters on the general functions of animals, including very good general accounts of breeding habits, embryonic development and genetics, the latter with a number of problems. An account of the principles underlying classification is then given, followed by an outline grouping of the animal kingdom. The last four chapters of the book are particularly good, and it is refreshing to find ecology, geographical distribution, fossils and evolution treated in such a modern manner in a book designed for students as an introduction to the subject.

The book is illustrated with nearly 300 figures, and there is a useful explanatory glossary of technical words. A further good feature is the series of references for further reading given at the end of every chapter. These are nearly all references to modern standard books, and give the particular portions of chapters which are related to the part of the subject discussed.

Gmelins Handbuch der anorganischen Chemie. Achte völlig neu bearbeitete Auflage. Herausgegeben von der deutschen chemischen Gesellschaft. Bearbeitet von R. J. Meyer. System-Nummer 8: *Jod*. Lief. 2. Pp. xviii+xxiii+245-660. (Berlin: Verlag Chemie, G.m.b.H., 1933.) 68.50 gold marks.

WITH the appearance of this number, the volume dealing with the four halogens is complete. The present issue deals at considerable length with com-

pounds of iodine with hydrogen, oxygen, nitrogen and other halogens. Very full details are given of the well-known and often quoted equilibrium between hydrogen, iodine and hydrogen iodide, and the effects of ultra-violet radiation, the electric spark, catalysts and α -rays upon the system are all reviewed. Then follow various methods of preparing the gas and the acid solution. On the large scale, both products are generally prepared by the method commonly used in laboratories, namely, the interaction of iodine, phosphorus and water. A fairly recent American technical process is quoted in which hydrogen is allowed to react upon iodine in the presence of suitable solvents, such as water, acetic acid, carbon tetrachloride, toluene or stannic chloride under a pressure of nearly 500 atmospheres.

The physical properties of hydrogen iodide are fully detailed. The disparity between the diameters of the hydrogen ion and the iodide ion is so pronounced that the dipolar character of the compound is very seriously weakened and the molecules become almost, if not quite, homo-polar. Optical properties are recorded fully with curves showing extinction coefficients of absorption.

Amongst chemical properties we find prominence given to the oxidation of the iodide ion by various reagents and to the metallic iodides. The question of pure solid polyiodides seems to have given rise to considerable differences of opinion, but there is evidence of the existence, at any rate, of hydrates and solvates of KI_3 , KI_7 , and of KI_9 . The various oxidation products of the halogens react freely with one another, often in such a fashion that an intermediate product stabilises itself by partial oxidation and partial reduction. The possibilities are very numerous and a useful summary is given of all the stoichiometric and reaction velocity equations involved in these reactions, together with references to pages in the text.

Flora of Syria, Palestine and Sinai: a Handbook of the Flowering Plants and Ferns, Native and Naturalized, from the Taurus to Ras Muhammad and from the Mediterranean Sea to the Syrian Desert. By Dr. George E. Post. Second edition, extensively revised and enlarged by John Edward Dinsmore. (American University of Beirut: Publications of the Faculty of Arts and Sciences, Natural Science Series, No. 1.) Vol. 2. Pp. xviii+928+5 plates. (Beirut: American Press; London: Oxford University Press, 1933.) 42s. net.

THIS volume completes the new (second) edition of Post's well-known flora of Syria, Palestine and Sinai. It has been revised and enlarged by J. E. Dinsmore of the American Colony in Jerusalem. The sequence of families for the Angiosperms is approximately that of the Bentham and Hooker system and the second volume includes the Gamopetalæ from the Compositæ to the Plantaginaceæ, the Incompletæ, the Monocotyledons, and the Vascular Cryptogams.

It also contains additions and corrections to both volumes, general indexes to Arabic, Hebrew and Latin names, and outline black and white maps, indicating the position of many of the localities quoted.

It is unfortunate that the keys are not uniformly constructed and that they are frequently incomplete. The first purpose of a flora such as this should be to enable the student to identify plants native to the country with the greatest possible ease and accuracy. Concise dichotomous keys leading to single species, not merely to groups of often 'critical' species, are a great help to identification, and their construction tests the validity of the author's taxonomy. Another criticism which can be brought against the book under review is the poor drawing and reproduction of many of the figures.

On the other hand, the new edition of the flora will be of great use to botanists studying the plant-life of the Nearer East, since it includes so many recent discoveries of new species and varieties and extended distributions.

W. B. T.

Uncle Joe's Nonsense: for Young and Old Children.

A Medley of Fun and Philosophy reported by J. W. Mellor. (Published for the Ceramic Society.) Pp. xii+231. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1934.) 12s. 6d. net.

THERE is more than a touch of the Carrollesque about this delightful foil to Dr. Mellor's chemical publications. Here we encounter the author of the monumental "Comprehensive Treatise on Inorganic and Theoretical Chemistry" (in thirteen volumes and still running) in his hours of ease—which appear to be more numerous than many students of chemistry have suspected! The book is one of airy persiflage, full of the pert and nimble spirit of mirth, dedicated appropriately to nieces and nephews in New Zealand, and forming a delicious *pot pourri* of ornithological studies, journeyings by land and water, lessons in dancing, and other 'trifles'.

"Why is the ship called *Laconia*?" The unsuspecting questioner caught a tartar, for in his reply the author of the "Comprehensive Treatise" traced the word conscientiously "through *lacus*, a lake, to a ship sailing on water, not in air. I supported my derivation by quoting analogous cases: *gramophone*, from the Greek *gramo*, I speak, *phono*, through a tin tube; *virgin*, from the Latin, *vir*, a man, and *gin*, a trap—a man-trap; and *husband*, from the Old English *hussy*, a woman, and *bond*, a tie—tied to a woman . . . I also added that the ship was called *Laconia* because *Laconia* was its name. I had in mind the boy who asked one of the keepers at the Zoo why the lions in his charge were called 'lions', and who received the illuminating answer, 'Because lions is what they are'."

The book abounds in clever verses and ingenious drawings. It will convince all who have the good fortune to read it of the fallacy of the idea that the man of science is necessarily devoid of humour and humanism and incapable of expressing himself in the common tongue, and for this reason in particular we welcome its publication.

J. R.

A Text Book of Applied Hydraulics. By Prof. Herbert Addison. Pp. xii+409+24 plates. (London: Chapman and Hall, Ltd., 1934.) 21s. net.

IN general, this work covers the usual field of modern textbooks on hydraulics, commencing in part 1 with a brief account of the fundamental principles of hydro-mechanics and proceeding in part 2 to deal with the practical applications of the subject to pipes and pipe systems, open channel control, hydraulic turbines and pumping machinery. The book has been designed for three classes of reader: the general student; the electrical practitioner, within whose province it falls to be familiar with the performance of pumps and turbines rather than with their mechanical details; and the specialist in water supply, irrigation and the construction of pumps and turbines. For the first of these classes, part 1 has been provided together with a number of worked out examples. These examples with their solutions occupy a considerable section of the book (64 pages) and are a valuable feature. The second class will find their needs specially catered for in part 2, while the third class may be expected to gather from the principles enunciated throughout the book a reliable basis for the study of more detailed treatises.

The rapid expansion of the use of hydro-electric power has led to important developments in turbine design, and units of very considerable horse-power are now in operation. Two chapters are devoted to a consideration of the construction and performance of hydraulic turbines. These give a serviceable comparison of the leading types, and there are useful diagrams of turbine performance and characteristics. The volume concludes with a chapter on hydraulic measurements.

B. C.

Liquid Dielectrics. By Dr. Andreas Gemant. English translation by Vladimir Karapetoff. (National Research Council Committee on Electrical Insulation, Monograph No. 2.) Pp. ix+185. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1933.) 18s. 6d. net.

DR. GEMANT'S monograph will be of value to all research physicists and engineers. He discusses first the resistivity, and dielectric constants of liquids, pointing out that as a rule the higher the resistivity the smaller the dielectric constant. From the practical point of view, it seems a pity that nearly all liquid dielectrics are organic substances, as inorganic compounds are generally much the more stable. The thermal, mechanical and optical properties of liquids are discussed and also their behaviour in an intense electric field.

The liquid dielectric most frequently used in electrical engineering is a mineral oil, and in high voltage cables it may be subjected to the most intense electric stress for many years. The motions of the oil in the cable due to variations in its temperature caused by change in the load sometimes cause empty spaces in the cable and so considerably weaken its resistance to electric stress. To prevent this, the use of a lighter oil in place of the heavy impregnating compound is being tried.

Normal and Abnormal Colour Vision*

By PROF. H. E. ROAF

RECENTLY attention has been directed to the number of accidents caused by mechanically propelled vehicles. The use of coloured signals may lead to difficulties for drivers with defective colour vision. Until the colour vision of persons who seem to disregard the coloured lights is tested, we do not know to what extent coloured lights constitute a difficulty to motor drivers with defective colour vision. In any case the remedy is simple, as a difference in shape of the coloured lights would be sufficient to prevent mistakes. It is true that the relative positions of the lights and other data may help in the recognition of the colour, so that the problem is not so serious as in the case of railway and marine services.

The aim of this address is to discuss three aspects of the physiology of colour vision. The first aspect is the validity of the trichromatic hypothesis. There may not be many new things to be said, but a restatement of the arguments is useful as showing to what extent the hypothesis can be relied upon. The second aspect is the nature of the departures from normal colour vision of those with defective colour vision. The third aspect is a brief consideration of some theoretical views on the nature of colour-perceiving mechanisms.

PHYSIOLOGICAL MEANING OF COLOUR

Colours are visible in the spectrum, and we can recognise certain colours which seem unitary and distinct from all others, namely, red, yellow, green and blue. There are, however, other unitary sensations which must be considered, namely, white and black: these cannot be produced by stimulation with any one region of the spectrum. These two sensations are sometimes described as belonging to the colourless sensations, but psychologically one cannot separate them from a discussion on colour.

Thus we find that certain colours are related to definite regions of the spectrum, but there are other sensations which do not correspond to any single group of wave-lengths: the latter are the purples, white and black. All colours can be represented by fusion of lights from several regions of the spectrum, and the minimum number of regions is three. This physical relation is generally considered of paramount importance in the discussion of colour vision.

In 1802, Young postulated that there were

three sensory mechanisms, because all colours could be reproduced by a combination of three regions of the spectrum. There has always seemed some difficulty in reconciling this view with the psychological point of view that there are six distinct kinds of visual colour sensation, namely, red, yellow, green, blue, white and black. In the discussion of this problem, some of these simple psychological effects can be shown to be built up from other sensory processes. The discussion of the sensation of yellow occupies an important place, but before we deal with the sensation of yellow it is simpler to consider the sensations of white and of black.

Sensation of white cannot be produced by any single unitary physical stimulation. It requires the simultaneous action of light from more than one region of the spectrum. This seems to me a fundamental consideration, because if a simple sensation like white can be produced only by a heterogeneous stimulation, it is possible for a simple sensation like yellow to be the result of a heterogeneous stimulation. The sensation of white can be produced by stimulation by light from the whole of the spectrum, or from three or from two selected regions. There is no fixed standard of white. A white surface is one that reflects all visible wave-lengths well and equally. In order to define a 'white' light a standard is taken of the radiation of a perfect radiator at $4,800^{\circ}$ K. or other specified temperature. When a white sensation is produced by light from two regions of the spectrum, the separate sensations produced by these radiations are said to be complementary.

Black sensation cannot be produced by any combination of radiations. It is always the result of a *relative* deficiency of stimulation. A black surface is one that does not reflect any visible wave-length to an appreciable extent. To produce a black effect with spectral lights a brighter light must shine alongside them. Thus, a red produced by wave-length of about 6500 Å. looks brown when a bright yellow produced by wave-length of about 5900 Å. shines alongside of it.

The transition between white and black through grey depends upon the relative amount of illumination. There must, however, be the right mixture of wave-lengths, otherwise the grey will be tinted with the colour sensation produced by those wave-lengths which are in excess.

We are now in a position to consider the phenomenon of yellow. Yellow is a unitary

* From the presidential address before Section I (Physiology) of the British Association, delivered at Aberdeen on September 10.

sensation which can be produced by a single group of wave-lengths or by two groups, one each on the 'red' and 'green' sides of the 'yellow' region. If we are to believe that three types of sensory mechanism are sufficient to account for colour vision, one of the four colours red, yellow, green and blue must be due to a stimulation of at least two of the other ones. For several reasons, yellow has been chosen as the heterogeneous one.

To my mind there is no more difficulty in considering yellow as due to stimulation of two types of receptors than to consider white as due to stimulation of more than one type. Experimental evidence supports this view. Macdougall, Rochat, and others have shown that a 'red' stimulus to one eye and a 'green' to the other will give a sensation of yellow. This result is obtained even with lights from the spectrum. The fact has been demonstrated by Hecht, but his method is not such a satisfactory proof as that obtained by other methods, for example, a 'red' glass over one eye and a 'green' one over the other, or two definite wave-lengths of the spectrum each presented to one eye.

Central summation of this type shows that the sensation is built up in the nervous system beyond the optic chiasma, as neither eye need be stimulated by the 'yellow' of the spectrum. The red and green sensations are lost, but their disappearance cannot be due to processes in the layers of the retina. As Macdougall points out, the alternative suggested by Hering that his four-dimensional system is cerebral rather than retinal deprives his hypothesis of its special value as a theory of colour vision. Hering's theory then becomes part of a general problem of how afferent stimuli are combined to produce perceptions, which is too complex a matter to be discussed here.

As the unitary sensations yellow, white and black can be built up from stimuli associated with other sensations, it is possible to reduce the number of data for colour perception to three.

The object of the above discussion is to show that there is no real objection to the trichromatic explanation of colour vision proposed by Thomas Young.

DEFECTIVE COLOUR VISION

Abnormal colour vision may be congenital or acquired. It is not my intention to discuss certain defects in colour vision due to disease, for example, tobacco amblyopia.

Defective colour vision is a condition in which the persons affected make mistakes in matching colours. Any explanation of the nature of colour vision must be able to explain how certain colours are mistaken. The usual form of defective colour vision is congenital, and does not alter during life.

This is what is generally understood when speaking of defective colour vision. The defect seems to consist in a decrease in the ability to distinguish 'red' from 'green', and the subjects distinguish fewer colours than the normal (euchromat); hence they may be spoken of as hypochromats. It is very difficult to compare the sensations of such cases with those of a normal person, but they are frequently described as having blue-yellow vision. Another way of expressing the fact is to say that in the spectrum they distinguish blue from not blue, whereas the normal person subdivides the not blue into red and green. As 'yellow' occupies the region between 'red' and 'green', the defect is most noticeable in the 'yellow' region of the spectrum, especially in the milder degrees of the defect.

Part of the evidence for these statements is that analysis of the mistakes made by hypochromats are all explained by a failure to distinguish red from green. Further evidence is furnished by observations on colour discrimination.

By measuring the difference in wave-length necessary to cause a difference in colour, it is found that normal people have two main maxima of discrimination where a difference in colour is recognised for a minimal change in wave-length. These maxima of discrimination probably indicate where there is a most rapid change in the ratio of stimulation of two different types of receptor organs. The hypochromat shows only one maximum of discrimination, thus suggesting that he has only two types of receptor organs.

In extreme degrees of this defect, the whole range of colours can be reproduced for these people by fusion of light from two regions of the spectrum.

The normal maxima are in the 'yellow' and 'blue-green' of the spectrum, whilst the hypochromat has only one maximum, that in the 'blue-green'. It appears as if the distinction on each side of the yellow had been diminished or lost: hence the failure to distinguish 'red' from 'green', and the whole not blue portion of the spectrum appears more or less of one colour. The bearing of this on any theory of vision is that we must be able to explain how the distinction between red and green can disappear, yet without marked decrease in the visibility of any portion of the spectrum. The threshold for light is not necessarily altered, and it is possible for hypochromats to see clearly through a filter which allows only the red end of the spectrum to pass through. In fact, a hypochromat who cannot see red geraniums amongst the green leaves can distinguish the flowers as light objects against a dark background when looking through a red glass filter.

THEORIES OF COLOUR VISION

In order to explain the phenomena of colour vision, it seems that it is necessary to have three groups of nerve fibres passing to the brain—one group giving rise to sensation A, a second to sensation B, and a third to sensation C. We must discover what wave-lengths stimulate A, B and C respectively, what sensations are produced by stimulation of one of these alone, and what is the effect of stimulating more than one of these, either to the same degree for each or to different ratios of response. Stimulation of the receptors may correspond to definite wave-length groups, but there may be a certain amount of rearrangement in the retinal synapses. It does not seem probable that the number of types of receptors or groups of nerve fibres can be reduced below three, if frequency of the impulses is to be related to intensity of stimulation, and if only one kind of impulse can pass up each fibre. It is like the solution of simultaneous equations: the number of equations must be at least equal to the number of unknowns to be found. That seems to be the essence of the trichromatic hypothesis as suggested by Young.

Helmholtz introduced the view that the differentiation is due to the presence of three photo-active substances which are acted on by the long, medium and short wave-lengths of the visible spectrum respectively. The range of radiation which affects these three substances overlaps so that, for example, some rays affect all three of these substances. Up to the present, there is no definite evidence for the presence of three photo-active substances; only one photo-active substance, rhodopsin or visual purple, has been found. Apart from this fact, the view of three photochemical substances such as postulated by Helmholtz does not agree with the experimental evidence. For example, in order to explain hypochromatism, it is not assumed that one photo-active substance is absent, but that the range of activity has shifted so that the one substance is activated by the range which was formerly active on the two separate substances. It does not seem likely that such a chemical transformation would occur.

Another suggestion is that put forward by Schultz (1866), namely, that there is one photochemical substance but different coloured filters to distinguish the various regions of the visible spectrum. Such filters have been found in amphibians, reptiles, birds and marsupials, but have not been found in other mammals. The coloured filters in the birds' retinae would explain the type of colour vision found in man. For example, by reducing the intensity of red pigment in the red filters the various degrees of hypochromatic vision

would be produced, but in a single human eye examined by me no such filters could be seen.

My own work leads me to suppose that the types of receptors which are stimulated by visible radiation are as follow:—

The first type of receptor is one which is stimulated by all parts of the visible spectrum and gives rise to a sensation of violet when stimulated strongly by itself. It is with some hesitation that one states that violet is due to stimulation of a single receptor, as psychologically it suggests a mixture of blue with a little red. If violet is the sensation corresponding to stimulation of one type of receptor, we must regard the unitary sensation of blue as due to stimulation of the receptors for green and violet. It may be that blue is the sensation due to stimulation of the single receptor, and that violet is the result of stimulation of the receptors which give rise to blue and to red sensations. This matter must be left in abeyance, but the use of the term 'violet receptor' is to be understood to mean either the receptor for violet or blue. Owing to the fact that fatigue to 'red' causes violet to appear more blue, Wright believes that the single receptor gives rise to a sensation of blue.

The evidence for the first part of the above statement is the same as that which caused Hering to speak of a white-black substance and von Kries to describe a bluish-white sensation as due to stimulation of the receptors for achromatic scotopic vision: these usually being regarded as the rods.

The evidence for the second part of the above statement is first of all that a narrow beam of any wave-length when shining slightly eccentrically gives rise to a violet sensation. This has been called secondary excitation, implying that the sensation is due to stimulation of receptors by nerve impulses passing along fibres of the optic nerve. It is unlikely that such stimulation would occur, and if so, why should the sensation produced be violet? On the whole, it seems simpler to interpret it as stimulation of rods by any wave-length. Furthermore, diseases involving the rods lead to night blindness or raising the threshold of achromatic scotopic vision. If this threshold is sufficiently raised, then there is loss of vision for violet, so that the distinction between green and blue is lost. This defect is a true violet blindness, because it is accompanied by a raised threshold for the short wave-length end of the spectrum. Finally, adaptation to light conditions is accompanied by a special raising of the threshold to the short wave-length end of the spectrum. Therefore, although the point is not proved, there is much evidence in favour of violet vision being a function of the rods.

The second type of receptor is one which is concerned with the not blue aspect of vision of the hypochromat. These may be cones, of which there need be only one variety for the hypochromat.

The third type of receptor would be functional in normal vision, and it seems as if this second variety of cone were one that distinguishes red from not red, and according to the activity of this variety the stages between normal vision and complete red-green confusion can be bridged.

Therefore, normal vision may be due to a receptor which gives rise to a red sensation, one which gives rise to a blue sensation and one which gives rise to a not blue, not red sensation which, of course, corresponds to green sensation. The actual wave-lengths of radiation that stimulate the several receptors are not known. The real

difference between various hypotheses is the extent and region of the spectrum which stimulates the end-organs.

In the Young-Helmholtz hypothesis the type of receptor responsible for the sensation of red is stimulated by almost the whole of the spectrum, but most strongly by the long wave-length end. The receptors for green are stimulated by almost the whole spectrum, but most strongly by the mid-region; and those for blue are stimulated by a large extent of the spectrum, but most strongly by the short wave-length end.

'Red' light of longer wave-length than 6200 Å. is supposed to stimulate the red receptor only, whilst shorter wave-lengths will stimulate the red receptor to decreasing degrees, but the other receptors to increasing extent, hence the change of colour with wave-length.

Sources of Cheap Electric Power*

By PROF. FRANCIS G. BAILY

THE general idea of the scheme of production of electric energy proposed takes as its basis the complete linking up of all parts of Great Britain by the Grid, and the subsidiary lines fed from it or from the stations directly. All stations are connected to the Grid, and as well as supplying their local consumers, put the additional power into the Grid as required. This is the well-known main function of the Grid. It is here submitted that this leads to a different scheme of generation from that now followed, and that sources of cheap power are rendered available that previously could not be utilised economically.

The questions to be considered are: (1) The proportion of consumers who are within economic distance of a pit-head station. (2) The quantity of very cheap coal that is available. (3) The relative advantages of widely spaced large stations and more numerous small stations. (4) The opportunity offered by the Grid to bring into economical use pit-head stations at small isolated mines, power from coke-oven and blast-furnace gas and hydro-electric stations. (5) The cost of transmission of electric power as compared with the carriage of the equivalent coal by rail or ship. (6) The effect of a substantial reduction in the cost of generation on the cost of distribution, and the selling price of electric energy.

The first question to be considered is whether pit-head production will so much limit the position of the sources of supply as to involve a great distance of transmission to a large part of the population.

If a distance of forty miles be regarded as still in the neighbourhood of the coalfields, a map of the coalfields shows that most of Great Britain is within this distance. A line across Scotland from Montrose to Arrochar on Loch Long is the northern boundary, and a line from Hull to Bournemouth, and up to Taunton in Somerset, marks the southern and eastern limits. A small part of Wales is also outside. Two-thirds of the population live in the area, and if London be omitted as a special case, only one-fifth of the rest are outside. There is also a probable coalfield in Lincolnshire, which if it materialises will bring in a good part of this fifth.

To a large extent, the population has gathered round the coal pits, and there are practically no large towns, except seaports, that do not lie within easy reach. A scheme depending on nearness to coal pits will have a large field for its operations, and it will in no way act prejudicially on parts which it may not be able to benefit.

It is proposed to use the lowest grade and waste coal, and the proportion required may be up to 10 per cent of the total coal raised. If the outputs of the different areas be examined, it is found that this proportion will in all cases be adequate for the population of the area. In some areas—Durham, South Wales and part of Yorkshire—where there is much less waste coal, the quantity of coal raised is so large that not more than 2 per cent will be required, which is easily provided from waste.

WASTE COAL

The term 'waste coal' will here be used to include all coal in the seam that is not at present sold, but

* From the presidential address before Section G. (Engineering) of the British Association, delivered at Aberdeen on September 6.

is, or can be, brought to the surface; and coal of poor quality that will be profitably used in the pit-head station, instead of being extensively cleaned for sale.

Of the dirty coal that is at present raised and remains as the residue of cleaning operations, some is dumped on to waste land and some into the sea, but the greater part is burnt in the furnaces of the mine power-station. The consumption is wasteful in the extreme, for burning is the cheapest way of getting rid of the otherwise useless material. About 6 per cent of the coal raised is used to produce steam for power to work the mines, whereas in a colliery where the coal is scrupulously saved and there is little waste, it is found that the fuel required is only 1.25 per cent of the coal raised, and the quality of it is exceedingly low. Hence some 5 per cent is immediately available for other purposes if it is used economically, to which can be added what is actually thrown away. The use of coal cutters and dry-cleaning processes, which are cheap to operate but increase the proportion of waste, will be more used if this is saleable.

Summing up all these actual and prospective sources of low-grade coal, it may be estimated that if an overall price of 5s. per ton at the cleaning floors were offered, in most districts a quantity equal to 10 per cent of the coal raised would be readily obtained, with a smaller proportion in the rest, and that this would yield some 18,000,000 tons per annum, with a calorific value averaging 10,000 B.T.H.U. per lb. This is 50 per cent more than is used to produce the present output of all the generating stations.

The general scheme should permit of using the waste coal from as many pits as possible, including even small isolated mines, for they assist in supplying the Grid at points otherwise unprovided for, and reduce the distance of transmission. What the lower limit of economical pit station will be need not be elaborately discussed, for the isolated pits provide only a small part of the total coal, and their exclusion does not materially affect the available supply.

The scheme will evidently provide an important amount of cheap fuel, and will permit of power stations of a size that ensures a low figure for cost of plant and running costs, so that the low price of the fuel is not offset by any increase in cost in other directions. It is true that the stations will not be placed in the towns, and to that extent distribution costs are increased; but, on the other hand, land is cheaper, and it is being found that a station consuming many hundred tons of coal a day will compel the use of expensive remedies against sulphur and dust, so the advantages of an urban site will be sensibly diminished. Moreover, most of the large towns are not far from coal mines, and the cost of transmission will be very small.

An argument that has frequently been brought against the pit-head station is that there is little likelihood of a sufficiency of cooling water for the condensation of exhaust steam, in order to produce the high vacuum that the turbine can make use of. But the gain in efficiency due to the high vacuum is often exaggerated by failure to apply comparable conditions and to take recent improvements into account. It may be claimed that the absence of cooling water can be definitely disregarded as a disability in the use of pit-head stations.

INDUSTRIAL STEAM

Another source of cheap power may be found in the proper utilisation of industrial steam. Many industries need low-pressure steam in their processes, and use boilers working at a pressure of 50 lb. or less. There is no difficulty in producing steam at 350 lb., superheating it and passing it through steam turbines, to exhaust at the required low pressure, and the steam so delivered is in all respects as good as that produced directly from boilers, as it does not come into contact with lubricating oil. The thermal efficiency of the turbine is 100 per cent, less the small radiation losses and bearing friction, for the rejected heat of the exhaust steam is used for the other purposes, and all steam friction loss is retained as heat in the steam. If the factory electric station is connected to the Grid, even a small one may put in all its spare output, no matter how irregular that may be, provided that consumers are not too far away, and that it can supply the energy at a price which will benefit all parties.

How much power can be obtained from this source it would be laborious to ascertain. Each factory would require separate consideration, and the cost of altering existing boiler plants would be important. But the change can be introduced gradually, new factories or renewal of plant affording opportunities, until all suitable factories are absorbed into the scheme. By that time the increased demand will easily take up all the power without disturbing the other sources.

The items in the cost of a unit have of recent years been codified and separated into parts dependent on the load factor and those that are independent, together with the influence of the size of the station. The costs for a normal station of 100,000 kw. and for a pit-head station of the same size have been calculated, assuming certain conditions.

At all load factors, the reduction in cost at the pit-head station is about one-twentieth of a penny per unit. While this reduction does not look impressive when compared to the usual charges for lighting, it makes a substantial difference to the cost of the unit for domestic heating, which

is now down to 0·5*d.* in some places; and it will be shown that any lowering of cost of production is followed by a decrease in cost of distribution, so that there will be a beneficial improvement on the first economy.

COST OF TRANSMISSION

The position of generating stations brings in the cost of transmission. In the coal areas, the numerous sources of supply will on the whole reduce transmission costs, but the supply of power to outside areas depends chiefly on the cost of electric transmission, as compared with other methods.

The cost of long-distance transmission of electric energy has been much reduced by increased voltage, and by reduced cost of transformers and transforming substations. It is considerably influenced by load factor, for capital charges and wages are constant, while line losses are much reduced on low load factors. For any distance of importance, the Grid at 132,000 volts will be the usual means, and the cost of transmission, when worked out for a distance of 100 miles, is only one third of the cost of carriage by rail of the corresponding quantity of coal. For shorter distances, the proportion varies somewhat, but it is always small. Carriage by sea, if the distance is considerable and both coal pits and generating stations are near the coast, is much cheaper, and coast towns distant from the coal areas will not be affected.

In the foregoing calculations of costs, the item of local rates has been omitted, for rates vary in different districts, and a general figure is not possible. The present charge for rates on electric supply stations is very high, and they have not come under the recent reduction of rates on machinery. Roughly, the item of rates on the generating plant alone amounts to about 0·06*d.* per unit, considerably more than wages and salaries, and more than half the cost of coal, and the rates on the cables bring the charge up to 0·1*d.* It is a tax or contribution towards local expenditure, which has grown to dimensions far greater than the early years of its operation seemed to indicate. Without demanding the complete abolition of rates on these public industries, some substantial reduction may be claimed, such as one-half, amounting to 0·05*d.* per unit. If to this is added the equal sum which the cheap fuel of the pit-head station can achieve, a total reduction of 0·1*d.* is obtained. The importance of this will now be discussed.

FUTURE CONSUMPTION

The cost for generation in large steam stations is 0·25*d.* per unit at the usual load factor of 0·4,

while the selling price is at least 0·5*d.* for domestic heating, power being 0·75–1·0*d.*, and lighting threepence to sixpence. Local rates account for some of this difference, but distribution and office expenses are the chief part. Both are nearly constant expenses for a given maximum demand, and are directly reduced by a high load factor. Also the cost is decreased by a greater density of load over an area. More consumers per mile of low-tension cable merely mean more feeding points and larger high-tension mains or a higher tension, and to obtain a more nearly universal demand and a larger demand per house is simply a matter of reduction of selling price, while they will themselves help greatly to reduce the cost further, if the process can once be started.

There are, as comparatively little developed directions for new demand, the fields of domestic heating of all kinds and electrification of railways. In these a successful competition with other methods depends largely on cost. Electric cooking, hot-water supply, and house-warming must be brought down to a figure not greatly exceeding that involved in the consumption of raw coal, if anything like a general adoption is to be brought about. A figure of one halfpenny begins to be persuasive, but above that the added convenience does not outweigh the cost in the view of most people, and even that figure only meets the competition of gas on equal terms, if the price of gas is eightpence per therm, and there are signs that this may be reduced. The possible demand is enormous, for the present consumption of domestic fuel is some forty million tons per annum, more than three times the whole of the coal used in electric supply for all purposes. Owing to the large losses of energy in the steam engine, with boiler losses and transmission, at the best only 20 per cent of the total heat in the coal burnt is delivered to the consumer. The domestic fireplace has a rather better efficiency, but it is not used so economically, so on the whole the amount of coal used will be much the same. The station uses a cheaper fuel, but loses on the cost of distribution. As domestic heating yields a high load factor, and offers scope for a high density factor, it will help greatly in lowering distribution costs.

The railways offer a large, though not so large, a field. This was explored by Lord Weir's committee of 1931, and the finding was favourable. The price of electric energy was taken at 0·5*d.* per unit, and at that figure the electric power came out at little less than the cost of present methods. Since then, locomotive designers have not been idle, and coal consumption has been reduced in the latest patterns, so that a substantial reduction on the halfpenny will be required. This should be quite possible, for the price that was assumed was

on the safe side and could be reduced to-day, and the further reductions indicated in this paper will bring the question to a practical proposition. The complete electrification was estimated to require a consumption of 5,400 million units, but probably a good many branch lines would not be electrified, and a total of 4,000 million may suffice. It is not a great addition to the total load, which was close on 16,000 millions last year, but it is a desirable increase, as it will have a good load factor and can be easily provided, for railways and population go together.

There are signs that a low price will bring in large consumers in the metallurgical industries. The use of electric furnaces is rapidly increasing, and below 0.5d. the private plant has little chance of competing, if complete reliability is to be ensured. The possible magnitude of this load it would be futile to estimate, but it will be considerable and will have an excellent load factor.

From the foregoing, it is evident that the electric supply industry can be put on the road to a substantial and even to a great increase, and that the new business will materially improve the load factor and reduce costs of distribution. The use of cheap fuel, and an alleviation of the burden of rates, will give the initial stimulus that is needed, and the great increase will automatically recoup the apparent loss to the rate fund of the local authorities.

To sum up the main theme, the Grid and the branch lines should operate not only as distributors of power to the consumer, wherever he may live, but also as collectors of power wherever it may be obtained, and like all successful middlemen, it should buy in the cheapest market and put the consumer into connexion with the nearest pro-

ducer, whether small or large. The small producer, in other goods as well as electricity, may show very low costs of production, but fail to find a steady market. The Grid can offer such a market, and while it has no warehouse or other means of storage, it can harmonise the consumer and producer by varying the output of the large stations, which will work on the principle of keeping up the pressure at distribution centres, and the current will flow naturally to where it is demanded. The stations will gradually be placed where their costs are lowest, and the pit-heads and coal-cleaning floors will be their natural sites for the greater part of Great Britain. The economies thus made possible will attract consumers that are at present in doubt, and a great increase will ensue.

The question of the ownership of these large pit-head stations will require consideration. Several solutions are possible, but for all of them it is essential that there shall be co-operation between the producers of coal and the producers of electricity. The one party must be assured of a steady sale of their cheap fuel, that they may be willing to remodel their business to suit the new outlet; the other party must be assured of a steady low price, that they may not be exploited after they have given hostages by large expenditure on the new stations. It seems a suitable case for a central control, as without guarantees neither party would be wise to commit themselves, though the advantages to both seem fairly certain and considerable. A proposal of such wholesale common action would have seemed impracticable ten years ago; but we are becoming used to central boards, and the Coal Board and the Electricity Board are already in being for the purpose.

Aberdeen Meeting of the British Association

NOW that the 1934 meeting of the Association has come and gone, it is possible to give some account of matters which were of general interest to the members. That it has been an unqualified success is the opinion of the chief officials of the Association, other members, and the public generally. The proceedings of the Association commenced with the president's address in the Capitol buildings on Wednesday evening, which upwards of 2,300 attended. The building provided was an ideal setting for a memorable opening address.

The two evening discourses were held in the MacRobert Hall, a building which holds about 800 persons, and on both occasions the Hall was well filled. The speakers were Sir Frank Smith, who delivered the Hardy Memorial Lecture, and Prof. W. L. Bragg, and the audience at the close showed their evident appreciation.

The attendance at sectional meetings was almost without exception good, and, in some cases, more persons wished to hear particular papers than could be accommodated comfortably. On the whole, the programmes provided in the sections appear to have satisfied the demands both of the more strictly scientific members and of the general public. The accommodation provided for the meetings of sections was in every way convenient and satisfactory, as also the arrangements for mid-day meals and other refreshments in proximity to the sectional meeting-places.

Most sections had a very full programme of excursions, of which every advantage was taken. Particular notice should be taken of the Telford Exhibition housed in proximity to the Engineering Section, which was so well patronised that it was arranged to continue the exhibition until the end of the second week. A practical demonstration on

a steep gradient adjoining the City of the "B.A." noise-silencer was carried out under ideal conditions and was well attended. The river-gauging demonstration some miles up the River Dee proved of interest to a large number of members. An excursion of unique interest arranged by Section A in conjunction with the Deeside Field Club was the excursion to Inverey, near Braemar, for the unveiling of the monument to Johann von Lamont. The president in his official capacity attended, and the unveiling ceremony was performed by Princess Arthur of Connaught. In all, thirty-six excursions of archaeological, biological, engineering and geological interest were arranged before the meeting, and some enthusiastic members have arranged for certain post-meeting excursions.

By kind permission of the owners, a number of works in Aberdeen and district was available for inspection by members of the Association. Each of the excursions to these works was fully booked and, in one case, so popular was the excursion that three additional visits had to be arranged. The different research institutes in the neighbourhood—Craibstone Experimental Farm, Macaulay Soil Research Institute, Rowett Research Institute, and the Fishery Board for Scotland's Marine Laboratory and the Research Station of the Department of Scientific and Industrial Research—were visited by the members of the sections interested in their respective activities as well as by other members of the Association. The Fishery Board for Scotland also generously placed its vessel, the *Explorer*, at the disposal of the local committee for demonstrations, and the vessel, which was berthed in Aberdeen Harbour during the week, was visited extensively. Five hundred members, in organised excursions, visited the Aberdeen Fish Market at 8 A.M. on two mornings; and, in addition, the various Corporation departments, particularly the municipal hospitals, attracted the attention of not a few visiting members.

A very full programme of general excursions had been arranged for the Saturday of the meeting, and the longer excursions proved to be very popular. The longest excursion, namely, the

Highland excursion to Inverness, through the Grampians, up the valley of the Spey and homewards by the coast, was booked to its full capacity, and all who took advantage of it were loud in their praises of the provision that had been made for their entertainment at Clava Cairns, Culloden and at Inverness. The Deeside excursion was also well attended and proved interesting to the members of the Association who had selected that excursion. Excursions of somewhat smaller dimensions went to Elgin, the Mearns and Donside. The different excursion parties were favoured with splendid weather, which added in no little measure to their enjoyment and appreciation.

Very ample arrangements were made for the entertainment of the Association by the City and the University. Particular mention should be made of the reception in the Art Gallery and adjoining buildings on the Thursday evening, the luncheon given by the Public Library to a number of the members on September 6, and the garden party in the grounds of King's College on September 11. These were highly appreciated.

On the Sunday of the meeting, an official service attended by the chief office bearers of the Association was held in the West Church of St. Nicholas, when the Principal of the University preached to a very large congregation.

During the meeting, some of the more striking buildings of Aberdeen were flood-lit. Particular mention should be made of the flood-lighting of King's College by gas, as visiting members and others were agreed that it was the most effective and beautiful of the whole range.

The students of the University contributed to the entertainment of the members by having a performance of "Town and Gown" at His Majesty's Theatre during the second half of the meeting. On the special night set aside for members of the Association, the house was packed and the audience showed every sign of appreciation of a fine cavalcade of the history of the City and University. The wind-up of the Association's social activities was a dance in the Beach Ballroom which took place on September 11, after the theatre, and was attended by upwards of seven hundred people.

Obituary

SIR THOMAS MUIR, C.M.G., F.R.S.

SIR THOMAS MUIR, who died at Rondebosch, South Africa, on March 21, 1934, was born on August 25, 1844, at Stonebyres, Lanarkshire, and educated at Wishaw public school and the University of Glasgow. Muir showed equal ability at classics and mathematics, but was persuaded by Kelvin (who influenced him profoundly) to devote himself to the latter.

After holding a small post at the University of St. Andrews and spending some time in Continental travel, Muir was appointed in 1871 to an assistant lectureship in Glasgow, and in 1874 to be chief mathematical and science master in the Glasgow High School, where for eighteen years he taught with notable success. His powers of organisation attracted the attention of Mr. Cecil Rhodes, then Premier of the Cape Colony, and eventually Muir was elected

to be superintendent general of education at the Cape. He reached South Africa in May 1892, and with the enthusiasm of a pioneer pulled together a loose educational system into a systematic whole. He served with conspicuous success until he retired in 1915, having left behind him a broad and liberal spirit in the Cape educational system.

Muir initiated three educational reforms. First he abolished the elementary examination in the schools and improved the curriculum by the addition of domestic economy, woodwork and drawing. Secondly, he encouraged the teaching of science, which at first he found to be almost non-existent. Thirdly, he made substantial improvement in the conditions for the training of teachers. He paid careful attention to the erection of properly equipped training institutions and schools. As a friend has lately remarked, "To whatever little village you go, you will find there no better building than the school."

With unstinted singleness of purpose Muir devoted his leisure, during and after official duties, to mathematics: and his writings upon determinants have already become classical. His first book, the "Treatise on the Theory of Determinants" (Macmillan), appeared in 1882, and a second in 1890. These were followed by the well-known four-volume "History of Determinants" (vol. 1, 1906; 2, 1911; 3, 1920; 4, 1923) together with a supplementary fifth volume (Blackie, 1929). The "History" has recorded with almost complete success the name, place and contents of every published book, thesis and note upon determinants from the earliest records up to date 1920. A sixth volume running to the year 1940 was actually in preparation. In the hands of most compilers such a work could be valuable perhaps but certainly dull. Muir, who had considerable literary and poetic gifts, made it positively gay! Forty-nine years separate the date of the first list

of writings on determinants from the publication of vol. 5.

Altogether Muir wrote 307 mathematical papers. He rendered notable service by making accessible to all mathematicians the pioneering work in algebra of Laplace, Bezout, Cauchy, Schweins, Jacobi, Reiss, Bazin, Sylvester and Cayley. By his artistic sense of form, his use of a telling notation and of judicious commentary, Muir moulded countless isolated and overlapping propositions into a convincing whole. He showed his greatness not in intuitive discoveries but in his eminent reasonableness. He reaches through his books a wide mathematical public, and has taken an essential part in the algebraic discoveries associated more particularly with Edinburgh, where so much of his work has been published.

Muir was a fellow of the Royal Society of Edinburgh, later receiving the Keith Prize (1884, 1899) and the Gunning-Victoria Prize (1916). He was an early president of the Edinburgh Mathematical Society, and an honorary graduate of Glasgow (1882) and of the University of the Cape of Good Hope (1901), where he was Vice-Chancellor. In 1892 he became a fellow of the Royal Geographical Society, and in 1900 he was elected a fellow of the Royal Society. He was made C.M.G. in 1901 and knighted in 1915.

Muir had wonderful health. From sixty to eighty-four years of age he played tennis, and later took exercise by sawing wood. He had a gentle kindly manner, a quick smile and a keen sense of humour. He loved flowers, was a scholarly musician, and had a fine literary sense. To the end, he preserved an unclouded brain and an acute and investigating spirit. By a deed of gift, Muir has bequeathed his wonderful library of mathematical books and serials to the Public Library of South Africa.

In 1876, he married Margaret Bell, of Dumbartonshire, who predeceased him by many years. He is survived by three generations. H. W. T.

News and Views

America and Trade Prospects

DISCUSSING the effect of American recovery on trade prospects at a luncheon arranged by the Aberdeen Chamber of Commerce on September 10 during the recent meeting of the British Association, Sir Josiah Stamp stated that the influence of a larger volume of American prosperity upon British trade would be chiefly through the stimulus of rising gold prices and lower value of gold, a revival of foreign trade, payment of debt through easier imports and a readiness to organise for an international standard of value. America could take the lead in reversing every one of the chief heresies at present throttling the world's prosperity. Unfortunately, a new phase of weakness has shown itself recently in American business activity, though in Great Britain a slight but distinct improvement has taken place since June last. In America, all the elements of which confidence can take advantage are now provided, though many

new features have been introduced which confidence has to surmount, and confidence is slow in coming. The complex situation in America may be classed under three heads, (1) salvage and desperate relief efforts after the disasters of 1933, (2) steady application of recognised or new remedies for recovery and (3) long run provision for a new industrial order. The first stage is now becoming less important, and therefore the measures taken under the three heads, hitherto contrary and mutually antagonistic, ought less and less to be so and more and more to emerge with the second dominant. It is impossible, however, to press on the provisions for a new order, before trade under any order at all is strong enough to stand it. Meanwhile, our own trade revival is testing the limits of domestic trade, and if a general increase in export trades does not reinforce it, further extension can only be obtained with increasing difficulty.

Hydro-Electric Power Development in Scotland

A PAPER on "Scottish Hydro-Electric Stations" by Mr. W. T. Halcrow, read on September 12 before Section G (Engineering) of the British Association at Aberdeen, provides an interesting account of the present state and future potentialities of hydro-electric power development in Scotland. Mr. Halcrow, whose paper appears in *Engineering* of September 14, commences by quoting from the final report (1921) of the Water Power Resources Committee the estimates of power available in the British Isles, which assign to Scotland 217,965 kw., to Ireland 113,000 kw., and to England and Wales 56,340 kw., making a total of 387,305 kw. of continuous output. These figures, being based on preliminary studies and imperfect information, will probably be considerably exceeded in actual realisation. A brief summary is given of the principal developments in Scotland at the present date, in which it is shown that schemes in operation or under construction amount to 169,700 kw. and proposed schemes to 155,600 kw., making a total of 325,300 kw. It is pointed out that in the Highlands there is a large number of lochs up to 1,200 ft. above sea-level, most of which can be readily adapted as storage reservoirs, and this fact, coupled with the suitability of the topographical features and the high average annual rainfall, makes this part of the country eminently suitable for the development of water-power.

THERE are three main types of water-power development in Scotland: (1) those with a fully regulated flow from the catchment area, giving a continuous output at 90-100 per cent load factor, and generally supplying power to a factory employing electro-metallurgical or other continuous process; (2) those with a fully regulated flow, but working on a much lower load factor, and used for supplying power for general purposes; and (3) those with a partially regulated flow, and having little or no storage. These three types have separate and distinct characteristics, and examples of each are cited, including in the first class the Lochaber installation with the realisation of which Mr. Halcrow and his firm have been associated. There is, finally, a brief consideration of the relative advantages of steam and water-power stations, from which Mr. Halcrow concludes that "notwithstanding the handicap of heavy initial expenditure, it is found that the cost per unit generated by water is less than by steam in stations of similar capacity".

Daylight Meteor

ON September 14 at about a quarter to four in the afternoon, a meteor was seen by a number of observers in the south and east of England. Perhaps the most accurate report is that given by Mr. Cullen, of the staff of the Royal Observatory at Greenwich, who went out into the courtyard to read the thermometers after observing the transit of Arcturus, the afternoon being a very clear one with a bright blue sky and sunshine. Mr. Cullen's attention was attracted by a bright object rocket-like in appearance, leaving a trail

and having a very bright nucleus. The object descended at an angle of about 40° to the horizon: it was seen over an arc of from 15° to 20° , and lasted two or three seconds. The meteor disappeared as if exploding into two bright objects, but no noise was heard. The approximate position of disappearance was R.A. 19 hr. 0 min., Dec. 0° . While Mr. Cullen considers this position rough, there can be no doubt whatever about the observer's longitude and his latitude is tolerably well known. The approximate sidereal time of the phenomenon was 14h. 17m. 5s. The area over which the object was seen seems to have extended to Cromer in the north, the Isle of Wight in the south, and Weston-super-Mare and Kent on the west and east respectively.

Archæological Finds from Egypt and Samaria

Two exhibitions illustrating the results of the past season's excavations at Tell el-Amarna on behalf of the Egypt Exploration Society, and at Samaria for the Palestine Exploration Fund and other bodies, are being held at the rooms of the Palestine Exploration Fund, 2 Hinde Street, Manchester Square, London, W, on September 17-October 13. Among the exhibits from Tell el-Amarna are perspective views of the Great Temple, upon the exploration of which the expedition has been engaged recently. They have been constructed on the basis of the remains of the temple as they have now been revealed, and show the position of the votive tables and other arrangements of the temple. A remarkable sculptured sandstone head, life-like in quality, is believed to be a representation of Smenkhkara, co-regent with Akenaton. From the police head-quarters of the city come a large number of antiquities, including amulets and rings of glazed glass paste, clay moulds from which jewellery was made and numerous fragments of inscribed wine-jars. From the 'record office', clay tablets inscribed in Babylonian cuneiform and a list of scribes were obtained. The exhibition includes minutely accurate copies on ivory of the Tutankhamen jewellery by Mrs. Winifred Brunton and paintings by Miss A. M. Calverley and Miss M. F. Broome of the reliefs, paintings and inscriptions of the tomb of Seti I, showing the progress of the great undertaking of the complete record of material of this tomb which is being carried out by the Society in co-operation with the Oriental Institute of Chicago and with the financial assistance of Mr. John D. Rockefeller, Jr.

THE exploration of the city of Samaria, a joint undertaking in which Palestine, the United States and Great Britain are participating, has now been in progress for three years. Among the more important discoveries have been the Temple of Herod, contemporary with Augustus, and part of a building of the 9-8th century B.C., which is believed to be Ahab's 'House of Ivory'. Among recent finds from the latter are a number of cosmetic jars, some of which still show the smear of paint, green and blue. A further addition is made to the remarkable collection of inlay ivory carvings characteristic of the site at this period, which is now of particular interest in view of

the recent discovery at Tell Duweir of an earlier manifestation of a similar school of artistic production. Among the subjects here represented are Egyptian gods, cherubim, the winged sphinx, palms and lilies. In addition to the antiquities, a large series of photographs is shown, which gives a comprehensive view of the chronological range and the extent of the excavations, as well as of the character of the objects found.

New Aeroplane for England to Melbourne Race

THE first flights of a new racing monoplane, known as the *Comet*, designed and built by Messrs. De Havilland for the England to Melbourne race, have just taken place at Hatfield. These preliminary trials were successful, and there is every reason to believe that the machine will be ready for its official airworthiness tests in what is probably a record time, the decision to produce the machine having been made only in January last. Three machines of the type have been built, all of which are entered for the race. The most outstanding feature of the design is the thin tapering wing, in which all the shear stresses are taken by the wooden skin covering. This idea is not entirely new, but its use has been developed much further in this case than hitherto. The wing, entirely of wood, consists of one main girder member made up with three spars, distance pieces giving a cellular construction, and an amalgamating skin of thickness varying to suit the stresses applied. A leading and trailing edge are attached to complete the aerofoil form. The two pilots are placed well behind the wing, with the main fuel tanks filling the body in front of them. A further smaller tank occupies the space behind them. Two special Gipsy Six (230 H.P.) engines are placed outboard, practically buried in the wings, with such parts as are necessarily protruding below, carefully cowled. The undercarriage legs are masked behind the engines so far as possible, and the lower portions are retracted to the same space during flight.

Sting of Hive-Bees

THE point raised by Dr. J. G. Myers, in *NATURE* of August 25, p. 290, regarding the ability of the hive-bee to withdraw its sting, is not a new one, and has elicited a letter of protest from a practical beekeeper, Mr. Z. B. H. Garrett, of Ingoldsby, Longfield, Kent. When bees are 'induced to sting' experimentally, they frequently extricate the sting as soon as the pressure or other inducement is relaxed. Naturally a bee can withdraw its sting from the soft tissues of, say, a wax-moth larva more easily than from the thumb of the experimenter. Another point which is generally overlooked is the age of the stinging bee. Up to three days or more after emergence, young bees can scarcely be persuaded to use their stings. The typical stinging age, as was first shown by Rösch, is towards the end of the period of domestic duties, and on the eve of the outdoor foraging period. It is reasonable to surmise that the sting glands reach their maximum development at this period of the bee's life, just as the lateral pharyngeal glands do at

a somewhat earlier stage—possibly to atrophy, as do the latter with advancing age. The stings received by the beekeeper as one of the hazards of his calling are given with a will by the guard bees, which are physiologically ripe for the job. Such bees make for the eyelids, nose, or the back of the neck, and seldom attempt to remove their stings, though the beekeeper should make a point of doing so, without squeezing the venom sac, at the earliest opportunity. It is otherwise with those bees that crawl up the sleeves or trouser legs. These have no *malice prepense*, and do not use their stings until they find themselves trapped by the pressure of the clothing or nervous movements on the part of the beekeeper. Such bees, if undamaged and given time, can often withdraw their stings and be coaxed out towards the light.

Mechanical Weather Forecasting

"DR. CURRY'S weather prophet" is an attractive aluminium instrument, light in weight, circular in shape, and thin enough to go easily into the pocket, which is being marketed in England by W. B. M. Unland, 72 Leadenhall Street, London, E.C.3. The face of the disc is adorned with a ring of coloured slips, ranging from a deep mystical blue, like the blue of the sky seen from a high mountain, through violet to a pinkish hue. In the centre of the disc is a tiny, restless compass. The tale of magic is not yet done: there are two little fairy casements. Through one, when the stage is set, can be seen a letter telling of the direction of the wind, and through the other, Dr. Curry's weather prediction in plain black print, an austere definite pronouncement. According to an experienced motor salesman, the public estimates the value of a motor-car by the array of instruments on the dashboard. Dr. Curry, or if not Dr. Curry, then the instrument designer who has given his idea practical shape, is evidently an equally profound student of ill-informed, would-be-expert humanity. Here is an instrument of character and charm which makes the more expensive forecasting aneroid barometer look as though it should cost far less. The price is 6s. 9d., and for an extra shilling the weather wisdom of the aneroid is 'thrown in' by a simple device. If mass production could bring the price even lower it might take even the South Sea Islands by storm, not because it is a praiseworthy attempt to get automatically a useful forecast from the observed direction of the wind and the relative humidity as shown by the hue of a chemically-treated slip, but because it is impossible for any human being to see one without being impelled to find out what it is all about.

Pulpwood for Paper in the United States

A LARGE amount of American capital has been employed for building newsprint mills in Canada. Recently, attention has been directed to the great pine forests in the Southern States and their suitability for making pulp for newsprint is being investigated. In the *Scientific American* of May, 1934, an interesting account is given by Dr. Herty of what is being done in this direction. It is pointed out that

the South Atlantic and Gulf States have within their borders more than a hundred million acres of 'cut-over' lands and more than twenty-five million acres of abandoned farm lands. Despite the carelessness of owners, magnificent forests of yellow heart pine trees have sprung up. If this wood is suitable for making pulp, then the whole needs of the United States, and in addition a flourishing export trade, could be maintained from this supply. A laboratory has been built in Savannah, and investigations on a commercial scale have been made. From the colour point of view, early experiments showed that the pulp was as good as that made from spruce in the northern mills. Later on, evidence of blue stain appeared on some of the samples and experiments were made to overcome this. It was discovered that logs left with the bark on them for three weeks showed no sign of stain (or fungus growth). The wood was therefore pulped and ground within three weeks after it had been cut. The quality of the printed paper made from it gave every satisfaction. It had a marked velvety feel, required little ink for printing and was more pliable than the average newsprint. While this work is being carried on in the laboratory, reforestation with young pine trees is proceeding at a rapid rate in Georgia.

The Load-Dispatcher

IN the early days of electricity supply, the chief engineer of the station was in charge at the main switchboard. To this, all the generators and the supply mains were connected. The engineer was responsible not only for the condition of the machines, but also for putting them into operation at the right times so as to obtain the maximum economy. Now that many stations of very different types are linked together, a suitable staff and a 'load-dispatching' plant are necessary in order to run the system economically. The office and plant may be part of one of the stations or may be quite separate. A paper on this subject was read by Dr. Sleicher to the Institution of Electrical Engineers on May 3. He gave an account of modern practice in Germany and in other European countries of the supervisory control systems as applied to large interconnected supply areas. He showed how important the work of the load-dispatchers is to the prosperity of the undertaking. They must know the right number of machines to be started and the time required to start them. In the Berlin municipal works, for example, the period of preparation from the moment of the order of starting until the opening of the stop valve is from 8 to 35 minutes. The time from the opening of the valve until full speed is attained is from 15 to 90 minutes according to the size of the turbines. The time for the synchronising and switching on to the system is very short in comparison with the starting-up period. A sudden demand for power cannot be met by turbines. When surplus water-power is available it is most useful when peak loads have to be carried. Eleven pumping stations are already in use in Germany for this purpose.

Wind Tunnels for Aeronautical Research

THE Aeronautical Research Committee's "Reports and Memoranda No. 1569" (H.M. Stationery Office. 1s. net), recently issued, gives a description of the new open jet wind tunnel at the National Physical Laboratory, and also describes the preliminary model experiments carried out in order to ensure the most efficient aerodynamic performance from the actual tunnel. The results are a striking vindication of the exponents of the use of the principles of dynamical similarity in comparing the behaviour of objects of similar form but varying sizes. These principles offer a convenient, and often the only possible, way of investigating questions in aircraft design and aerodynamic problems generally. Two model tunnels were made, the second based upon experience with the first—and also the compressed air tunnel—in matters of the shape of the ducts, shape and positions of guide vanes at the corners, design of air screws, etc. The power factor of the models was subject to a large scale effect. At the jet speed mainly used during the experimental work, namely, 50 ft./sec., the power factor was 1.8. The variation with Reynolds's number indicated that a full-scale power factor of about 2.6 might be expected. The full-scale tunnel now completed has exactly equalled expectations. The distribution of velocity in the jet is as good as was anticipated, and the power factor has the predicted value of 2.6. The elliptical nozzle of the tunnel has a horizontal major axis measuring 9 ft. 1½ in., and a minor axis of 7 ft. 0 in., and an input of 375 B.H.P. at the air-screw yields an airspeed of about 210 ft./sec. in the jet. The final model is being used for further small-scale research.

Problems in Deep-Level Mining

THE Association of Mine Managers of the Transvaal (Johannesburg) has just issued an interesting volume entitled "Some Aspects of Deep Level Mining on the Witwatersrand Gold Mines with Special Reference to Rock Bursts". The volume contains six papers by leading practical authorities on Witwatersrand mining, together with the discussions of these papers and an appendix specifically dealing with rock bursts. In spite of the title, rock bursts are not discussed in all the papers submitted; thus, in the very first paper, dealing with mining on the Robinson Deep Mine, is the following statement with regard to rock bursts: "This is a subject of such importance that a detailed discussion of same is outside the scope of these notes". The other papers, however, deal with rock bursts at considerable length, although some of them confine their attention mainly to a class of rock bursts which are called "pressure bursts"; these are defined as follows by Mr. R. E. Mickel, the underground manager of the Durban-Roodepoort Deep Mine: "this type of burst includes bursts in the mined out areas, except punch bursts, and bursts on faces where the solid is not completely destroyed"; apparently this definition is accepted by everybody, but there seems to be a general feeling that that particular variety of rock burst which is known as a

pressure burst is fairly well understood by those who have to deal with these very dangerous phenomena. One short paper deals with "Rock Bursts Prevention", but it would seem that the author has not really succeeded in preventing these serious accidents. The volume may be strongly recommended to all interested in deep-level mining problems.

Missions in New Spain

INTEREST inspired by the archæology of Mexico and Central America is apt to divert attention from the study of the Indians themselves who lived in these regions, and the effect on them of the clash of cultures which arose out of the Spanish conquest, both at the time and in their subsequent history. It is, in fact, only comparatively recently that it has been realised that the customs and beliefs of the Indian of to-day present an unrivalled field for the study of syncretism in culture and religion. The possibilities of such study are suggested, for example, by a recent publication of the Institut d'Ethnologie of Paris, "La Conquête spirituelle du Mexique", by M. Robert Ricard (*Trav. et Mem.*, 20), in which it is remarked that the failure of the Church to establish a native priesthood as part of the campaign of Christianisation has never ceased to affect the course of history in the country down to this day by segregating the native population, even though the Spaniards were never affected by the colour-line in the accepted sense. M. Ricard's able study of the Catholic missions in Mexico from 1523-4 until 1572, that is, from the first arrival of the mendicant friars, after the conquest of Cortez, down to the arrival of the Jesuits, is based on a careful study of early records. It has, as one side of the picture, the culture of the Indians whom the friars sought to convert, as seen through the eyes of writers such as Sahagun, who recorded native customs for the instruction of those whose duties called them to the work. M. Ricard's researches have placed the early work of the Church in a more correct perspective than has hitherto been possible.

Studies of American Social Areas

THE thoroughness and detail with which American investigators carry out their inquiries is well exemplified in a series of bulletins recently published by Cornell University Agricultural Experiment Station, dealing with the social and economic characteristics of various counties in New York State. In one of these bulletins written by Mr. H. C. Hoff-sommer and entitled "Relation of Cities and Larger Villages to Changes in Rural Trade and Social Areas in Wayne County, New York", it is explained that the villages with a population of 500 persons or less have suffered severely from the competition of the larger villages. The smaller villages, however, have maintained their status better socially than economically, and it is interesting to note that the average distance travelled is shortest for church attendance and greatest for the purchase of women's dresses. The data show that social life at present is carried on in relatively small areas. That it will always be

so does not follow, and a trend towards the uniting of small social areas into larger ones is evident. But the expansion of the social areas has been much less marked than that of commercial areas. This leads to the conclusion that although churches, schools, and other social and educational agencies may unite for better and more effective work, the areas which they can effectively serve will remain relatively small as compared to those of the more specialised economic services.

Showers of Fish

FOR more than two thousand years, occasional showers of fish are said to have occurred in various parts of the world, but especially in India, in stormy, or at least showery, weather. In the *Journal of the Asiatic Society of Bengal* (29, No. 1; 1933), Dr. Sunder Lal Hora discusses Indian examples of the phenomenon, and gives references to papers dealing with these, some of which appeared more than a century ago. He also considers various explanations that have been advanced, and obviously inclines to the one according to which the fish in such a shower are sucked up from a pond or river by a waterspout and are deposited on the ground when the waterspout collapses. There is on the face of it no obvious objection to the theory, for the waterspout does sometimes occur in India, when the funnel-shaped tornado cloud that occasionally depends from a cumulo-nimbus cloud passes over any inland sheet of water. Dr. Hora's paper is followed by one by S. N. Sen, who for a number of years was on the staff of the Meteorological Office, London. Sen examines the meteorological conditions over India at the time when a recent shower of fishes was reported from the Muzaffarpur District, Bihar, on July 10, 1933, and finds that they were such as would frequently give rise to very disturbed cyclonic weather and violent thunderstorms, and that some notably heavy rains occurred on the day in question. The theory favoured by Dr. Hora remains, however, to be proved. One is tempted to think that what has generally been observed has been heavy rain and afterwards many small fish on the ground, but not a shower of fish, and that the minds of native observers of the two separate phenomena have been affected by mythological beliefs that seemed to offer an explanation of what had been observed. Dr. Hora refers to such a myth (a Hindu myth) connected with the rain-god Indra, according to which the waterspout is the trunk of one of Indra's elephants (the rain clouds are believed to be his elephants), who are engaged in sucking water up from the underworld during a storm in which the funnel cloud appears.

Forest Fires

DURING last year's drought, fires caused considerable damage in plantations in Great Britain; also to the beautiful heaths and commons which form so picturesque a feature of certain English counties. This year, apart from official statistics, the reports in the Press afford evidence that this fire damage

persists. When forest conservation was introduced into the tropical and sub-tropical portions of the British Empire, fire protection was considered to be one of the first important steps to inaugurate. The success achieved in India in this respect is well known; but, efficient and energetic as the forest service of that country showed itself in the fine system of fire protection introduced into the State forests, it would never have achieved success without vigorous official support. A Science Service Mail Report (Washington, D.C., July 30) states that owing to the drought, there has been a 66 per cent increase in forest fires for 1934 over the average of the past three years. National and State forests have, it is said, become like tinder in a great many areas, and the smallest spark is sufficient to light them. In 1933, there were 140,722 fires, the area burnt being 43,889,820 acres, the total damage being estimated by the U.S. Forest Service at 60,274,960 dollars. If the number of fires increases at the same rate as already experienced this year, the totals will exceed those of 1933. Attention is directed to the fact that a sum of 75,000,000 dollars has recently been earmarked for the 1,300 mile shelter belt of trees extending from the Canadian border to Texas, and the work is expected to continue for ten years. A comparison of the annual expenditure on this new forest belt with the destructive losses from forest fires shows that eight times the money spent each year for the next decade on planting trees would barely equal the value of the loss by fire in 1933.

Field Museum of Chicago

THE Field Museum of Natural History, one of the most progressive in the world, has suffered from the adverse financial conditions of the times, which have brought about declines in the value of securities held in endowment funds and reduction in income from endowments, contributions and memberships. Schemes of expenditure have had to be very much curtailed and economies enforced, but the result has been a gratifying reduction of the deficit carried forward from the previous year. Part of the success was due to the influx of visitors to Chicago for the Century of Progress Exposition, for the museum visitors for 1933 numbered 3,269,390, an annual attendance exceeding that ever attained by any museum in the United States, and probably a high record for the world. The growing fame of the Field Museum has something to do with its success. Consider the two major exhibits opened to the public in 1933: one, the Chauncey Keep Memorial Hall containing sculptures representing the principal races of mankind, and the Hall of the Stone Age of the Old World, with its restorations of types of prehistoric men and phases of their cultures. Both these new halls are unique—no other institution has exhibits illustrating these subjects on the scale of the Field Museum. In the zoology halls there were added natural groups of African lions, gaurs or seladangs of Asia, Florida manatees, orang-utans, bowerbirds, and many series not treated as natural groups. Expeditions and field work had to be avoided

except where they were financed by special funds contributed for the purpose; even so, zoological collecting was carried on in Guadalupe Island, in Guatemala and in West Africa, fossil collecting in Colorado and the eastern States, and archaeological excavations on the site of the Lowry ruin in south-western Colorado.

Agriculture in New Zealand

IN opening the annual Dominion Conference of the New Zealand Farmer's Union at Wellington, Lord Bledisloe, the Governor-General, reviewed some of the current problems of the agricultural industry. After expressing the view that in no other country has the farmer brighter prospects, he urged the need for 'planning' control if economic success is to be realised. The lack of uniformity that still exists in both the dairy and cattle industries of New Zealand is preventing the extension of markets, and the elimination of second-rate produce must be effected as soon as possible. This cannot be brought about by Government intervention or control, but lies in the hands of the farmers themselves. Comparison with successful agricultural countries, such as Denmark, shows that this type of self-organisation is the most satisfactory. Speaking with reference to the cattle industry, Lord Bledisloe deplored the continuation of the embargo imposed on the importation of British livestock. The measures adopted in Great Britain for the suppression of epidemics such as foot-and-mouth disease are so drastic, he said, that the risk of introducing this complaint into New Zealand is nil. On the other hand, the loss to their cattle industry (especially in view of the present hopeful prospect of a remunerative trade in chilled beef and bacon pigs) is a very serious matter. In general, the outlook for the future is a hopeful one, but harmonious co-operation between town and country, factory and farm must be achieved if a lasting prosperity is to be assured.

Abattoir Design

A REPORT on abattoir design has recently been issued (Economic Series, No. 40. H.M. Stationery Office. Price 1s. net) by a technical committee appointed by the Ministry of Agriculture and Fisheries last December to consider the output, structure, layout and equipment of factory abattoirs. The Committee recommends that the principal characteristics of a factory abattoir should be single control, specialisation of labour, continuous process, the killing being spread fairly evenly over at least four days of the week, and a uniform condition and appearance of the finished product in place of the variations at present existing in the condition not only of the meat but also of the by-products. The Committee prefers a multi-floor factory abattoir to the single floor type found in nearly all the public abattoirs in England, on grounds both of hygiene and economy. It is recommended that in order to raise the general level of the condition of home-killed meat, all the meat and red offals should be adequately cooled before removal. Provision should also be made for

the production of dripping, sausages, skins, tripe and calves' feet, tallow, meat meal, blood manure, and animal glands for medicinal purposes. In conclusion, the Committee suggests that the difficulties of adjusting the slaughtering charges and the prices of by-products retained at the abattoir for processing might be minimised by leasing the abattoirs to slaughtering and by-product companies or associations. The local authority would thus be relieved of the difficulty of fixing service charges and yet could reserve to itself the right of general supervision.

Generic Names of British Insects

UNDER this title, the Council of the Royal Entomological Society of London has decided to issue, in parts as completed, a work designed to promote stability in the use of scientific nomenclature as applied to the insects of Great Britain. The scheme has been entrusted to a Committee on Generic Nomenclature, under the chairmanship of Sir Guy Marshall, with the assistance of the entomologists at the British Museum (Natural History). The terms of reference involve the preparation of "lists of scientific names to be fixed as genotypes of genera of British insects with a view to the suspension where necessary of the law of priority in respect of those generic names". The separate orders of insects are being dealt with by small panels of specialists acting as sub-committees of the central committee. The first list of generic names to be published under this scheme is entitled "The Generic Names of the British Rhopalocera with a Check List of the Species" (Feb. 1934) by Mr. Francis Hemming, and is to be obtained, price 3s. 6d., from the Society at 41, Queen's Gate, S.W.7. In this publication, the authority for fixing the genotype is given in each case, followed by the chief synonyms and the accepted names of the British species, for each genus concerned. There follow, wherever necessary, notes on special questions of nomenclature that may arise. In the case of four generic names, namely, *Argynnis*, *Vanessa*, *Strymon* and *Colias*, it is contended that the strict application of the rules of nomenclature should be suspended since, otherwise, it would involve the disturbance of these long-established names to no real advantage. The whole undertaking should prove a useful guide to all entomologists and a strong incentive towards the attainment of uniformity.

Value of Experiments on Animals

THE eighth Stephen Paget Memorial Lecture of the Research Defence Society, on "Experiments on Man", delivered by Prof. J. Barcroft, appears in *The Fight against Disease*, No. 3, 1934. The question whether the results of experiments performed on animals can be regarded as being applicable to man is discussed. It is concluded that in a great many cases the relevant information can be obtained from animal experiments. In certain instances, it may be necessary to perform the experiments on man, as in the elucidation of sensation and mental performances, and in the communication of disease when animals

are unaffected by the virus. Attention is directed by the treasurer to the need for increased financial support for the Society.

Announcements

THE Trustees of Herbert Spencer have in the Press a book by Dr. J. Rumney on sociology, giving an account of the part Spencer played in founding the science, and showing to what extent his views have guided later scholars. The book will be published by Messrs. Williams and Norgate, Ltd., in the early autumn.

AT the annual general meeting of the Lister Institute of Preventive Medicine, held on May 30, the governing body presented the Institute's fortieth annual report. In addition to items concerning administration and finance, the Report gives a survey and summary of the scientific work carried out in the various departments during the year, forming a record of much valuable research. The Institute also houses the National Collection of Type Cultures, a collection of authenticated cultures of bacteria and fungi, which are available for those who may require them.

THE British Federation of University Women, Crosby Hall, Cheyne Walk, S.W.3, has issued and published a revised and enlarged second edition of "A List of International Fellowships for Research" (Price 2s.). The purpose of the book is to provide both men and women graduate students and research workers in nearly all countries with information concerning the opportunities open to them for carrying on their work in other countries by means of travelling fellowships or scholarships. Most of the fellowships listed are open equally to men and women, but those restricted to either sex are distinctively marked.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A lecturer in mining at the Chesterfield Technical College—The Clerk to the Governors, Technical College, Chesterfield (Sept. 24). A chief lecturer in electrical engineering at the West Ham Municipal College, Romford Road, Stratford, E.15—The Principal (Sept. 27). A chief veterinary officer for the North Riding of Yorkshire County Council—The Clerk to the County Council, County Hall, Northallerton, Yorks (Oct. 1). A resident tutor in physics and mathematics at Borough Road College, Isleworth, Middlesex—The Principal. An assistant lecturer in education (especially in science subjects) at University College, Exeter—The Registrar.

ERRATUM. By a regrettable mistake, the Hardy Memorial Lecture at Aberdeen was referred to in early issues of NATURE of September 15, p. 411, as having been delivered by Sir Frank Heath. The lecture was, of course, given by Sir Frank Smith, whose name appears correctly in later issues.

Letters to the Editor

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

Spectrum of Chlorophyll

SOME knowledge about the mechanism of 'assimilation' may probably be gleaned from a detailed picture of the atomic processes involved in the absorption of light in dissolved chlorophyll. As I have not been able to find sufficient quantitative data on this subject in the existing literature, I have made some rough measurements to this purpose.

Samples of chlorophyll *a* and *b*, kindly put at my disposal by Prof. Stoll of Basle, were dissolved in alcohol (10 mgm. in 100 c.c.). Absorption measurements were then made with a König-Martens spectrophotometer at different concentrations (10^{-4} - 10^{-5}). The results, for which no high precision is claimed, are partly shown in Fig. 1.

As is well known, both chlorophylls show a strong absorption in the red part of the spectrum accompanied by a weaker absorption in the yellow and green part. (To the right of the main peak in Fig. 1 a weaker maximum is to be seen for both chlorophyll *a* and *b*. A closer examination reveals three of these maxima for chlorophyll *a* at distances roughly 1, 2 and 3 times 1200 cm.^{-1} from the main peak, and two for chlorophyll *b* at distances 1 and 2 times 1400 cm.^{-1} . They are probably related to vibrational levels.) The whole of this absorption, extending from about $680 \text{ m}\mu$ to $500 \text{ m}\mu$, will be termed here the 'red band'. In addition, a 'blue band' is present in both cases, beginning at about $500 \text{ m}\mu$ with chlorophyll *b* and $460 \text{ m}\mu$ with chlorophyll *a*. Finally one or more 'ultra-violet bands' seem to exist. In the ultra-red one very weak band ($f < 0.002$) at 3μ has been found by D. van Gulik (*Ann. Phys.*, 46, 147; 1915). It does not necessarily belong to the same molecular group as the other bands.

We shall, in the first place, be concerned with the red band. Its 'oscillatory strength' or 'number of absorption electrons per molecule' may be calculated from the integrated absorption as follows:

$$f = \frac{mc^2\pi e^2}{N} \int d\left(\frac{1}{\lambda}\right) \frac{\log I_0/I}{\log \epsilon} = \frac{1.13 \times 10^{13}}{6.06 \times 10^{23} \times 10^{-4}/902} \int d\left(\frac{1}{\lambda}\right) \frac{\log I_0/I}{0.434};$$

where N is the number of molecules per c.c., 902 is the molecular weight of chlorophyll *a* (907 for *b*); m , c , π , e and ϵ ($=2.718$) are well-known constants. The result is $f=0.24$ for chlorophyll *a* and 0.22 for chlorophyll *b* (0.13 and 0.11 respectively for the main peak alone; from F. Perrins' measurements on the polarisation of the fluorescent radiation (*Ann. de Phys.*, 12, 169; 1929) the same value may be deduced: $f = \tau_0/3\tau = 0.126$). The values of f for the blue bands were roughly estimated to be about 0.3 or a little more.* These high numbers prove conclusively that the absorption is not due to ionic

* For comparison some rough values I have determined for other substances may be quoted: iodine in carbon disulphide (green band), 0.016 ; potassium permanganate in water, 0.05 ; oxyhaemoglobin (double peak between $600 \text{ m}\mu$ and $500 \text{ m}\mu$ only), 0.33 (see also R. A. Houston, *Proc. Roy. Soc.*, 82, 606; 1909).

movement alone but that an *electron* is lifted to a higher level too.

As the *a* and *b* spectra are not essentially different, we shall henceforward refer to them together. The whole red band (including its yellow and green tail) but not the blue or ultra-violet bands, may be produced in fluorescence by irradiating with light of a sufficiently short wave-length. The main peak alone appears when excited by light of its own wave-length ($600\text{--}680 \text{ m}\mu$ produced by filters or prism). By comparison with a mastix emulsion (assumed to scatter without true absorption) it was found that for this red light the yield (fluorescent to incident radiation) is of the order of magnitude 10 per cent; for blue light it was less.

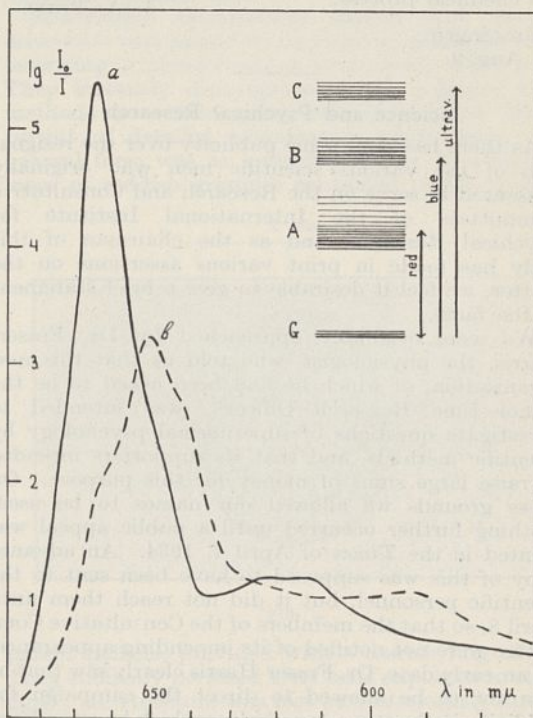


FIG. 1. 'Red' absorption band of chlorophyll *a* (full curve) and *b* (broken curve). Logarithm of incident to transmitted intensity for 1 cm. layer of 1 mgm./10 c.c. alcoholic solution. In the corner: Diagram of energy levels and transitions corresponding to absorption and fluorescence bands.

These facts may be explained by assuming a system of energy levels as indicated diagrammatically in Fig. 1. The electron may jump from its ground state *G* to at least three different higher levels, *A*, *B* and *C*. These electronic levels are further subdivided by the accompanying ionic vibrations, whilst the different 'rotational levels' are smeared out by the interaction with the surrounding medium. A further essential feature of this picture is the assumption that in state *A* the electron has only a moderate chance of losing its surplus energy without emitting radiation, for example, by collisions with the surrounding medium, so that there is a reasonable probability (10 per cent) for it to fall back with emission of light. In the higher states the converse is true. To explain this difference we may, for example, suppose that in state *A* the electron keeps more 'inside' the molecule. An alternative but less plausible explanation would be to ascribe a high probability ($f \gg 0.3$) to the transition *BA*. It would

be worth while to look for the corresponding emission band ($\lambda = 1.15 \mu$) in fluorescence.

Chlorophyll is capable of assimilation only if it is in a special state, as is the case in living plants. Mr. K. Meyer, of Zurich, informs me in a private letter that he has probably succeeded in producing solutions *without* loss of assimilating activity. At any rate it may be presumed that the active state is not *very* different from the free state. So an application and elaboration of the preceding considerations does not appear to be out of place. Slight changes in the spectrum will of course accompany the transition to the active state; especially a decrease of fluorescence yield is to be expected as the energy of state *A* is now used for the chemical process.

J. A. PRINS.

Groningen.

Aug. 9.

Science and Psychical Research

As there has been some publicity over the resignation of the various scientific men who originally consented to serve on the Research and Consultative Committees of the International Institute for Psychical Research, and as the chairman of this body has made in print various assertions on the matter, we feel it desirable to give a brief statement of the facts.

We were originally approached by Dr. Fraser-Harris, the physiologist, who told us that this new organisation, of which he had been asked to be the "whole-time Research Officer", was intended to investigate questions of supernormal psychology by scientific methods, and that its supporters intended to raise large sums of money for this purpose. On these grounds we allowed our names to be used. Nothing further occurred until a public appeal was printed in the *Times* of April 7, 1934. An advance copy of this was supposed to have been sent to the scientific personnel, but it did not reach them until April 8, so that the members of the Consultative Committee were not notified of its impending appearance. At an early date, Dr. Fraser-Harris clearly saw that he was not to be allowed to direct the campaign for publicity in the manner and place which he considered best. The appeal was couched in such terms that we felt it necessary to resign from any connexion with the Institute. Some resignations were sent in at once, others after correspondence with the Institute. The chief ground for our resignation was the wholly non-scientific attitude thus revealed, for example, the statement that the Institute would at first concentrate on making the *proof* of survival its primary object. Unwarranted attacks on other bodies concerned with psychical research also contributed; and finally the fact that no members of the scientific personnel were consulted in framing the appeal or laying down policy did not augur well for the carrying on of the Institute on a scientific basis.

We would also like to record our strong disapproval of the treatment accorded to Dr. Fraser-Harris. After ten months without any remuneration except reimbursement of postage expenses, he was offered a small sum for one year and asked to "get to work" in the séance-room of the London Spiritualist Alliance (!), no mediums or scientific apparatus being provided, much less the laboratory originally proposed. By May 28, conditions had become so impossible that he resigned, having given eleven months'

service, which interfered materially with his other work. A subsequent attack on him by the chairman of the Executive Committee of the Institute in *Psychic News* was abusive in tone, and contained a number of inaccurate statements.

We think it worth while to record these facts publicly, as they show the difficulty of scientific men collaborating with professed 'spiritualists', as were all those actively concerned with the inception of the Institute. They appear either to have no idea of what constitutes scientific method, or to have thought that they could obtain a dummy committee of scientific workers to confer scientific respectability on a propagandist enterprise. We are of the opinion that the investigation of so-called 'supernormal' phenomena is a very fruitful field for scientific research; but to secure the new knowledge we need an intelligent co-operative attitude, not only on the part of those who approach the subject from the scientific side, but also of those who approach it from the side of spiritualism (spiritism).

JULIAN S. HUXLEY.

F. C. S. SCHILLER.

E. W. MACBRIDE.

King's College,
London, W.C.2.

Determination of Dipole Moments in Solution

RECENT work on the estimation of dipole moments in solution, particularly by Müller¹ and Jenkins², has shown that, contrary to that which was formerly believed, the apparent dipole moment of a substance in solution is not independent of the non-polar solvent in which it is measured, although in the case of each solvent the polarisations of the solute are extrapolated to infinite dilution. The apparent dipole moment decreases as the dielectric constant of the solvent increases. As a further consequence of this effect, the temperature variation of the polarisation at infinite dilution in a given solvent leads to a value of the moment which is too low, since the dielectric constant of the solvent decreases as the temperature rises.

Several attempts have been made to correlate these results with the moments measured in the vapour state, and to deduce from measurements in solution, a moment which shall be independent of the solvent.

Sugden³ has shown that if measured values of the molecular polarisability P_2 in solution are plotted against the corresponding values of the volume polarisability $(\epsilon - 1)/(\epsilon + 2)$ for solutions of benzonitrile, nitrobenzene and chlorobenzene in a number of non-polar solvents, the points for each substance all lie near a straight line, the slope of which is approximately equal to $P_2\mu$, that portion of the total polarisation which is due to the permanent dipoles.

During the discussion at the symposium held by the Faraday Society at Oxford last April, I pointed out that if the formula suggested by Prof. Sugden,

$$P_{\text{liq.}} = \alpha + P_{\text{gas}} - P_2(\epsilon - 1)/(\epsilon + 2),$$

were of general applicability, then $P_{\text{liq.}} \sim (\epsilon - 1)/(\epsilon + 2)$ lines for the same solute at different temperatures would converge to a common point at $(\epsilon - 1)/(\epsilon + 2) = 1$, and that the moment could be obtained from the slopes of the lines.

There were then no data to test this. I have now measured the polarisation of nitrobenzene in solution in decane (di-isoamyl) and in *p*-xylene at concentra-

tions up to nearly 28 per cent by weight of solute and at 20° intervals from 20° to 120°.

The values of P_2 at each temperature when plotted against $(\epsilon - 1)/(\epsilon + 2)$ give straight lines which, when produced, meet at a common point at $(\epsilon - 1)/(\epsilon + 2) = 1$. The slopes of these lines yield the following moments in Debye units ($D = 1 \times 10^{-18}$ e.s.u.).

t	μ	t	μ
20°	4.30 D	80°	4.25 D
40°	4.30 „	100°	4.22 „
60°	4.25 „	120°	4.19 „

The average is 4.25 D , which is in good agreement with the value 4.23 D for the vapour recently published by Sugden and Groves⁴. These results will shortly be published and discussed in more detail elsewhere.

F. FAIRBROTHER.

The University,
Manchester.
Aug. 6.

¹ Müller, *Phys. Z.*, **33**, 732; 1932. **34**, 689; 1933. **35**, 346; 1934.
² Jenkins, *NATURE*, **133**, 106, Jan. 20, 1934. *J. Chem. Soc.*, 480; 1934.
³ Sugden, *NATURE*, **133**, 415, March 17, 1934.
⁴ Sugden and Groves, *J. Chem. Soc.*, 1094; 1934.

Cyclic Components of Paraffin Wax

CRYSTALLOGRAPHIC considerations have led Mr. Yannaquis¹ to the conclusion that some of the components of paraffin wax belong to the naphthenic series. In the course of our work on the composition of asphalts derived from paraffinous petroleum², similar conclusions were reached with regard to some fractions of wax, which had been prepared by solvent extraction from petroleum asphalts.

Successive crystallisations from pyridine and ether, followed by an ultimate crystallisation from benzene, enabled us to separate the bulk of the paraffin wax into four fractions of different melting points. Elementary analysis of those fractions, carried through most carefully, proved that there is always a certain deficiency in the hydrogen content as required by the formula $C_n H_{2n+2}$.

Fraction 1	m.p.	76° C.	C: H ratio corresponds to	$C_n H_{2n+1}$
" 2	"	63° C.	"	$C_n H_{2n}$
" 3	"	57° C.	"	$C_n H_{2n-1}$
" 4	"	50° C.	"	$C_n H_{2n-2}$

It is obvious that the first fraction is to be considered as a mixture of true paraffins with some cyclic hydrocarbons which are most probably the chief components of the remaining fractions. The iodine number being rather small and amounting to 5 only, the occurrence of cyclic hydrocarbons in undistilled paraffin wax seems to be adequately established. The decrease of the hydrogen content of the fractions is followed by an increase of the specific gravity from 0.798 at 80° C. to 0.817 at 80° C. and of the refractive index n_D^{20} from 1.4470 to 1.4558. Another fact pointing to the cyclic constitution of these hydrocarbons is the slope of the temperature-viscosity curve, which is markedly steeper in the case of fractions with a smaller hydrogen content.

J. MÜLLER.
S. PILAT.

Laboratory of Petroleum Technology,
Lwow, Poland.
Aug. 1.

¹ *Ann. Combustibles liquides*, **9**, 295; 1934.
² *Asphalt und Teer*, **32**, 708; 1932. **33**, 421; 1933.

Red 'Water-Bloom' in South African Seas

WHILE the R.R.S. *Discovery II* was refitting in Simonstown, a remarkable profusion of a red 'water-bloom' was observed in Simons Bay. The sea close inshore was strongly discoloured, large areas appeared blood-red. These were often sharply marked off from other areas in which the sea was of a more normal greenish hue. Motor-boat runs indicated that the red water extended along the greater part of the east coast of Cape Peninsula on July 15 and 16, 1934. Similar phenomena were observed during a previous commission, once early in June 1930 on entering Table Bay from the north, and on several occasions in False Bay.

Microscopic examination showed that the discoloration was caused by myriads of ciliate Protozoa, belonging to *Mesodinium* or some closely allied genus. They instantly disintegrated when ordinary fixing methods were attempted, and moved too fast to permit of detailed examination when alive. The general form was as indicated in Fig. 1, a globular mass of reddish granules contained within a trans-

c. 40 μ

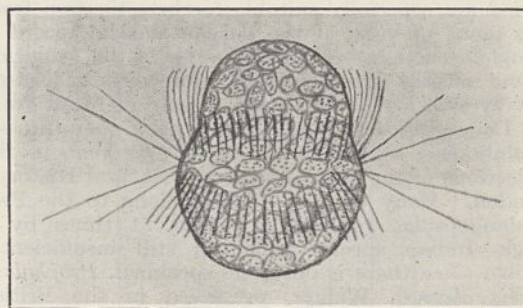


FIG. 1.

parent pellicle, provided with a double ring of cilia. They suddenly perished after brief exposure to strong light; all structure was lost instantaneously and the red granules turned yellow, and later, green. This was evidently the cause of the green scum that accumulated at the tide line all along Cape Peninsula at the time. Probably the granules are symbiotic zoochlorellae, for they appeared to maintain an independent holophytic existence for some time after the death of the ciliates. These organisms approach the northern *Mesodinium rubrum* more closely than any other species described in the literature available, but Hamburger and von Buddenbrock's¹ figures are not adequate to determine whether it is indeed the same. So far as I can ascertain, ciliates have not previously been recorded as a cause of extensive discoloration of the sea.

A brief general account of the formation of 'water-bloom' by micro-organisms, sometimes thick enough to be destructive to the higher forms of marine life, appeared last year in *NATURE*². Dinoflagellates appear to be the most frequent cause^{3,4}, but euglenoid flagellates have also been known to form it⁵. Off South Africa, *Noctiluca scintillans* is mentioned as a cause of 'red water' in summer. Unfortunately, all our observations have been made between May and October when we have rarely obtained *Noctiluca* in large numbers, but I suggest that further study of 'red water' round the Cape, particularly in relation

to meteorological and hydrological conditions, would well repay local naturalists. A very rich mixed plankton of Diatoms, *Ceratia* and Copepoda, was present when the 'red water' invaded Simons Bay; rotifers were feeding upon the ciliates, the dominance of which was beyond question, and other free-living Protozoa were also present. It is hoped that it will be possible to publish a general account of the discoloration of the sea by living organisms in the future.

T. JOHN HART.

R.R.S. *Discovery II*,
Cape Town.
July 26.

¹ Cl. Hamburger and von Buddenbrock, "Nordisches Plankton", 13.

² NATURE, 132, 253, Aug. 12, 1933.

³ W. E. Allen, *Bull. Scripps Inst.*, 1, No. 15.

⁴ R. Hirasaka, *Annot. Zool. Jap.*, Tokyo, 10, Art. 15.

⁵ Hornell, *Madras Fish. Bull.*, 11, Rept. 2; 1917.

Phylogenesis of the Stridulating Organ of Locusts

It is an interesting task in palæozoology to reconstruct the lineages on which recent and fossil groups have developed and, at the same time, to trace the general laws of phylogeny. Groups having developed a new and well-defined organ at a certain geological period are especially suitable for investigation from this point of view, if the palæontological record is complete enough. A good example is the evolution of the musical apparatus in the forewings of locusts. A very rich series, composed mostly of forms from the Lower Liassic of England and the Upper Jurassic ('Solnhofener Schiefer') of Bavaria is kept in the collections of the British Museum (Natural History), London. Many of these fossils belong to the Prophalangopsidæ, represented in recent times by a single Indian species which is still insufficiently known since there is only one specimen, *Prophalangopsis obscura*, Walker, preserved in the British Museum.

I have studied forty to fifty fossil relatives of this recent species. This very peculiar family flourished in the Jurassic. It was then that they developed their musical apparatus and gave rise to the modern families of Gryllidæ and Tettigoniidæ. The results of my investigations may be summarised as follows:

(1) The most primitive forms have no organ for producing sounds, though some of them might have had ears in the fore-leg. Their fore-wings have a primitive and variable venation. They lived in the Upper Palæozoic and later. Apart from the Prophalangopsidæ, they developed the Elcanidæ in the Triassic and the Jurassic, and the Gryllacrididæ which have persisted since the Upper Palæozoic. The modern Acrididæ also seem to have branched off here.

These primitive forms, when producing sounds by rubbing the fore-wings against each other, only added a new function to the normal function of the wing, which is flying; the existing organ (the wing) proved to be fit for an additional purpose.

(2) The second stage is represented by the Prophalangopsidæ. They have a musical apparatus *statu nascendi*, covering nearly the whole fore-wing of the male. The veins are strongly curved, and certain areas of the wing are elevated and others depressed, its surface thus being rough and stiff. The Mesozoic and recent Gryllidæ with their more highly specialised venation are doubtless descendants of Prophalangopsidæ. But the latter family also is ancestral to the modern Tettigoniidæ.

In this second stage, the fore-wings are distinctly

adapted to the additional function of producing sounds. But still the wing, practically as a whole, served for the two functions; for flying quite naturally and for producing sounds by rubbing the radial, median, cubital and anal parts of one wing against those of the other wing. The wings were laid flat above the abdomen when at rest.

(3) One Prophalangopsid genus, *Cyrtophyllites*, Oppenh. of the Upper Jurassic, shows how the stridulating organ of modern Tettigoniidæ developed from that of the Prophalangopsidæ. The main part of the musical apparatus is restricted to the cubito-anal area, and the latter is the only part covering a corresponding part of the other wing. The fore-part of the fore-wing is folded down the sides of the body.

In the Tettigoniidæ still flourishing, these characters are much more stressed. The cubito-anal area in both fore-wings is highly modified, small and asymmetrical, and is restricted to the very base of the wing. The great advantage of this restriction of the stridulating organ is that—in accordance with the laws of levers—the animals were enabled to intensify the noise without using more power.

In this way, the structure of the fore-wing was consequently improved during geological times and adapted to the requirements of the new function, though the original function of flying was not lost in many of the locusts. But some of them reduced the wings so greatly that only the musical apparatus remained, and in these cases we are entitled to speak of a real change of function of the organ.

Thus the development of the stridulating apparatus of the fore-wing of locusts clearly explains how an organ may change its function and how unnecessary it often is to discuss whether the organ preceded the function or vice versa. If a function (for example, the production of sound) is older than its special organ (musical apparatus) it often can be shown that another organ (the fore-wing) is still older than the function in question and that the special secondary organ developed from this original one after the function had been changed.

Further results:

(1) The ear in the tibia of the fore leg is fully developed in the second (prophalangopsid) stage, and evidently older than the musical apparatus.

(2) The development described above is restricted to the male sex, but, in the Upper Jurassic and later, forms appear in which the females have certain male characters in the fore-wings.

(3) Some reversibility of evolution can be observed in the shape and venation of the wing.

FRIEDRICH ZEUNER.

Department of Geology,
British Museum (Natural History),

S.W.7.

Aug. 24.

Sensitivity of Dividing and Non-Dividing Cells to Radiation

IN his reply to the letter of Dr. Love published in NATURE of August 18, Dr. Mottram asks for an experiment which demonstrates the peculiar sensitivity of the premitotic cell to gamma radiation but at the same time disallows the prevention of mitosis as a measure of radio-sensitivity. This is the aspect of the problem to which we have particularly addressed ourselves, and we have found that a cell *in vitro* can be prevented from dividing by a dose of radiation which produces no recognisable effect

either on resting cells or on those already in the process of division. In our opinion this is a perfectly legitimate index of sensitivity.

We are now studying the effect of gamma irradiation upon the embryonic columnar epithelium of a chick embryo of two days' incubation, in which, as one of us (A. G.) has shown¹, the point in the cycle of division of any cell may be deduced from its form and position within the epithelium. All dividing cells, together with those about to divide, and those which have just divided, are arranged in a layer bordering the lumen. Resting cells (that is, non-dividing cells) are found away from the lumen towards the surrounding mesenchyme. When a resting nucleus is about to divide, it migrates towards the lumen and assumes a streamline form. When it reaches the lumen it becomes globular and then divides. The daughter nuclei retreat away from the lumen, and assume the streamline form in the reverse direction.

In the streamline nuclei approaching the lumen, chromosomes are already beginning to form, and it is this stage to which the term 'pre-mitotic' should be applied. By irradiating suitable embryos *in ovo* or explanted whole *in vitro* we can study the reaction of cells at each stage of the cycle of division to irradiation.

Small doses of irradiation have no effect on resting or on dividing cells, but cause an arrest of the mitotic cycle in premitotic cells in just the same way as we have already demonstrated for cells in tissue cultures; the migration towards the lumen still takes place, but the formation of the chromosomes is inhibited.

A heavy dose causes degeneration throughout the tissue, but always to a greater extent in the premitotic and dividing cells than in the resting cells. The exact distribution and degree of degeneration among cells in these three conditions of activity under different physical conditions have yet to be determined, but we hope shortly to publish our results and thus furnish the details for which Dr. Mottram has asked.

F. G. SPEAR.
A. GLÜCKSMANN.
A. F. W. HUGHES.
C. W. WILSON.

Strangeways Research Laboratory,
Hills Road, Cambridge.
Aug. 29.

¹ *Z. Anat.*, 93, 1930.

Chemical Constitution of Vitamin B₁ as deduced from Ultra-Violet Absorption Spectra

In earlier papers¹, we pointed out the correlation of absorption at 2600 A. with the activity of various B₁ concentrates and the probability that the active material is a purine or pyrimidine derivative as indicated by its apparent absorption maximum at this point^{2,3}. The materials discussed in these papers¹ were impure concentrates. Peters and Philpot⁴ concluded from studies of crystalline preparations made at Oxford that the maximum characteristic of B₁ is more probably at 2450 A.

Through their kind co-operation, we have been enabled to study during the past year two of Dr. Peters's crystalline preparations, as well as two from Dr. Ohdake, and three prepared by Dr. Seidell, in addition to several made in our own laboratory. The parallel biological and spectrographic assays of these materials again indicate a marked correlation between absorption at or near 2600 A. and biological activity. The absorption curves, some of which are

reproduced here (Fig. 1), resemble those of cytosine⁵, having maxima at 2650 and 2350 A. and extinction values of the correct order. Lack of correlation between absorption and activity at 2350 A. as well as at 2600 A. in the earlier materials studied was probably due to the presence of end-absorbing impurities in some of the concentrates. The present results indicate that the active material may be built around a pyrimidine of the cytosine type.

On the basis of preliminary experiments, we believe that the discrepancies between our results and those of Peters and Philpot may be explained as effects due to the solvents used. According to his published curve⁵, Windaus's crystals gave still different results, having a single maximum at 2600 A. with little absorption in the short-wave region. It is possible

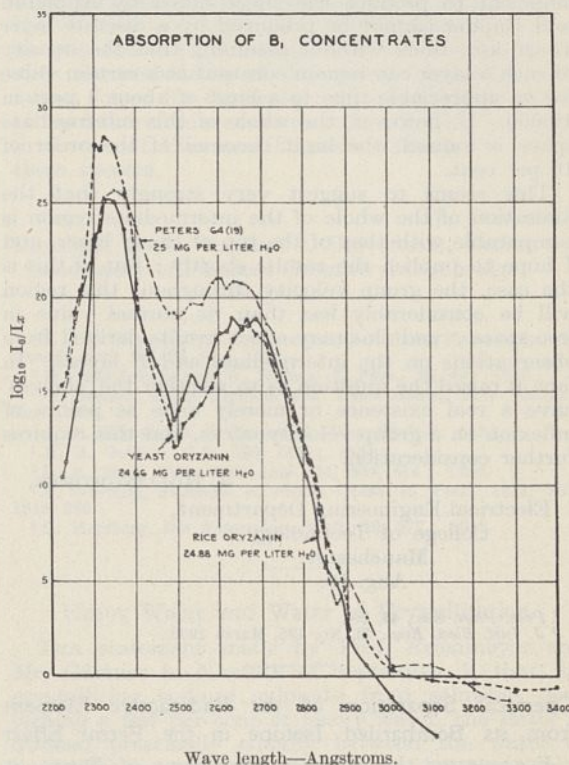


FIG. 1.

to explain this by presuming that more than one of the pyrimidines can form the nucleus of the active molecule—uracil serving in the Windaus crystals, cytosine in the others. Windaus's early formula⁵ for his crystals contains one less N (N₃) than the formulae of van Veen or Ohdake (N₄), which is in agreement with this hypothesis (uracil has N₂, cytosine N₃).

Full details of these results and of investigations of the influence of full and filtered ultra-violet irradiation on B₁ crystals will be published elsewhere.

FRANCIS F. HEYROTH.
JOHN R. LOOFBOUROW.

Basic Science Research Laboratory,
University of Cincinnati.
July 21.

¹ Heyroth and Loofbourow, *Bull. Bas. Sci. Res.*, 3, 237; 1931. *NATURE*, 130, 773, Nov. 19, 1932. *Bull. Bas. Sci. Res.*, 4, 35; 1932.
² Heyroth and Loofbourow, *J. Amer. Chem. Soc.*, 54, 3441; 1931.
³ Heyroth and Loofbourow, *J. Amer. Chem. Soc.*, in press.
⁴ Peters and Philpot, *Proc. Roy. Soc., B*, 113, 48; 1933.
⁵ Windaus *et al.*, *Z. physiol. Chem.*, 204, 123; 1932.

Structure of the Ionosphere

IN a recent paper, Appleton and Builder¹ mention a striking fact that on certain occasions, when the ionosphere is being surveyed by the 'pulse' method, there is a reversal in the times of arrival of the two magneto-ionic components into which the upgoing ray is split. They attribute this to differential group retardation, and it occurred to me a short time ago that this effect might throw some further light on a suggestion I have made previously², namely, that the whole intermediate space between the *E* and *F* layers is ionised to a value very little less than that of the top of the *E* layer.

I have made some approximate calculations of this group retardation, which indicate that a time delay sufficient to produce the effect noted by Appleton and Builder cannot be produced by a discrete layer 15-20 km. thick without assuming that the density of such a layer can remain constant at a certain value for an appreciable time to a limit of about 1 part in 10,000. If, however, the whole of this intermediate space is ionised, the limit becomes of the order of 10 per cent.

This seems to suggest very strongly that the ionisation of the whole of the intermediate region is comparable with that of the top of the *E* layer, and I hope to publish the results shortly; but, if this is the case, the group velocity throughout this region will be considerably less than its normal value in free space; and this may affect results derived from observations on the intermediate and *F* layers. In fact, it raised the question as to whether the 'shelves' have a real existence or merely arise as points of inflexion on a group-velocity curve, and this requires further consideration.

J. HOLLINGWORTH.

Electrical Engineering Department,
College of Technology,
Manchester.
Aug. 19.

¹ *Proc. Phys. Soc.*, 45, 208.

² *J. Inst. Elect. Eng.*, 72, No. 435, March 1933.

Chemical Separation of the Radioactive Element from its Bombarded Isotope in the Fermi Effect

FOLLOWING the pioneer experiment of Fermi, it has been found by Fermi, Amaldi, D'Agostino, Rasetti and Segrè that many elements up to the atomic number 30, when bombarded by neutrons from a radon-beryllium source, are transmuted into a radioactive element which is chemically different from the bombarded element. In several cases of this type, they succeeded in separating chemically the active substance from the bulk of the bombarded element, and there is no inherent difficulty in getting any desirable concentration of the radioactive element.

They have not observed such chemical changes in elements above the atomic number 30, though many of these heavier elements show strong Fermi effects. For some of these, for example, arsenic, bromine, iodine, iridium and gold, they could show that the activity is carried by the bombarded element, which in the circumstances leads to the conclusion that the radioactive element is an isotope of the bombarded element.

In order to separate the radioactive isotope of the bombarded element from the bulk of the bombarded

element, one has to find a new principle of separation. We have attempted to apply the following principle. If we irradiate by a neutron source a chemical compound of the element in which we are interested, we might expect those atoms of the element which are struck by a neutron to be removed from the compound. Whether the atoms freed in this way will interchange with their isotopes bound in the irradiated chemical compound will depend on the nature of the chemical compound with which we have to deal. If we work under conditions in which such an interchange does not take place, we obtain the radioactive isotope 'free', and by separating the 'free' element from the compound we can obtain any desirable concentration of the radioactive isotope.

We have applied this principle to iodine. Ethyl iodide has been irradiated and a trace of free iodine added to protect the radioactive isotope. By reduction and precipitation as silver iodide in water, it was easy to concentrate the activity so as to get from the precipitate ten times as many impulses of the Geiger-Müller β -ray counter as directly from the irradiated ethyl iodide¹. Apparently a large fraction of the active substance could be extracted from the ethyl iodide. The quantity of the active element obtainable in the precipitate will naturally depend on the quantity of the compound subjected to irradiation.

This principle of isotopic separation has also been applied to some other elements which, like iodine, are transmuted into their own isotopes, and further experiments mostly with organic compounds are in progress.

LEO SZILARD.

T. A. CHAEMERS.

Physics Department,
Medical College,
St. Bartholomew's Hospital,
London, E.C.1.
Sept. 10.

¹ *Proc. Roy. Soc., A*, 146, 483; 1934.

Activated States in the Spectrum of Copper Hydride

IN addition to the well-known band system ${}^1\Sigma^* \rightarrow {}^1\Sigma$ in copper hydride, we recently reported¹ a new band system ${}^1\Sigma^{**} \rightarrow {}^1\Sigma$, the activated states ${}^1\Sigma^*$, ${}^1\Sigma^{**}$ forming a doublet ($\nu_e^* = 23431$, $\nu_e^{**} = 26369$), previously known in the spectra of gold hydride ($\nu_e^* = 27658$, $\nu_e^{**} = 38231$). In the spectrum of silver hydride², ${}^1\Sigma^{**}$ has not been found, although its presence is indicated by irregularities in ${}^1\Sigma^*$.

Extending our analysis into the ultra-violet region in the spectrum of copper hydride (in emission), we were able to disentangle two new band systems, composed of *P-Q-R*-branches and forming ${}^1\Pi \rightarrow {}^1\Sigma$ systems, the constants of the ${}^1\Pi$ -terms being given below:

	ν_0	B_0	γ_0
${}^1\Pi^*$	27100	6.39	0.018
${}^1\Pi^{**}$	27957	6.065	0.066

($\gamma_0 = \Delta$ - doubling coefficient).

A more detailed account will appear later.

A. HEIMER.
T. HEIMER.

Laboratory of Physics,
University of Stockholm.
Aug. 2.

¹ A. Heimer and T. Heimer, *Z. Phys.*, 84, 222; 1933.

² E. Hulthén and R. V. Zumbstein, *Phys. Rev.*, 28, 13; 1926.

³ E. Bengtsson-Knave, Dissertation, Stockholm, 1932.

Absorption Spectrum of Oxygen at High Pressures and the Existence of O₄ Molecules

At high pressures gaseous oxygen exhibits a large number of absorption bands between 12610 and 2200 Å., similar to those of the liquid¹. In order to establish the nature of these bands one of us together with Finkelburg² commenced about three years ago to measure the dependence of the intensity of absorption at high pressures on the oxygen concentration and on the presence of foreign gases. Some results have already been published^{2,3}. We now wish to report briefly on the most important recent results, since *all* the bands have now been classified in the ways described below, and because the absorption spectrum of oxygen has been investigated by other workers^{4,5}. The complete account of this work with the relevant data will appear shortly in *Zeitschrift für Physik*.

From the variation of the absorption with the concentration of oxygen and with the addition of foreign gases, conclusions may be drawn as to the carriers or processes which are involved in the production of the individual bands.

1. If the absorption varies *linearly* with the O₂-concentration and is *not* influenced by foreign gases, it must take place in an (almost) undisturbed O₂-molecule.

2. If the absorption varies with the *square* of the O₂-concentration and is *not* influenced by foreign gases, two O₂-molecules must take part in the act of absorption: that is, a collision pair O₂-O₂ or a loosely bound O₄ molecule.

3. If the absorption varies with the *square* of the O₂-concentration and its intensity is influenced by foreign gases without change of structure in the spectrum the absorption takes place during the collision in *one* O₂-molecule, in which the selection rules may be altered by the collision.

Corresponding to these considerations we actually find *three* groups of spectra:

Group 1. Intensity increases *linearly* with O₂-concentration; no influence of foreign gases; bands from 10320 to 6890 Å. Attributed to forbidden transitions $^3\Sigma - ^1\Delta$ and $^3\Sigma - ^1\Sigma$ in the *normal* O₂-molecule.

Group 2. Intensity increases with the *square* of the O₂-concentration; no influence of foreign gases; bands from 6300 to 3289 Å. Since *two* O₂-molecules are involved, and *only* two, these bands definitely correspond to absorption by an O₄-molecule. These bands coincide with those which were suggested by Ellis and Kneser⁴, on the basis of their term values, to be electron-combination terms between two O₂-molecules. The present experiments confirm this suggestion, since the bands possess the *necessary* physical characteristics.

Group 3. Intensity increases with the *square* of the O₂-concentration, and, at constant O₂-concentration, *linearly* with the concentration of foreign gas. The intensity varies with the foreign gas, without alteration in the structure of the spectrum, the effect increasing, at constant partial pressure, in the order He, Ne, A, N₂, CO₂. Bands from 2859 to 2440 Å. followed by continuous absorption. These bands have been attributed by Wulf⁶ to the O₄-molecule. In a previous paper with Finkelburg² it was shown that the vibration terms converge to the dissociation energy of the O₂-molecule in normal atoms, which led us to suggest that the absorption takes place in

one only of the colliding O₂-molecules. Evidence supplied by Warburg⁷ on the influence of N₂ on the absorption led us to investigate the influence of other foreign gases with the above results, which confirm that suggestion. These bands therefore correspond to absorption by one O₂-molecule during the collision, by which it may be influenced, with either O₂ or a foreign gas molecule (or by loosely bound polarisation molecules O₂-X). A probable relationship of this system with the bands observed by Herzberg⁵ in O₂ at 1 atm. will be decided by experiments now in progress.

Molar extinction coefficients for the various absorbing carriers can be calculated from these absorption measurements. The order of magnitude is 10⁶ or 10⁷ times smaller than the normal absorption (Schumann-Runge bands). The probability of the electron combination transition (group 2) must, on quantum mechanical grounds, be small compared with the probability of the normal transition. The values found for the molar extinction coefficients of group 2 therefore seem to us to be a further argument in favour of Ellis and Kneser's attempt to explain these spectra.

H. SALOW.

W. STEINER.

Physikal. Chem. Institut d. Universität, Berlin.

Laboratory of Physical Chemistry, Cambridge.

July 31.

¹ J. C. McLennan, H. D. Smith and J. O. Wilhelm, *Trans. Roy. Soc. Canada*, Sect. III, **24**, 65; 1930.

² W. Finkelburg and W. Steiner, *Z. Phys.*, **79**, 69; 1932.

³ W. Steiner, *Trans. Faraday Soc.*, Gen. Discuss. Free Radicals, Sept. 1933, 34.

⁴ J. W. Ellis and H. O. Kneser, *Z. Phys.*, **86**, 583; 1933.

⁵ M. R. Guillian, *C.R.*, **198**, 1223; 1934.

⁶ O. R. Wulf, *Proc. Nat. Acad.*, **14**, 609, 614; 1928.

⁷ E. Warburg, *Sitzungsber. d. Preuss. Akad. d. Wiss.*, 1914, 832 1915, 230.

⁸ G. Herzberg, *Die Naturwissenschaft.*, **19**, 577; 1932.

Heavy Water and Water of Crystallisation

THE statement made by Prof. Erlenmeyer and Mr. Gärtner in *NATURE* of September 1, that, by crystallising sodium sulphate from solutions containing a few per cent of heavy water, the latter is divided practically equally between the water of crystallisation and solution, is in harmony with experiments I carried out some months ago. To ascertain if heavy water normally present in ordinary water could be concentrated by crystallisation, several litres of warm saturated solution of sodium sulphate were cooled. The crystals that separated were heated and the refractive index of the expelled water was determined with the Pulfrich refractometer as this was thought to afford a sensitive method of observing any change in the composition of small quantities of water. The dehydrated salt was added to the original solution and a fraction again crystallised out. This process was repeated many times until the original solution was reduced to small bulk. No change in the refractive index could be detected, however, between the initial and final fractions from either crystals or solution. It does not appear possible, therefore, to concentrate heavy water in this manner.

J. NEWTON FRIEND.

Technical College,
Birmingham.

Sept. 3.

Research Items

The Ainu. A Research Committee of the Anthropological Section of the British Association appointed to carry out research on the Ainu on the basis of work done in Yezo by Dr. N. Gordon Munro, reported at the Aberdeen meeting. Dr. Munro finds that there are differences in custom and belief among the islanders owing in part to tribal conflict and lack of union in ancient times and owing in part to the clash of culture between Ainu and Japanese in modern times. In the majority of Ainu communities the old mode of life has changed, and hunting is practically a thing of the past. Inheritance and authority are patrilineal and marriage is patrilineal. Descent, however, is strictly matrilineal and exogamy is strictly enforced. The mother's brother has a voice, but not a decisive voice, in the selection of a husband for her daughters, and is said still to have some authority over her children. Dr. Munro has discovered that every woman wears a secret belt, and his investigations of the custom seem to support the statement that totemism exists among the Ainu, for which, however, there hitherto has seemed to be but little evidence. Each of these girdles or belts is supposed to have been the gift of a special spirit. The varieties of belts examined up to the present are attributed to *Kamui Fuchi*, who authorises other *Kamui* to bestow it, or to other *Kamui* identified variously with a bear, wolf, grampus (the chief sea deity), a hare, fox or deer—all females. It is found that it was forbidden to marry anyone of the same 'belt', the objective criterion of the clan, the penalty for infringement being death, later commuted to a fine and a compulsory shortening of the belt. Formerly the levirate was a general custom, signified by a special name, 'wife-lifting'. Two brothers might not marry two sisters. The sororate and marriage with a deceased wife's sister were forbidden, and the children of two sisters might not marry, though cross-cousins might, unless their mother had the same belt. The belt is the one criterion by which the Ainu decide all questions of marriage.

Palaeolithic Caves in Derbyshire. In a report presented at Aberdeen of the Research Committee of the Anthropological Section of the British Association on the exploration of caves in Derbyshire, Mr. Leslie Armstrong states that during the past year an additional 15 ft. of the rear passage of the Pin-Hole Cave, Cresswell Crag, has been examined. The purpose of the excavation was to prepare a section of the deposits down to bed-rock for permanent exposure. No part of this section of the cave exceeds five feet in width, and in places it is not more than two feet wide; but progress has been slow on account of a layer of hard crystalline deposit 9-12 in. thick, which crowned the deposit and the numerous slabs of rock cemented into it. The stratification has been well defined throughout. Artefacts were more numerous than was expected. Tools of quartzite, crystalline stalagmite and limestone occurred in all three Mousterian levels. Two finds of special interest were a bone tool, 2 in. long, roughly triangular in form, which was cut into two prongs, and what appears to be a bone 'bull-roarer', $3\frac{1}{2}$ in. long and $\frac{7}{8}$ in. wide, of pointed oval form, perforated near one end. In comparison with other portions of the cave, animal remains were less numerous, and no additions to the fauna have been made. Mr. T. Petch reports on fungi occurring on

flies collected by Mr. Armstrong in Pin Hole Cavern. Five species of fungi have been collected of which *Hirsutella*, parasitic on *Blepharoptera*, is a new species. It occurs in two forms. In one it first forms discontinuous brown patches of mycelium on the body of the insect, and afterwards erect fuscous clavæ up to 8 mm. long. In this condition, the fungus is fertile. In the second it develops into long hair-like strands, 8 cm. long, and is usually sterile. Specimens of *Stibella Kervillei*, Quel., first recorded in Britain by Mr. Armstrong in 1923 from the Creswell Caves, demonstrate that this fungus is not parasitic on insects as was thought, but is parasitic on another fungus, a *Hirsutella*.

Extinction of the Bird of Providence. New light regarding the extermination of this petrel, *Pterodroma melanopus*, has been revealed in a recently discovered contemporary account of the slaughter of the birds on Mount Pitt, Norfolk Island, in the early days of the settlement of New South Wales (Gilbert Whitley, in *Australian Zoologist*, 8, 42; 1934). The account is contained in a manuscript diary, kept by Lieut. Ralph Clark of the Royal Marines, which is preserved in the Mitchell Library, Sydney. Clark was appointed Quartermaster-General and Keeper of the Public Stores, and in this capacity he kept a conscientious tally of all the petrels or "Mount Pitt Birds" killed by the marines, sailors and convicts from day to day. The records of numbers show that in April 1790, 13,251 birds were killed, in May 82,321, June 70,699, part of July 5,091, so that from April 10 to July 10, 170,000 were slaughtered. Capt. John Hunter stated in the same year that Mount Pitt was crowded with the birds, and as full of holes as any rabbit-warren, and on May 2, Clark writes: "The Birds of mount Pit last night were so thick that the [sic] came down a little after sunset like a shower of hail. My servant was there and kil'd himself 193 Birds it is a great Blessing that we have these Birds in such abundance"; and on May 9, after 4,783 birds had been brought in, "long may this Blessing continue".

Hawaiian Oribatid Mites. Bulletin 121 of the Bernice P. Bishop Museum (Honolulu: 1934) consists of a contribution by Mr. A. P. Jacot entitled "Some Hawaiian Oribatoidea". In reviewing the taxonomic character of the superfamily, the author lays special stress upon the importance of the bristles and their arrangement. These offer an untouched field for the study of evolution as expressed in structure. In the course of these studies it has been found essential to name each bristle, or pair, since they hold radically different positions in different subfamilies. In addition to describing a number of new species of these mites, the author discusses at some length the various natural agencies that may account for their distribution. Principles governing the geographical distribution of large animals cannot be applied on the same basis to a microfauna. In the latter connexion, the influence of wind, birds, ocean currents and driftwood, and other agencies are taken into account. The paper is illustrated by sixteen plates portraying structural characters of various species.

The Alizarin-KOH Method of Staining Vertebrate Skeletons. With reference to paragraphs on this subject

which appeared in NATURE of Feb. 4, 1933 (vol. 131, p. 171) and March 24, 1934 (vol. 133, p. 465), Mr. M. Rahimullah and Prof. B. K. Das write to point out that their paper (*J. Osmania Univ. Coll., Hyderabad, Deccan*, 1, 1-3; 1933) presented the first account of the adaptation of the alizarin-KOH method to the preparation of skeletons without the surrounding soft parts; that the suggestion of xylol as an alternative fluid for the preservation of such skeletons is new, as is also the statement that, in xylol preparations, a paste of amyl acetate and gelatin will hold together small bones which may have become separated by accident.

Distribution of Sex-Factors in the X-Chromosome. While it is now well recognised that the X- and Y-chromosomes furnish a basis for sex determination in many animals and plants, yet the question is still debated whether in particular cases a single sex factor or a series of factors in the X-chromosome are involved. Dobzhansky and Schultz (*J. Genet.*, 28, No. 3) have made an important contribution to this problem by an investigation of the sex-determining genes in the X-chromosome of *Drosophila*. Their method was, by the use of X-rays, to fragment the chromosomes and produce individuals with duplications and deficiencies. Fragments of known length both genetically and cytologically were added to males, females and intersexes of known constitution by crossing, and in this way the effect on the expression of sexual characters of adding a certain section of the X-chromosome could be studied. Intersexes were found to be especially sensitive to small variations in their sexual balance. Duplication or deficiency of the long inert section of the X-chromosome had no effect on the type of intersex, but duplication of any other portion produced a shift towards femaleness. Deficiency of the extreme left-hand end produced a shift towards maleness. The amount of the shift towards femaleness was roughly proportional to the cytological length of the duplication. The conclusion is reached that the X-chromosome contains numerous female modifiers scattered more or less evenly along all its parts except the inert region. The sex-determining rôle of the X-chromosome is the sum of all these effects. The authors believe that selection has tended to accumulate such factors, while in such organisms as frogs and fishes a single sex factor may still be present because they have more recently changed from a hermaphrodite to a dioecious condition.

Absorption of Manganese by Plants. A valuable contribution to the literature on the effects of manganese in plant growth appears in a recent paper by Carsten Olsen (*C. R. Trav. Lab. Carlsberg*, 20 (2), 1-34; 1934). A survey of the manganese content of leaves from a number of land plants from natural soils of different pH values shows that increase in soil acidity is accompanied by increased absorption of manganese, due presumably to the increased concentration of soluble manganese salts in the soil solution. Plants from basic soils show a very small manganese content. Iron content, on the other hand, seems to bear no consistent relationship to hydrogen ion concentration. Similar results were obtained with artificial soils in pot experiments with barley and buckwheat. Plants grown in water cultures of different pH but constant manganese sulphate concentration show a maximum manganese absorption at pH 6-7. The absorption increases with increase of manganese concentration

in the medium. Manganese is probably absorbed as manganous ion, manganous salts being stable in acid soil. Hence water and swamp plants contain large amounts of manganese, even when grown in a neutral or basic medium, provided the latter is deficient in oxygen and oxidation of manganous salts to manganese dioxide is retarded. Plants grown in cultures free from manganese do not develop chlorosis, which seems to depend rather on the ratio of iron to other absorbed ions, but suffer from 'grey speck disease'. When developed in basic soils (for example, by oats), the disease is less serious in moist or clay soils where access of oxygen is diminished.

Minerals of Kimberlite. In a paper read before the Geological Society of South Africa on April 16, 1934, Prof. S. J. Shand presented an admirable study of the minerals occurring in kimberlite and their relative proportions. He finds that enstatite is by far the commonest pyroxene, probably ten times as abundant as all the others put together. Chrome-diopside comes next, and after it a pale green diopside possibly holding a little of the jadeite molecule. These minerals, together with garnet, are xenocrysts that have been picked up and enclosed by the kimberlite magma, since out of the thousands of grains examined not one showed a trace of crystalline form. It is concluded that ilmenite, which is scarce in the xenoliths, is probably mainly a product of the kimberlite magma. Garnetiferous rocks of the eclogite type make up only about one part in a thousand of kimberlite. They consist mainly of garnet-enstatite combinations and are not eclogite in the original sense of the term. Shand considers that it would be well to return to Beck's name *griquaite* for these rocks. The endogenous kimberlite minerals are found to be olivine (and serpentine), phlogopite, ilmenite and perovskite with a little augite in some cases. The suggestion is made that since lime is a common constituent of the rock, kimberlite may have originally contained some easily decomposed lime-mineral such as melilite.

Water Pressures on Works on Sand Foundations. A study (*Research Pub.*, 2, No. 5. Government Printing Office, Lahore. 1s. 6d.) by Dr. McKenzie Taylor and Mr. Harbans Lal Uppal deals with the relationship between pressure and stream flow. Lamb ("Hydrodynamics") has shown that lines of equal pressure are orthogonal to the stream line; from which, and the observations referred to in *Research Pub.*, Nos. 3 and 4, NATURE, Sept. 15, p. 425, it follows that by tracing the stream lines and at the same time determining the pressures on a horizontal line cutting the stream lines, the equi-pressure lines can be drawn. The apparatus used by the investigators is described and the results of the pressure measurements under models tabulated for various heads. Diagrams are also given of the equi-pressure lines. Application of the foregoing lines of investigation has been made to a model of the Khanki Weir at the headworks of the Lower Chenab Canal and the results recorded in another publication (*Research Pub.*, 2, No. 6. Government Printing Office, Lahore. 1s. 6d.) in which the repairs rendered necessary to a number of bays of the dam are discussed with diagrams of equi-pressure lines and photographs of pressure observations.

Vibration of Beams and the Whirling of Shafts. The problems of vibrating beams and whirling shafts are of considerable practical importance in engineering.

Assuming that the materials are perfectly elastic, mathematical solutions have been obtained which are of use to the engineer. Unfortunately the complete theory is very complicated. In a paper in the *Scientific Proceedings of the Royal Dublin Society* (Aug. 1934), Dr. H. H. Jeffcott shows how approximate solutions can be obtained by simple graphical or tabular methods. In a previous paper he gave algebraic solutions of particular cases. His new method leads to solutions sufficiently exact for all practical purposes. It has to be remembered that there is always some uncertainty about the mechanical data and so it is unnecessary to aim at high accuracy in getting numerical values. Approximate solutions are all that are needed. The methods given are of general applicability and can be applied to the solution of problems involving moving and pulsating forces or hammer blows.

Fine Structure of X-Ray Absorption Edges. A theory of the fine structure of X-ray absorption edges has been given by R. de L. Kronig. The electron leaving the atom suffers scattering by the neighbouring atoms, and in the case of an atom embedded in a crystal lattice this scattering only allows the electron to escape when its energy has one of several discrete values. A similar effect occurs when the atom under consideration resides in a gas molecule, the de Broglie waves scattered by the neighbouring atoms interfering with the original wave in a manner which depends on the wave-length and therefore on the velocity of the issuing electrons. In *Physica* of July (1, No. 9), D. R. Hartree, R. de L. Kronig and H. Petersen give a calculation for the fine structure of the Ge K-edge in GeCl_4 and D. Coster and G. H. Clamer describe an experimental investigation which agrees with the theory. The GeCl_4 molecule is well adapted for investigation since the Ge K-band lies in a region of the spectrum suited to experimental investigation, while the molecule has a symmetrical tetrahedral structure which greatly simplifies the calculations. Further, the Cl atoms scatter quite strongly and give a well-marked structure to the edge. The atomic field for neutral chlorine is required since GeCl_4 is a non-ionic molecule. It was calculated by the self-consistent field method. The wave equation was then set up and solved for an electron in this field (the four Cl atoms merely involve multiplication by 4) and the effect on the fine structure finally calculated. The deformation of the Cl structures by the intermolecular forces and exchange between the escaping photoelectrons and the other electrons were neglected. The positions, and the order of magnitude of the intensities of the fine structure components, are correctly predicted. It appears that in some cases this method may be used to throw light on molecular constitutions and in particular to decide between homopolar and ionic binding.

Magnetic Moment of the Proton and the Deuteron. I. I. Rabi, J. M. B. Kellogg and J. R. Zacharias (*Phys. Rev.*, Aug. 1) have used a new molecular-beam method for obtaining a value for the magnetic moment of the H^1 and H^2 nuclei. The method depends on using a magnetic field which is highly inhomogeneous, but not strong enough completely to decouple the nuclear and electron spin. The magnetic moment of the nucleus does not contribute directly to the total moment of the atom, but it influences the average orientation of the electron moment with respect to the field. From the inhomogeneous field experi-

ment it is possible to measure the magnetic moments of the magnetic states, and the nuclear moment is deduced in the same way as in the method depending on the hyperfine structure of spectral lines. In the experiments a beam of neutral atoms was derived from a Wood's discharge tube and deflected by a field produced by a heavy current in a pair of wires. No iron is used in the magnetic system. The value obtained for the moment of the proton is 3.25 ± 10 per cent and for that of the deuteron 0.77 ± 0.2 . The former value agrees moderately well with the value obtained by Stern, Estermann and Frisch, using a different method depending on the deflection of hydrogen molecules in a strong inhomogeneous field. (See *NATURE*, 133, 911, June 16, 1934.)

Isotopes. 55 pages and 4 plates in the issues of the *Physikalische Zeitschrift* of July 15 and August 1 are devoted to a review of the present position of our knowledge of isotopes, by Dr. J. Mattauich of the University of Vienna. The various methods which have been developed for the investigation of isotopes based on the use of positive rays or on the displacements of line or band spectra are described in turn, and the final table of results covers nearly five pages. For each substance, the table gives the atomic number, the integral atomic weight, the method or methods used, the relative amount of each isotope present, and in many cases its packing fraction and its atomic weight to five significant figures, with the possible limits of error. Nearly 260 references are given.

Paschen Series in Stellar Spectra. A comparison of the Paschen and Balmer series of hydrogen in some stellar spectra made at Mount Wilson Observatory has been described by Merrill and Wilson (*Astrophys. J.*, July). The Paschen series is, of course, in the infra-red region of the spectrum, and its investigation in stellar spectra has been made possible by recent improvements in the infra-red sensitivity of photographic plates. Investigation of the infra-red regions in stellar spectra is considerably hampered by the presence of bands in the spectrum of the earth's atmosphere, but there happens to be a gap through which the Paschen series from $m = 24$ at 8333 Å. to $m = 11$ at 8862 Å. can be seen. The general behaviour of the Paschen series in the spectral sequence is, as was to be expected, roughly the same as that of the Balmer series. The Paschen series is conspicuous in the c stars β Orionis $cB8$ and α Cygni $cA2$. Comparison of the two series should yield a direct value of the surface temperature of the star, from the relative number of hydrogen atoms in the second and third states. The authors have carried out photometric measurements of the intensities of the lines in the two series, and deduce stellar surface temperatures in this way, but the result is not completely satisfactory because the different members of each series do not give the same number of atoms in the quantum state common to all the members of the series, as simple theory predicts that they should do. One is reminded of the highly anomalous intensities exhibited by the first few members of the Balmer series in the solar spectrum. The value obtained from the Balmer lines for the number of atoms in the second state increases with increase of m , coming to a maximum at about $m = 15$ in most stars—well on in the series. The authors find $9,000^\circ$ for β Orionis and $8,800^\circ$ for α Cygni for the effective temperature ($2^{1/4} \times T_0$) in both cases.

Problems of Freshwater Biology

A SURVEY of certain aspects of freshwater biology was arranged by Sections D (Zoology) and K (Botany) of the British Association, under the chairmanship of Dr. E. S. Russell, at Aberdeen on September 10. One of the major problems considered was that of the production of algae in natural waters. These organisms serve as producers of organic materials, and hence their number is a measure of the amount of sub-aqueous life possible. They also serve as indicators of the quality of the water, a field which requires further investigation. On the other hand, their presence may lead to tastes or odours undesirable from a water consumer's point of view and, in waterworks, they may, if abundant, cause considerable expense in filtration.

Prof. F. E. Fritsch, in opening the symposium, pointed out that very little is really known about the way in which the phytoplankton of lakes and reservoirs pass through their periods of dormancy, or of the manner in which they are able to develop and to become abundant in the free floating condition. Few species are known to produce resting spores, and motile developmental stages appear to be infrequent. Prof. Fritsch summarised the existing information.

Dr. W. H. Pearsall then dealt with the relation between the abundance or scarcity of algae and the chemical composition of the dissolved substances in the waters. He developed the view that the proportions between available nutritive substances, such as those yielding carbon, nitrogen and phosphorus, are of great importance both in determining algal abundance and also in deciding which species become predominant.

The examples quoted in these earlier papers suggest that freshwater biologists will soon require a further detailed knowledge both of the water movements in lakes and also of the manner in which nutritive substances are produced by the oxidation of organic matter in natural waters. Mr. J. T. Saunders approached one of these problems, that of water movements in lakes, by a rather novel method. Using a form of thermocouple, he has found it possible to measure water temperatures so rapidly as to throw considerable light on water movements. Among other details of interest was the conclusion that the oily patches common on the wind-swept surfaces of lakes are of lower temperature than the surrounding surface waters, and represent the upwelling of the return currents which balance the surface wind-drift.

Dr. B. Barnes approached the second problem, that of the sub-aqueous decay of organic matter, in summarising the available information about the biology of the aquatic fungi. Apparently these little-known organisms occur chiefly in shallow water and during periods of low temperature. Many of them are parasites and all appear to be of infrequent occurrence. Hence they may play only a small part in sub-aqueous organic decay, which is presumably to be attributed chiefly to bacteria.

Another major problem of aquatic biology, that of the food chains by which the larger animals are linked with the smaller organisms, was dealt with by Mr. F. K. Pentelov, who summarised extensive observations on the foods of fishes, particularly trout. His conclusion that trout have catholic tastes and are, on occasion, practically omnivorous, received abundant confirmation in the subsequent discussion.

Building Trades Exhibition

IT is not so many years ago that building was one of the most traditional of our industries, its methods and materials having been handed down from generation to generation and being in many instances peculiar to their special localities. That this state of affairs no longer exists, and that the very varied assortment of trades now occupied in building have indeed 'put their house in order', is made evident by even the briefest of tours of the Building Trades Exhibition, which is being held at Olympia on September 12-26.

The immediate impression conveyed by the Exhibition is undoubtedly that of the high quality and specialised nature of the products exhibited. In some instances, as, for example, with electrical apparatus, it is fairly obvious that the products are the direct outcome of intensive research. In others, notably in the use of that apparently unsuitable material, aluminium foil, as a thermal insulator, established scientific principles have been successfully interpreted in a practical form.

Even with the older materials, such as bricks, paints and plasters, indications of scientific development are to be seen on every side. To appreciate this, it is only necessary to examine a stand such as that of Imperial Chemical Industries Ltd., where an extensive range of plasters and cement products is being shown, each suited to a special purpose and

supplied ready mixed so that the minimum of time and skill is needed for application. The fact is also well illustrated by the number of materials which are now produced to detailed specifications.

The focus of scientific interest in the Exhibition lies, of course, in the comprehensive exhibit arranged by the Department of Scientific and Industrial Research, illustrating the work of the Building Research Station at Watford and of the Forest Products Research Laboratory at Princes Risborough. This ranges from fundamental work on the constitution of cements, to such varied problems as the behaviour of structural steelwork and reinforced concrete, the stability of paints on plastered surfaces, the designing of buildings to receive maximum sunshine, and the control of insect and fungoid pests in timber.

Perhaps the most interesting section of this exhibit is that dealing with the investigation of the causes of fracture of reinforced concrete piles during driving. Special piezo-electric gauges are embedded in the pile and are connected as required to a cathode ray oscillograph to give records of the impulsive and vibrational stresses caused by the blow. It has been found that tensile stresses of a dangerous order may be developed either at the head or the toe of the pile, according to the nature of the blow and the type of ground into which the pile is being driven. The

recording apparatus is shown working in conjunction with a model pile-driver.

Another interesting series of exhibits on this stand is concerned with the 'creep' of concrete. When subjected to sufficiently high tensile or compressional stresses, concrete has the property of flowing slowly to relieve the stress, a feature which in some circumstances might have unfortunate consequences. Methods of examining this property are shown, together with numerous experimental data.

In the Heating Section of the stand of the Department of Scientific and Industrial Research, special mention may be made of the instruments developed for the measurement of the degree of comfort of a room in terms of 'equivalent temperature'. The 'eupatheoscope' is a research instrument designed to react to its environment in much the same way as a human being. Simple portable instruments, on the principle of the kata-thermometer and suitable for the general use of the heating and ventilating engineer, are also exhibited.

Finally, attention may be directed to the very

topical exhibit of the 'housing centre', dealing with London's slum problem and entitled "New Homes for Old". Much of the material exhibited—for example, the reconstructed slum—has mainly a humanitarian appeal, but those portions concerned with the town-planning aspect of the problem, particularly that due to the "Mars" group of architects, are of a notably scientific character. It is to be hoped that the analytical treatment of the slum problem, which is here exemplified in the case of Bethnal Green, will lead to a better appreciation of its complexity and to its more rapid solution.

One of the most interesting suggestions for re-planning is that of the British Steelwork Association, that buildings in the centre of London could with advantage be made more nearly uniform in height, but that, on selected island sites, greater height than the standard should be allowed, provided that ground area was given up for the widening of the surrounding streets. The suggestion is supported by an attractive model.

H. E. B.

Chemistry of Antigens and Antibodies*

DR. J. R. MARRACK prefaces his review of the chemistry of antigens and antibodies and the nature of the reaction between them by a short account of certain aspects of physical chemistry, including recent developments of our knowledge of the shapes and sizes of molecules and the application of this knowledge to proteins, on account of their importance in connexion with immunological specificity. The part played by polar forces in the orientation of molecules, in their distortion and in the specificity of the binding of one molecule to another, as in mixed crystal formation, is described, whilst an account of the structure and properties of different proteins, especially those of the serum, forms an excellent introduction to the main part of the review.

Antibodies appear to be proteins, and attempts to prepare them free from proteins have failed. It is generally agreed that they are precipitated with the globulin fraction of serum, whatever method of precipitation is used, but are usually not confined to any particular fraction: the antibodies in anti-pneumococcal horse (but not rabbit) sera are, however, unique in that a large proportion can constantly be separated, highly purified, in a fraction of the serum globulin, by precipitation in low salt concentration or with alcohol. The stability of antibodies to various agents is similar to that of the proteins.

The composition of the antigen-antibody complex is also in favour of the view that antibodies are proteins: for example, the precipitate of antigen and antibody contains about 90 per cent protein, even when the antigen is one of the specific carbohydrates obtained from pneumococci. An appreciable amount of globulin is taken up by the antigen from the antiserum; the evidence suggests that this globulin is the actual antibody rather than protein adsorbed non-specifically by the antigen-antibody compound. No definite differences between antibody and normal serum globulins have been demonstrated, except the specific power of combining with antigens possessed

by the former. On immunisation, a considerable new formation of globulin takes place, but only a part of this can actually react with the antigen.

Our knowledge of the nature of antigens has been increased by the work carried out in the last decade on the antigenic character of artificial azo-proteins. Various diazotised compounds can be coupled with proteins, combining presumably with the tyrosine and histidine of the protein molecules. The protein then has a new immunological character dependent on the determinant group attached to it. Thus the serum of an animal immunised to it will give a precipitate with other proteins coupled with the diazotised compound; anaphylactic shock can be produced in a guinea pig sensitised to it by injecting another protein containing the same determinant group. Both precipitation and shock can be prevented by the presence of an excess of relatively simple substances coupled with the diazotised compound, for example, an amino-acid such as tyrosine; these substances do not themselves form a precipitate with the antibody.

The specificity of the artificial antigen depends both on the group introduced and its spatial configuration. Natural protein antigens do not apparently contain such characteristic determinant groups, but only differ in the proportions and arrangement of the amino-acids of which they are built and the consequent structural differences. Immunological reactions may reveal differences between proteins which are not detected by physical or chemical methods. In addition to proteins, several polysaccharides have been isolated from different organisms, which react specifically with appropriate antisera, and their structure has been worked out sufficiently for it to be possible to relate this to their immunological behaviour.

The antigen-antibody reaction takes place in two stages: in the first, combination occurs, due to intermolecular forces, the specific character of the combination being ascribed to an appropriate distribution of polar fields on the determinant group of the antigen and on the antibody and to purely spatial considerations, since the approach of a determinant

* Medical Research Council. Special Report Series, No. 194: The Chemistry of Antigens and Antibodies. By Dr. J. R. Marrack. Pp. 135. (London: H.M. Stationery Office, 1934.) 2s. 6d. net.

group to a receptive site on the antibody may be prevented by an inert substance which gets in the way. The presence of such receptor sites on antibody molecules usually makes no difference to the protein, detectable by ordinary means: the adsorbing sites of a globulin acting as an antibody appear different from those by which it is bound when acting as an antigen. Combination of antigen and antibody is usually followed by a secondary reaction, such as precipitation, agglutination, etc. The principal constituent of antigen-antibody precipitates is protein derived from the antiserum. In the case of sensitised particulate antigens, it appears that the antibody globulin coats the particles, conferring new properties upon the complex which are very similar to those of proteins denatured, for example, by heat.

Dr. Marrack's review describes in great detail the features of the second stage of the antigen-antibody reaction and concludes with a brief discussion of the theories of the production of antibodies, including Ehrlich's side-chain theory, with which, he concludes, the developments of immunology appear to be in agreement.

The First Rhodesian Meteorite

SOUTHERN RHODESIAN GOVERNMENT'S GIFT TO THE
BRITISH MUSEUM

IT was announced in the *Times* of May 25 that the first Rhodesian meteorite had been presented to the British Museum by the Government of Southern Rhodesia. The stone, weighing 48 lb. 11 oz. (22 kgm.), has since been received, and it is now on exhibition in the Central Hall of the Natural History Museum at South Kensington. It fell at 12.45 p.m. on March 7, 1934, in the Mangwendi Native Reserve, 40 miles east of Salisbury. A brilliant meteor (fireball) was seen, and three loud detonations followed by a rushing noise were heard, the detonations being heard over a radius of 50 miles. The natives said "the sun came rushing from the sky and buried itself in the earth", and they called the stone "Miminimini" meaning "something to make you gape". In its fall, it broke off the branches of a tree and made a hole 3 ft. across and 18 in. deep in stony ground. The stone itself was broken and fractured by the fall. In addition to the main mass, several small pieces were recovered, and the weight of the whole must have been about 60 lb. But this could have been only a fraction of the original weight when the stone entered the earth's atmosphere at a height of about 100 miles. Travelling with an initial velocity of 20-40 miles a second, the intense heat developed by the resistance of the air melted and dissipated material from the surface, causing a rapid diminution in size of the stone and in its velocity.

Fortunately, the stone was secured soon after its fall by the officers of the Geological Survey of Southern Rhodesia, and in the Survey Laboratories at Salisbury it has been submitted to a detailed and complete chemical and petrographical investigation. It consists mainly of stony matter with small proportions of metallic nickel-iron (3.17 per cent) and iron sulphide (troilite, 4.98 per cent). The stony portion consists of olivine, enstatite and feldspar, forming a compacted mass of minute broken fragments with curious rounded grains (chondrules). Such a structure is not met with in terrestrial rocks, and its mode of origin is still an unsolved problem. Various types of meteoric stones and irons are known.

The new Rhodesian stone is very similar in structure and composition to those which fell as a shower at Soko-Banja in Serbia on October 13, 1877.

While meteoric irons weighing several tons are occasionally found, meteoric stones are invariably much smaller. A large mass of more friable stony matter entering the earth's atmosphere is broken up by the air resistance and falls as a shower of smaller stones; for example, at Pultusk in Poland on January 30, 1868, there was a shower of about a hundred thousand stones. The largest single stone in the British Museum collection weighs 133½ lb.; it fell at Parnallee in Madras on February 28, 1857. The largest mass of meteoric iron in the collection is one weighing 3½ tons, which was found at Cranbourne near Melbourne in 1854.

The first meteoritic specimen to be deposited in the British Museum was a fragment of the famous Pallas iron from Siberia, which was presented in 1776 by the Imperial Academy of Sciences of St. Petersburg; and fragments of one from Argentina were presented by the Royal Society in 1778. Since then, the collection of meteorites has steadily grown, and it is now the most representative collection in the world for the study of these mysterious extra-terrestrial bodies, about which much has yet to be learnt. The new Rhodesian meteorite is the fifth largest stone in the collection, to which it is a very valuable addition. Thanks are due to the Director of the Geological Survey and to the High Commissioner and the Prime Minister of Southern Rhodesia, on whose recommendation this generous donation of a unique specimen was made.

University and Educational Intelligence

THE following awards by the Institution of Naval Architects have recently been made: 1851 Exhibition Commissioners post graduate scholarship in naval architecture, 1934 (£250 per annum for two years), to Mr. Leonard Redshaw, of the University of Liverpool; Elgar scholarship in naval architecture, 1934 (£130 per annum for four years), at the University of Glasgow, to Mr. W. Ainsworth Jameson, of Messrs. William Denny and Brothers, Dumbarton; Earl of Durham prize to Mr. R. A. J. Truscott, of H.M. Dockyard, Devonport.

GERMAN educational reforms are being watched with close attention in the United States. Evidences of this appear in the pages of recent numbers of *School and Society*. In the issue of May 5 is a criticism by Prof. I. L. Kandel, Teachers' College, Columbia University, entitled: "The New German Nationalism and Education". This article alleges that the Nazi regime has set out deliberately to destroy that new education of republican Germany which was beginning to be a model for the world, and that the cult of hatred and revenge is fostered with unprecedented venom and barbarism. A week later appeared under the heading "Science and Education in Nazi Germany" an account of how the *Zeitschrift für Mathematischen und Naturwissenschaftlichen Unterricht* supports enthusiastically the purposes of the *Führer*. There is a very definite preoccupation with military preparedness on the part of several writers of recent mathematical and physical articles in the *Zeitschrift*, and biologists' contributions have emphasised *Völkerbiologie* and *Rassenkunde* as cornerstones of the new German education.

Science News a Century Ago

The Scientific Congress in France

Quoting from *Galignani's Messenger*, the *Times* of September 22, 1834, recorded that "The Scientific Congress, which has been sitting at Poitiers has closed its session. The number of its members amounted to 230". Among the questions discussed was that of the policy of employing troops on public works such as roads, while the agricultural section presented a resolution that "Salt may be beneficially used in the feeding of cattle, and in improving land, consequently the tax upon this article, which prevents it being so used, ought to be reduced". The Congress was deeply concerned with "the immorality which degrades many of the literary productions of the present day"; and it declared that "the French Academy at Rome should be suppressed being no longer of any utility". The proceedings of the Congress, it was said, have proved that the institution cannot fail to increase the welfare and happiness of society, and it was decided that the next meeting should take place at Douai in 1835.

Opening of Leeds and Selby Railway

One of the oldest sections of the London and North Eastern Railway is that from Leeds to Selby about twenty miles long. Authorised in May, 1830, it was constructed by J. U. Rastrick (1780-1856) and was opened on September 22, 1834. The first train left Leeds at 6.0 a.m. drawn by an engine of 18 horse-power named *Nelson*. "To this were attached," says the *Annual Register*, "three of the first class carriages, and six carriages of the second class, the former carrying eighteen passengers each and the latter twenty-four. The requisite preparations having been completed, a start was made; but, the rain having rendered the tram-rails so slippery that the wheels of the engine turned round at times without any sensible locomotion, only two miles were completed in a space of forty minutes. It was, therefore, thought advisable to lessen the drag of the machine as much as possible; and with that view the passengers, who occupied the six second class carriages, were stowed into five of them, and the sixth was left behind. The engine, however, proceeded at the same slow pace for some time longer, amid the jeers and laughter of the bystanders, who called to the police officers and others attendant upon her, to put their shoulders to and push her along". After stopping at Garforth viaduct "the engine shot away with her load, and did the remaining fourteen miles in forty-two minutes, being at the rate of twenty miles an hour". The whole journey occupied two hours and twelve minutes, but the return journey was made in one hour sixteen minutes. Within a year of its opening, the railway, says Sherrington, had in operation combined rail and water passenger fares between Leeds and Hull, and combined rail and road fares between Leeds and York, both through Selby.

Chemistry Lectures at the Royal Institution

In an advertisement in the *Times* of September 27, 1834, under the heading "Royal Institution of Great Britain" it was announced that "The extended and practical Course of Chymical Lectures and Demonstrations for medical and general students delivered in the Laboratory of this Institution, by Mr. Brand and Mr. Faraday, will commence on Tuesday, Oct. 7,

at 9 o'clock in the morning, and will be continued on Tuesdays, Thursdays and Saturday at the same hour. Two courses are to be given during the season, which will terminate in May. For prospectus of the lectures and terms of admission application may be made to the Lecturers or to Mr. Fincher at the Royal Institution". Joseph Fincher was then the assistant secretary of the Institution. Speaking of the lectures, the physician Thomas Gordon Hake (1809-1895) in his "Memoirs of Eighty Years", published in 1892, said: "There was no medical school at St. George's, the anatomical students went to Great Windmill St., where Mr. Caesar Hawkins lectured and taught. The chemical students went to the Royal Institution in Albemarle Street, where Faraday and Brand were professors. The lectures were then delivered at eight in the morning; beautiful and perfect they were; the attendance was very thin. I am proud to remember that I imbibed my first ideas of chemistry at such a fountain head. Faraday was most charming, most unpretending; his experiments never failed, nor did those of his colleague who was a model lecturer; gentlemanly, perfect of expression, exact of execution."

Societies and Academies

PARIS

Academy of Sciences, July 30 (*C.R.*, 199, 329-392). GEORGES CLAUDE: A floating Claude-Boucherot installation. D'ARSONVAL: A visit to the Tunisie. Remarks on the Claude-Boucherot installation for utilising the thermal energy of the sea. NATAN ARONSAJN: Dirichlet's series with linearly independent exponents. EUGÈNE REMES: The effective calculation of Tchebitchef's polynomials of approximation. STEFAN BERGMANN: Integral and meromorph functions with two complex variables. GEORGES ALLARD: A general method of statistics applicable to indiscernible particles. A method for obtaining the law of statistical distribution of the molecules of a gas. This is an extension of Planck's method, and allows a closer analysis than the methods of Bose-Einstein and of Fermi-Dirac. PIERRE LEJAY: Gravity observations in Malaya, the Dutch Indies, Cambogia and Cochin China. Proof that work done with the Holweck-Lejay pendulum is in close agreement with that of Vening Meinesz. D. G. DERVICHIAN: Polymorphism in the monomolecular layers of fatty acids at the surface of water. THÉODORE KAHAN: The thermal variation of the structural demagnetising factor in nickel and cobalt. The existence of the structural demagnetising field in nickel and cobalt is confirmed by evidence of its thermal variation. The factor of this field decreases as the temperature rises. MORICE LETORT: The kinetics of the thermal decomposition of the vapour of acetaldehyde. The true order of the reaction, derived from the initial data, is 1.5: a higher value, approximately 2, results from the wall effect. WILFRIED HELLER: The coagulation of hydrophobe sols by freezing in relation with mechanical coagulation. ANDRÉ DE PASSILLÉ: Study of the dissociation of the ammonium phosphates. Data are given for the dissociation of $(\text{NH}_4)_2\text{HPO}_4$ and anhydrous $(\text{NH}_4)_3\text{PO}_4$. The study of the dissociation of the latter proves the existence of a compound $(\text{NH}_4)_5\text{H}(\text{PO}_4)_2$. RENÉ PERROTTE: Ricinic acid and 12-ketostearic acid. M. TIFFENEAU and MLLÉ.

B. TCHOUBAR: Transpositions in the cyclohexane series. The migratory aptitude of the migrating radical is influenced by its position in space. EDMOND URION: The oxidation of Δ -1-methylcyclohexene by selenious acid. GEORGES DUPONT and WITOLD ZACHAREWICZ: The *cis* and *trans* isomers of myrtanol. GEORGES MIGNONAC and ERWIN DITZ: The polymerisation of acetylene under the influence of heat. A yellow gaseous hydrocarbon, chlorene. The acetylene is passed in a rapid stream through a quartz tube at 750° C. and the products immediately cooled to -70° C. Two dimers of acetylene possessing the composition C_4H_4 were isolated, one of which possesses the remarkable property of being greenish yellow in the gaseous state: the name of chlorene has been given to it. JEAN HERBERT: Study of the corrosion figures of glass. The corrosion figures of glass change with the mode of attack, and have nothing in common with the figures formed when crystals are attacked by an appropriate reagent. The figures change with the concentration of the hydrofluoric acid used. G. DENIZOT: The structure of the Canary Islands considered in relation with the problem of Atlantis. The submersion of the Atlantic area was complete about the middle of the Tertiary period. Afterwards, the accumulation of volcanic products caused emergence from the sea at some points, and at times, relations with the African continent were possible. ANTONIN LANQUINE: Breaches of the Provençal chains at the borders of the northern and eastern Varois regions. R. FAILLETTAZ and R. BUREAU: The records of atmospheric at Tamanrasset (Hoggar) in the course of the Polar Year. F. RATHERY and P. M. DE TRAVERSE: Perfusion of the intestine, and glycolysis. GEORGES BOURGUIGNON: Extemporaneous variations of the chronaxy under the influence of the pain caused by chronic rheumatism. MLADEN PAIC: The rotatory dispersion of the sera of normal and syphilitic rabbits. The suggestion by Rondoni, that the rotatory power of the serum was of value in the diagnosis of syphilis could not be confirmed. MAURICE LEMOIGNE and ROBERT DESVEAUX: The origin of the nitrogen deficit in aerobic microbial cultures. The nitrogen deficiency is due to a transformation, probably an oxidation, of the ammonia arising from the decomposition of the proteins of the medium. HARRY PLOTZ: The filtrability of the tubercle bacillus. Utilising the method of electrophoresis, experiments are described proving that the tubercle bacillus can pass through the L_2 Chamberland filter. This, in the author's opinion, is the true origin of what has been called the tuberculous ultra-virus. CHARLES SANNIÉ and JEAN VERNE: Study of the toxic action of cations on the cells of various organs cultivated *in vitro*.

ROME

Royal National Academy of the Lincei, April 8. G. BRUNI and M. STRADA: New methods for separating heavy water H_2O from ordinary water H_2O . Increase of the heavy water contained in ordinary water may be effected by fractional freezing. Also, large natural carnallite crystals from Stassfurt and Beierenode yield water showing as much as 0.4 per cent of D_2O . L. CAMBI and A. CAGNASSO: Complexes of metals of the first transition series with dipyrindyl and phenanthroline. M. CAMIS: Vitamin content of certain African cereals (1). Existence of the B complex. Experiments on pigeons show that vitamin B is present in *Eragrostis tef*. and *Sorghum aethiopicum*

and, to a less extent, in *Pennisetum spicatum* and *Eleusine coracana*. A. PALATINI: Saint-Venant's conditions in any V_n . W. BLASCHKE and E. BOMPIANI: Enumerative reasoning on mixed textiles (*tessuti misti*). S. BERGMANN: Certain properties of transformations by a pair of functions of two complex variables. L. SOBRERO: Application of hyper-complexes to the problems of plane elasticity (3). M. VILLA: Hyper-algebraic hyper-surfaces. B. SEGRÈ: The moduli of irregular algebraic surfaces. M. RENATA FABBRI: A particular movement of a heavy solid about a fixed point (limit of variability). G. L. ANDRISSI: The system 61 Cygni. Calculations made with the help of the measurements available indicate that the orbit of this double is hyperbolic, but the observations are too few to permit of the calculation of the orbit. A. BARONI: Alloys of lithium and cadmium. A reply is made to recent criticism by Zintl and Schneider of the results of the author's X-ray examination of these alloys. C. COLOMBI and L. PAOLAZZI: Splenic leuco-cateresis.

SYDNEY

Linnean Society of New South Wales, May 30. LILIAN FRASER: An investigation of the sooty moulds of New South Wales (2). An examination of the cultural behaviour of certain sooty mould fungi. Representatives of all types of sooty mould fungi, with controls, were grown on agar media containing a variety of different food materials. The results of these experiments are presented and discussed. H. L. JENSEN: Contributions to the microbiology of Australian soils. (1) Numbers of micro-organisms in soil, and their relation to certain external factors. Counts of bacteria, actinomycetes and fungi in fifty soils from New South Wales, and periodical counts of the same groups of micro-organisms in a soil from Sydney are recorded. The relation of the numbers of micro-organisms to humus content, soil reaction, moisture content and temperature is discussed. Humus content and moisture are shown to be the most important factors in governing the numbers of micro-organisms. H. M. R. RUPP: The habitat, character and floral structure of *Cryptanthemis Slateri* (Orchidaceæ). The supposed association of *Cryptanthemis* with the tuberous roots of *Dipodium punctatum*, R.Br. has been found to be apparent rather than real, and is not constant. It has been established that the flowers are developed and matured beneath the actual surface of the soil; but after maturity, elongation of the rhizome appears to bring the withered capitulum level with the surface, beneath accumulations of debris. The details of the floral structure were established by careful examination of fresh flowers before they suffered any ill-effects from exposure.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, 20, 251-321, May 15, 1934). MARSTON C. SARGENT: Causes of colour change in Blue-green Algæ. *Gloeocapsa montana* was cultivated in an inorganic medium in flasks standing in a glass-bottomed water-bath over various sources of light. The cycle of colour changes from dark blue-green in low intensity light to buff in high intensity light could be repeated several times with a single culture. Colour is dependent primarily on intensity of illumination; colour of incident light, temperature and composition of medium have minor

effects. W. BAADE and F. ZWICKY: (1) On super-novæ. Two types of novæ are recognised: (a) common novæ; (b) super-novæ. The former are fairly frequent in certain systems; the latter have appeared in all stellar systems at long intervals, and at maximum brightness emit nearly as much light as the whole nebula in which they originate. Tycho Brahe's nova of 1572 was probably a super-nova of the Milky Way. It is considered that the appearance of a super-nova represents the rapid transition of an ordinary star into a body of much smaller mass. (2) Cosmic rays from super-novæ. Assuming that cosmic rays are related to a sporadic process, such as the 'flare-up' of a super-nova, the intensity of such rays reaching the earth can be derived; the computed intensity is in fair agreement with that obtained by direct observation. The view is advanced that a super-nova represents the transition of an ordinary star to a neutron star, of very small radius and extremely high density, with emission of cosmic rays. EDWIN HUBBLE and MILTON L. HUMASON: The velocity-distance relation for isolated extra-galactic nebulae. These nebulae show the same relationship as the cluster nebulae; hence their luminosity functions are closely similar. H. H. PLOUGH and P. T. IVES: Heat induced mutations in *Drosophila*. Exposure of larvæ for 24 hours to a temperature of 36° C. produces six times the number of mutations observed in controls, thus confirming the general results of Goldschmidt and Jollos. The number of mutations is approximately the same whether male or female parent is heated, and is doubled when both are heated. Increased tendency to produce somatic modifications is inherited, but only through the female line. CLYDE E. KEELER and W. E. CASTLE. Blood-group incompatibility in rabbit embryos and in man. Of the two agglutinins of rabbit blood, the embryos contain the same agglutinin as the mother, probably via the placenta, unless they have inherited the other agglutinin from the father. A maternal agglutinin is neutralised in an embryo containing the antagonistic agglutinin, but the process is gradual and no blocking of the circulation occurs. A similar process probably applies in man. FRANK H. CLARK: Linkage studies of brachyury (short tail) in the house mouse. No linkage was detected with any of the fourteen other mutant genes generally recognised as being inherited independently. EDWARD W. BERRY: Miocene Patagonia. Preliminary studies of a collection from the valley of the Rio Pichileufu, at lat. 41° 10' S. and long. 70° 52' W. The plant remains are almost entirely of leaves, chiefly of dicotyledons, with a few cyprinodont fish scales and beetle elytra. The plant species confirm generally the findings from Mirhoja, lat. 44° 20' S., long. 70° W. that the flora is a mixture of mesophytic and drier soil types, which enjoyed greater and better distributed rainfall and a more genial climate than the present flora. It is also typically American. MARSTON MORSE and EVERETT PITCHER: On certain invariants of closed extremals. G. A. MILLER: Confusions in the use of the mathematical term group. F. A. SAUNDERS, E. G. SCHNEIDER and EMILY BUCKINGHAM: The strontium II and barium II spectra. CHARLES HAIG: The effect of intensity and wave-length on the response of *Avena* to light. For short exposures (1 sec.) and white light, reaction time decreases with increasing intensity up to 100 millilamberts and then increases. The response curves are rectangular hyperbolæ and in two parts, indicating two photoreceptor processes, which are found, by using partially shielded seedlings,

to be located near the tip and base of the stem respectively. The relative sensitivities of these regions to light of different colour are different. T. W. TORREY: Temperature coefficient of nerve degeneration. The results suggest that degeneration is mainly a chemical process. G. H. PARKER: The prolonged activity of momentarily stimulated nerves. Severing one or more long rays in the tail of a catfish or killifish, causes the melanophores in the radial band thus denervated to assume a state of dispersed pigment producing a marked dark band. This condition persists for a day or so to a week. A fresh cut within the dark band produces a secondary dark band; adrenalin causes all the bands to fade quickly, but as its effects wear off, the bands reappear. A 'cold block' applied to a band also causes it to fade. It is concluded that the nerves concerned remain active for periods up to days after severances from their centres. CLARENCE W. BROWN and FRANKLIN M. HENRY: The central nervous mechanism for emotional responses (2). A technique for destroying the deeper nuclear regions within the cerebrum with a minimal destruction of the intervening cortex. A radio frequency current of 3×10^6 cycles generated by a vacuum tube oscillator was used. The electrode adopted consisted of a nickel silver wire coated with bakelite (outer diameter 0.014 in.) and ground to a smooth point. By this means, regulated destruction of deep-seated nuclei can be achieved, while 'restraining' centres in the cortex are uninjured. T. C. SCHNEIERLA: Raiding and other outstanding phenomena in the behaviour of Army ants. Ants of the genus *Eciton* form temporary colony clusters or 'bivouacs' and move off ('raid') in either 'swarms' or 'columns' according to species. A colony remains 'bivouacked' in a given place (statory condition) when eggs are present and also for about three weeks while the young are in cocoons; otherwise they make a new 'bivouac' every evening (nomad condition). The raids show two peaks of activity, in the morning and afternoon respectively.

Forthcoming Events

Saturday, September 29

MICROCHEMICAL CLUB, at 11 a.m. Second meeting to be held at the University of Reading.

NATIONAL SMOKE ABATEMENT SOCIETY, September 27-29. —Sixth Annual Conference to be held at Glasgow. Dr. H. A. Des Voeux, President.

FARADAY SOCIETY, September 27-29. General discussion on "Colloidal Electrolytes", to be held at University College, London. Discussion to be introduced by Prof. H. Freundlich.

Official Publications Received

GREAT BRITAIN AND IRELAND

The Economic Proceedings of the Royal Dublin Society. Vol. 2, No. 32: Weathering of the Stonework of the National Museum and of Government Buildings. By A. G. G. Leonard and James Ginnell. Pp. 529-532. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 6d.

Scottish Society for Research in Plant-Breeding. Report by the Director of Research to the Annual General Meeting, 26th July 1934. Pp. 30. (Edinburgh.)

OTHER COUNTRIES

Report and Balance Sheet of the National Botanic Gardens of South Africa, Kirstenbosch, Newlands, Cape (and the Karoo Garden, Whitehill, near Matjesfontein), for the Year ending 31st December 1933. Pp. 27. (Kirstenbosch.)

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 86. Zoological Results of the Matto Grosso Expedition to Brazil in 1931. 3: Birds. By Witmer Stone and H. Radclyffe Roberts. Pp. 363-397. (Philadelphia.)