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American and British Coal Production.

THE United States Geological Survey has just issued its detailed Report on the Coal Production of the United States for the three years 1919–1921 ("Mineral Resources of the United States," 1921, Part 2). Whilst it is no longer possible to congratulate the Geological Survey on the promptitude with which it issues these reports, it must be admitted that an exceptionally large mass of statistics is here rendered available. The recent practice is to issue mimeographed weekly reports, which are generally published within a fortnight of the period to which they refer, and to postpone the publication of the printed detailed statistics until these have been carefully compiled and collated; and it must be admitted that there is a good deal to be said for this policy.

These statistics are particularly interesting in Great Britain at the present moment, when British coal-miners have given notice to terminate the agreement under which they have recently been working, with the avowed object of obtaining an increase in wages. Coal-miners in Great Britain are too prone to look only at British statistics, and apparently fail to realise that, as coal producers supplying the world's markets, which directly or indirectly is after all the main object of British coal production, they are in competition with the coal producers of all other nations, and must carefully consider what other nations are doing before putting forward demands which necessarily affect the price at which British coal can be placed upon the markets of the world. It is useless to produce coal at a price which is not competitive so far as the world's markets go, and therefore, in any discussion concerning the cost of coal production, the doings of other nations must be carefully considered, and in this respect none is of greater importance than the United States of America. The quantity of coal produced in the United States during the four years ending 1921 is as follows :

Year.	Bituminous Coal (statute tons).	Anthracite (statute tons).	Total (statute tons).
1918	517,308,840	88,237,520	605,546,360
1919	415,946,480	78,653,750	494,600,230
1920	507,738,110	79,998,470	587,736,580
1921	371,357,850	80,779,870	452,137,720

It is really the bituminous coal production which chiefly affects Great Britain, for the production of anthracite in this country is negligible, while the American output of anthracite is practically all consumed at home, so that it is only the bituminous coal production which comes into competition with the production of British miners. The coal output

of Great Britain may be compared with the above as follows :

	Statute tons.		Statute tons.
1918 . .	227,714,579	1921 . .	163,216,505
1919 . .	229,743,128	1922 . .	249,584,085
1920 . .	229,503,435		

Thus it will be seen that the American production is between two and three times the British. The average value per ton of the United States coal production in the three years in question is as follows :

Year.	Bituminous Coal.		Anthracite.	
	Per short ton.	Per statute ton.	Per short ton.	Per statute ton.
1919	$2·49	9s. 10·8d.	$4·14	16s. 10·1d.
1920	3·75	18s. 3·7d.	4·85	23s. 8·2d.
1921	2·89	13s. 4·9d.	5·00	23s. 2·5d.

In the above the price is shown in sterling per statute ton, the necessary calculations having been made to convert the American quotations (dollars per short ton) to the British equivalents, with due regard to the current rates of exchange. This may be compared with prices for the last three years in Great Britain, namely :

1920 . . . 1l. 14s. 7d.
1921 . . . 1l. 6s. 2d.
1922 . . . 0l. 17s. 8d.

The price of the American coal is thus very much below that of the British, and it is evident that, unless Great Britain is favoured with considerably lower transport freights, competition would be impossible, and that the only chance of this country holding its own in the world's markets is to keep prices down to the lowest possible level. Upon the whole, British coal may fairly be said to be slightly superior in quality to American coal, but though this superiority would be sufficient to give Great Britain the advantage at approximately equal prices, it would not suffice to counterbalance any marked increase of British over American prices.

The main reason for the difference in price is readily seen to be the greater output per man in the United States. This output is determined by dividing the production by the number of men reported as being engaged. The determination of the latter figure is always a matter of some difficulty; the American report states "that the figures reported are not the average number of men actually working at any one time, nor the aggregate number of men who have worked at the mine during the year, nor the absolute average number on the pay rolls, but rather the number of men commonly dependent on the mine for employment. They represent the number ordinarily reporting for work when the mine starts plus the absentees, the men who have been working recently and who will work again, but who for one reason or another are not on hand." The above represents quite fairly what is also aimed at in British labour statistics, but it is difficult to say either in the case of the United States or of Great Britain that this is the figure which is really obtained. The following are the American statistics :

BITUMINOUS COAL.

Year.	Persons Employed.			Days worked.	Average Tonnage (statute tons) per Total of Employés.	
	Underground.	Surface.	Total.		Per day.	Per year.
1919	508,801	113,197	621,998	195	3·43	668·7
1920	529,812	109,735	639,547	220	3·57	786·6
1921	567,289	96,465	663,754	149	3·75	559·8

The following table gives corresponding information with regard to Britain :

Year.	No. of Persons Employed.			Days worked.	Output per Total Persons Employed (statute tons).	
	Underground.	Surface.	Total.		Per day.	Per year.
1920	973,586	253,299	1,226,885	..	..	187·1
1921	908,066	223,530	1,131,596	184	0·784	144·2
1922	921,737	226,732	1,148,469	262	0·829	217·3

A better comparison is obtainable in the output per man underground, the following being the figures for the deep bituminous mines of the United States and for British coal mines :

Year.	American Production, statute tons per day from deep Bituminous Mines.	British Production per day per man underground (statute tons).
1919	4·14	..
1920	4·29	..
1921	4·34	0·977
1922	..	1·033

It has been suggested that this disparity is in part due to the fact that in America a certain amount of coal is got by such methods as steam-shovel mining in open casts, where the production per man employed is very considerable; but a table in the volume before us shows that the production from such open-cast workings is only between 1·2 and 1·6 per cent. of the total output, so that its effect is negligible. Of more importance is the method of mining employed. In America there are practically three methods in use: the coal is either (1) shot off the solid, (2) under-cut by hand and broken down, or (3) under-cut by machines and then broken down, the percentages produced by these three methods being as follows :

Year.	1.	2.	3.
	Per cent.	Per cent.	Per cent.
1919	15·3	23·6	59·2
1920	16·6	20·7	59·8
1921	13·9	18·8	65·6

The following figures show the number of machines in use and the average tonnage produced per machine :

Year.	Machines in Use.	Average Tonnage produced per Machine.
		Statute tons.
1918	18,463	15,665
1919	18,950	12,969
1920	19,334	15,882
1921	19,618	12,412

In Great Britain, shooting off the solid is prohibited on account of the danger connected therewith. There is, however, no reason to suppose that this dangerous method of working very greatly increases the output per man, and in any case only about one-sixth or one-seventh of the total American output is obtained in this way. Attention should rather be directed to the results obtained by mechanical coal-cutters. The following table gives certain particulars respecting coal-cutting in Great Britain :

Year.	Total number of Machines in Use.	Tons cut per Machine.	Percentage of Total Coal cut by Machines.
			Per cent.
1920	5,071	5,954	13·15
1921	5,259	4,383	14·12
1922	5,434	7,016	15·27

At first sight it would appear as though there were ample room for improvement in the British method of operations, and that the situation might be improved by the increase of coal-cutting machinery. Britain is not very far behind, however, in the ratio of the number of machines to the total coal output; thus in 1921, there was in the United States one coal-cutting machine for every 18,929 tons of bituminous coal produced, whereas Great Britain had one coal-cutter for every 31,035 tons of coal output, but it will be noted that in Great Britain the production per machine is much smaller. It is, moreover, unfortunately the fact that all seams are not equally suitable for cutting by machinery, and that American coal seams upon the whole lend themselves much better to machine mining. It is not suggested that the limitations of the use of machinery have as yet been reached, but it may fairly be said that at the present moment Great Britain has more to hope for from the evolution of coal-mining machinery than from more extended application of existing types. In any event, the volume of statistics issued by the United States Geological Survey comes opportunely as a useful reminder to the coal-mining industry in Great Britain of the amount of hard work that will be required from all concerned if the country is to hold its own in competition with the United States as a coal producer and coal exporter.

Sir William Crookes.

The Life of Sir William Crookes, O.M., F.R.S. By Dr. E. E. Fournier d'Albe. Pp. xix+413+4 plates. (London : T. Fisher Unwin, Ltd., 1923.) 25*s*. net.

EVERYONE who knew Sir William Crookes at all well will be sure to turn to his biography with a mind full of charity towards the biographer. For it seemed a singularly difficult task for anyone to portray with fidelity the characteristics of a man who, beyond all his great scientific contemporaries, had the quality of elusiveness. He was also in a peculiar way solitary in his own world ; in spite of intensely human qualities there was something about him which, outside a very narrow circle, forbade friendship to become intimacy. One can suppose that Sir Oliver Lodge would be as likely as any man of science to have come close to Crookes, and he writes indeed a very interesting foreword to the volume ; but even in so favourable a case, we gain nothing pulsating with the warm blood of an intimate friendship.

It does not appear how Dr. Fournier d'Albe came to undertake his difficult task, and perhaps it does not matter. The question is only suggested by the quality of the achievement, for, to the present writer at least, the biographer seems to have been successful to a truly remarkable degree. The book scarcely discloses any personal relations between its author and Sir William Crookes, and though it gives no vivid or detailed picture of the man at work or at play, it seems somehow to give the utmost we could have obtained from any quarter, and far more than we ever expected. It is a pleasure to acknowledge the faithfulness and fairness of the record ; the proportion is quite excellent. Now and again perhaps the reader may be inclined to murmur that something he is reading might have been omitted, yet in the end he will probably feel that admirable justice has been done and that the questioned passages have contributed touches absolutely necessary to portray the man as he really was. Biographies of those who have recently passed away too often lapse into mere eulogies.

It is unnecessary to recapitulate to readers of NATURE the chief facts and achievements of Crookes's life. They make a very wonderful story, and Dr. Fournier d'Albe's book should take its place among the select biographies prescribed to men entering upon a scientific career. It is of the utmost importance that they should see how much of the great work in science has been done unconventionally.

The present writer recalls vividly his first familiarity with the name of Crookes. It was in the days when the scientific world in which Crookes worked was under a strict regime. The standards, both philosophical and

experimental, such as those of Thomson and Tait, to which the young were taught allegiance, were somewhat merciless, and one could almost hear the sounds of a sharpening axe for men suspected of any recklessness in speculation or looseness of scientific habit. Young men of that day heard Crookes spoken of not only as the man who had discovered thallium, but also as a man who had scarce the right to have made so important and unquestionable a discovery. How far these ideas were born of his dealings with spiritualism, of his very mixed celestial and terrestrial chemical interests, his miscellaneous authorship, his speculative scientific views as exemplified in his mistaken interpretation of the radiometer, need not be discussed. But it cannot be denied that to a very large section of the very respectable scientific world, Crookes presented the spectacle of a man of extraordinary ability continuing to sow profusely the wild oats of genius far past the allotted time. His manipulative skill and its products were of course undeniable facts, the ingenuity and boldness of his views unquestionable; but on reading the record of his discoveries to-day, it is impossible not to recall, with an uneasy feeling of regret, the atmosphere of censorious criticism in which he pronounced views that we now perceive had in them so much of the real element of prophecy.

It is, of course, the kind and degree of this prophetic element in Crookes that dominates our thoughts of him, and in the minds of those who spent any time with him there is the haunting memory of a man who carried in his very appearance and manner something of the eerie. Sir Oliver Lodge says "his personality was not specially impressive." That is certainly true of any purely intellectual manifestations, and in the sum it might perhaps be said of the life of Crookes that it stands in something like uniqueness as exhibiting the easy terms of purely conventional intellectual equipment on which a man of true intuition can make great conquests. There is perhaps a danger in this great example, but if there is we may consider it to be far outweighed in the record of Crookes's life by the example of a man of high courage, untiring industry, and great achievement, cutting his own course, immutably true to himself through good and ill report. The present writer gratefully recalls, as many others will do, the unvarying kindness of Crookes to younger men, and his readiness to help them with the great resources of his experimental skill. We may rejoice that in the later part of his life any smart from injustice suffered in earlier days was in his own mind entirely effaced by abundant evidence of the honour in which he was held throughout the world of science.

We may conclude with a passage which might well have stood as a text for this notice. It is extracted from a lecture by Crookes, a lecture delivered—and this is the important fact—in 1879:

"In studying this Fourth state of Matter we seem at length to have within our grasp and obedient to our control the little indivisible particles which with good warrant are supposed to constitute the physical basis of the universe. We have seen that in some of its properties Radiant Matter is as material as this table, whilst in other properties it almost assumes the character of Radiant Energy. We have actually touched the border land where Matter and Force seem to merge into one another, the shadowy realm between Known and Unknown, which for me has always had peculiar temptations. I venture to think that the greatest scientific problems of the future will find their solution in this Border Land, and even beyond; here, it seems to me, lie Ultimate Realities, subtle, far-reaching, wonderful.

Yet all these were, when no Man did them know,
Yet have from wisest Ages hidden beene;
And later Times things more unknowne shall show.
Why then should witlesse Man so much misweene,
That nothing is, but that which he hath seene."

A. SMITHELLS.

Bird Studies.

(1) *Guide to the Birds of Europe and North Africa.* By Col. R. G. Wardlaw Ramsay. With a Biographical Memoir by Dr. William Eagle Clarke. Pp. xi+355. (London and Edinburgh: Gurney and Jackson, 1923.) 12*s.* 6*d.* net.

(2) *Notes on the Birds of Dumfriesshire: a Continuation of the "Birds of Dumfriesshire."* By Hugh S. Gladstone. Pp. 115+4 plates. (Dumfries: Dumfriesshire and Galloway Natural History and Antiquarian Society, 1923.) 10*s.* net.

(3) *The Natural History of South Africa.* By F. W. Fitzsimons. *Birds.* In 2 vols. Vol. 1. Pp. xvi+288+5 plates. Vol. 2. Pp. vii+323+5 plates. (London: Longmans, Green and Co., 1923.) 12*s.* 6*d.* net each vol.

(4) *Birds and their Young.* By T. A. Coward. Pp. viii+151+44 plates (12 coloured). (London: Gay and Hancock, Ltd., 1923.) 10*s.* 6*d.* net.

(5) *Wild Life in Devon.* By Douglas Gordon. Pp. ix+239+8 plates. (London: John Murray, 1923.) 7*s.* 6*d.* net.

(6) *Wild Bird Adventures: a Nature Story Book for Boys and Girls.* By Richard Kearton. Pp. ix+181+32 plates. (London, New York, Toronto and Melbourne: Cassell and Co., Ltd., 1923.) 5*s.* net.

THE stream of books about birds continues unabated. They are written from many different points of view and for different kinds of readers, and they are of varying merit. We have

systematic works of reference and studies of special problems or of particular regions for the serious ornithologist; popular manuals, elaborately illustrated works of the "gift-book" type, and volumes of essays for the more general reader; and stories about birds for the children. The six books which lie before us form a representative collection.

(1) Col. Wardlaw Ramsay's posthumous book, to which Dr. Eagle Clarke contributes a preface and a short memoir of the author, is intended for the shelf of the serious student. It is wholly a work of reference, dealing systematically with the birds of Europe and North Africa. Each species and sub-species is briefly described and its distribution indicated. The information is necessarily given in very summary form, for the volume is quite a small one, but there is no doubt that it will be useful. There are books of every size on British birds alone, but there was certainly room for one dealing within convenient limits with the birds of a wider area.

(2) It is thirteen years since Mr. Gladstone gave us his "Birds of Dumfriesshire," an admirable regional study of avifauna. The present slim volume, in addition to incorporating the list of *corrigenda* and *addenda* issued shortly after the main work, brings the subject-matter up-to-date. Regional works of this kind, and of this high standard, have much more than a local interest. They are of great value to the compilers of works dealing with wider areas, and they will afford a basis for future investigations into changes in avifauna. Even in a dozen years a careful student like Mr. Gladstone has changes to record. The hawfinch, which in 1910 was an uncommon visitor that had once been found breeding, now bids fair to become established in the county. Similarly, the jay is increasing and is extending its range from the south of the county northwards, and the great spotted woodpecker is now firmly established. To the list of "very rare or accidental visitors" the glossy ibis has been added. In 1906 it was estimated that there were 16,488-17,555 rooks' nests in the county: the revised census for 1921 shows a decrease to 15,503-15,999 nests. More serious are the corresponding figures for the black-headed gull, which has suffered from the drainage of lochs and other causes: in 1910 there were 5145-5300 nests according to the estimate; in 1914 this had fallen to 3624-3846; and in 1921 there were only 2563-2737.

(3) Mr. Fitzsimons's first volume consists of a popular essay on birds for South African readers. His point of view is that of the economic importance of birds to man, and the abundance of insect pests in his country gives added force to the moral. His second volume is more a work of reference, although of a popular kind. It has a section on the food of South African birds, a section giving brief accounts of the appearance and habits of the more important species, and a classified list of South African birds, giving their common and scientific names and in many cases also the Dutch and native equivalents. This list has been spread by the printers over more than a hundred pages; it could well have been condensed to make room for a table of contents giving the plan of the volumes and for an index, both of which the work unfortunately lacks. It is well illustrated, and should serve a useful purpose.

FIG. 1.—Snipe on nest: a puzzle. From "Wild Life in Devon." [*F. Pitt.*

(4) Mr. Coward is a well-known writer on birds with a sound knowledge of his subject, and we welcome another volume from his pen. His present theme is one of great interest, for the young of wild creatures never fail to attract. He rightly begins with an account of the different kinds of nests, and from this proceeds to describe the sizes, shapes, colours, and numbers of eggs. One chapter then deals with nestlings of the helpless, "nidicolous" type, and another with chicks of the active, "nidifugous" type. There follow accounts of the habits of young birds and of their parents, and of birds during the period of adolescence and immaturity. In the final two chapters Mr. Coward discusses briefly the habits of mature birds, and in describing courtship and mating he brings the wheel full cycle to the beginning of his main theme. The whole is a competent piece of description, written on a straightforward plan and in plain language without loss of scientific accuracy. The book is well got up and has numerous illustrations, many of them in colour. The artist is Mr. Roland Green, but although his effects are generally pleasing his drawing is at times distinctly "wooden": his kittiwake, for example, will disappoint those who are familiar with this graceful bird.

[*R. Kearton.*

FIG. 2.—An avocet shaking the sand off his feet before resting. From "Wild Bird Adventures."

(5) Mr. Gordon is a sportsman who is also a true naturalist. Often he writes of shooting or hunting, but he has always more than a mere sportsman's interest in the quarry; and he seems to be equally happy without a weapon in his hand or when he is among those wild things which are not "game" in any sense of the word. Some of his best chapters deal with mammals, but his chapter on the nightjar or "fern owl," for example, is charming and full of careful observation. The book consists of a series of unconnected essays. They make pleasant reading and are obviously the outcome of a deep delight in wild Nature. The illustrations include several excellent photographs of beasts and birds by Miss Frances Pitt (Fig. 1).

(6) Mr. Kearton addresses his book to children and so disarms criticism of such chapter headings as "Why the Whinchat Chatted," "Why the Old Grouse Groused," or "How Reggie Helped the Redshank." The characters are referred to throughout as "Mrs. Wagtail" or "Mr. Rat," while the author, thinly disguised as "the old naturalist in grey," moves through the stories in the rôle of a benign providence—with a camera! But, despite the anthropomorphism of the treatment, perhaps inevitable in this kind of writing, the little incidents described are based on intimate observation. The illustrations, *e.g.* Fig. 2, are of the high standard which has been so long associated with Mr. Kearton's name.

Geometry in Schools.

The Teaching of Geometry in Schools: a Report prepared for the Mathematical Association. Pp. 74. (London: G. Bell and Sons, Ltd., 1923.) 2*s.* net.

THE Report on the Teaching of Geometry in Schools prepared by a Committee of the Mathematical Association is, up to a point, a restatement, most welcome for its freshness and the authoritative character of the source from which it comes, of doctrine that is now more or less thoroughly understood. This perhaps we may sum up as follows: by the time a boy is through his Fifth Form, or School Certificate work, he should not merely know the more interesting theorems of Euclid I.-IV. and VI., but should also have systematised or organised his knowledge at least back to the fundamental propositions, *i.e.* Euclid I. 4, 8, 26, 27-29. Special emphasis is laid on this systematising; and this is unquestionably the point which needs the attention of teachers at the present time: "the average boy should be submitted to Euclidean rigour at the right time and not before. . . . The Euclidean discipline was ineffective in the old days because it was given too soon; perhaps the danger at the present day is that it may not be given at all."

So far there is no difficulty, even for the teacher who is not a specialist; the work is straightforward, and given ordinary intelligence and teaching skill, can be

carried out effectively. But the Committee proceeds to discuss the more difficult question: what is to be done as to these fundamental propositions themselves?

Three courses are open: (1) to leave them alone; (2) to adopt Euclid's treatment; (3) to amend Euclid's treatment in the light of modern criticism.

First as to congruence. To a Fifth Form boy, Euclid's method of superposition presents no difficulty; but "it is a tissue of nonsense" and "should not be used at any stage." The Committee therefore advises that the general "principle of congruence" should be stated as an axiom, and that Euclid I. 4 should be derived from it by an argument which "resembles very closely the argument by superposition" and is stated at length.

For practice two questions arise: can it be done? and is it worth while? As the Committee admits, "the argument is one which teacher and student alike will tend to avoid"; and this is certainly true. To the average boy it will be repulsive in the extreme. Still it is merely wearisome, not impossible.

The other question is more serious. The underlying difficulties are philosophical rather than strictly mathematical. The idea of "uniformity" in the universe is difficult to grasp unless one can conceive the opposite; and a boy will certainly be puzzled by the expressions "a given distance, a given angle," if he has to lay aside his ordinary notions of measurement based on the actual motion of a rigid body. At the best a Fifth Form boy's geometrical knowledge and power are not very highly developed, and it may be urged that he will be better employed in developing them further by straightforward work, than by attempting to deal with these fundamental and difficult questions. It is suggested that discussion of these would be more in place in Sixth, than in Fifth Form work.

Next as to parallels; here there is no difficulty. As the Committee rightly states, "at the age of fifteen a boy will be able to appreciate the need of an axiom and the distinction between direct and converse theorems"; *i.e.* there is no difficulty now in making him appreciate the argument of Euclid I. 16, 27, axiom, 29. Further, this argument is sound in itself, and there is therefore no reason why it should not be adopted. It may be added that experience shows that, provided it comes at the proper time, *i.e.* after the subsequent work has become familiar, boys will thoroughly enjoy the process of working backwards through these propositions—a very different process from the old way of reading Euclid.

But while the Committee apparently approves this treatment for ordinary use, it discusses at some length a very interesting alternative, namely, the assumption of a general "principle of similarity" and the deduction therefrom of the ordinary propositions about parallels.

The suggestion can be defended on scientific grounds and is attractive in many ways; whether it would be wise to adopt it generally is another question. It means a revolution in existing practice, and while the work generally is so weak, this is not desirable unless for the strongest reasons. So it seems right to examine the Committee's reasons with some care.

"(i.) No observations are more obvious, familiar, and striking than that . . . the plan of a figure may be realised in an endless variety of scales. These facts should therefore be taken as the formal basis of argument."

Even if the premiss be granted (and it seems an overstatement), the conclusion does not follow. A child's idea of a circle or a sphere is that it is the "same all round," a very true and important idea; but one needing analysis before it can be used as the basis of argument. We deliberately discard it and introduce a quite different conception. Similarly the Committee advises that symmetry should be used freely "to enable the student to appreciate immediately certain facts about the matter in hand; but the Committee does not recommend it for purposes of formal proof."

"(iii.) The adoption of the policy advocated would strengthen the position of similar figures in the earlier stages."

But there is no difficulty whatever in bringing the equivalent of Book VI. into the work quite early, *e.g.* before circles, and this is in fact sometimes done.

"(iv.) The postulate of similarity resembles and supplements the postulate of congruence in an obvious way that is gratifying to the æsthetic sense." This is both true and important, but the doubt has already been expressed as to whether it is wise to deal thus with congruence in Fifth Form work. The alternative would be to keep to Euclid's treatment in the Fifth Form and to discuss the whole subject afresh in the Sixth, especially the various possibilities of rearrangement.

"(v.) The independence of the postulate of similarity can be made acceptable by very simple means." Reference is made to the spherical surface, where congruence holds, but similarity does not. This is specious, but unconvincing; to the boy the spherical surface is a three-dimensional entity in a sense in which the plane is not, and he will say, quite rightly, "I can double the sides of the spherical triangle and retain the angles, but I must double the radius of the sphere." In fact, the reference really leaves us in ordinary space where similarity does hold, and the independence of

the two postulates is not shown. To make the contrast effective the reference must be to three-dimensional spherical geometry (Riemann's) or to hyperbolic, and this is beyond the boy's scope; a curved surface is familiar, but "curved space" is not.

"(vi.) The new plan has over Euclid's an important psychological advantage. . . . A beginner does not readily appreciate the necessity of proving a converse; consequently the far-reaching significance of the assumption about parallels tends to be overlooked. This can hardly happen in the case of the postulate of similarity."

This argument the Committee has already demolished by pointing out that "at the age of fifteen a boy will be able to appreciate the need of an axiom and the distinction between direct and converse theorems." It looks as if for a moment the Committee had nodded, and confused the Fifth Form boy with the "beginner" in the Third.

Perhaps the workable compromise would be in the lower Forms to accept Euclid I. 4, 8, 26, 27-29 as known facts (as the Committee approves); to systematise the subsequent work on this basis in the Fifth (this is necessary as the minimum); further, still in the Fifth, to explore Euclid's theory of parallels and Book I. 8, 26, but still to retain Book I. 4 as an axiom (as of course Hilbert does); but to leave to the Sixth Form the exploration of the alternative method and the fundamental difficulty of congruence. For a Fifth Form, Euclid would be a very good text-book, not in all its details, but in its general order; our teachers at least ought to be thoroughly familiar with this first of all; discussion of alternatives would be both more interesting and more fruitful with this as a solid background.

Our Bookshelf.

Type Ammonites. By S. S. Buckman. Vol. 4. (Recd. in 11 parts.) Pp. 68+197 plates. (London: Wheldon and Wesley, Ltd., 1922–3.) 6*l*.

THIS publication, we are told, is concerned with the illustration of ammonites from the Jurassic strata of the British Isles. The present volume includes plates 269-422, good, bad, and indifferent, but in numbers a generous proportion of the whole. In a work entitled "Type Ammonites" the illustration of old and hitherto unfigured species is appropriate; but the publication of *Chalcedoniceras chalcedonicum*, for example, has yet to be justified, generically and specifically; and in the absence of descriptions, Galilæiceras, Galilæites, Galilæanus, and others, possibly from the same bed, may well be taken to be individual variations of one species.

There could scarcely be a sharper contrast than the parts now before us and the excellent first volume. Subscribers had been told that, beginning with volume iii., it was necessary to issue plates only and to discard the descriptive letterpress, but that the "necessary" text would run consecutively. In volume iv., with the exception mentioned below, there is no such text, and without at least comparison with known forms, it is impossible to recognise such objects as the "*Ammonites biplex*" and "*Ammonites virgatus*" of plates 402A and B, given a new generic and specific name. The palæontologist who may use this work already knows that in the Portlandian, as in other rocks and road-heaps thereof, there may yet be found many mysterious types.

There is, in the last part, a "series of short diagnoses" relating to the family Macrocephalitidæ, which is intended to illustrate the method of working with regard to generic names. In the opinion of the reviewer sufficient condemnation of this method is contained in Mr. Buckman's concluding sentence: "The totals [of numerical values] therefore give the natural order."

All who are interested in the stratigraphy of the Jurassic, however, will welcome this volume, for it contains Part I. of Jurassic Chronology, comprising the Upper Oolites. This marks a very important advance in stratigraphical correlation; and, though found to be wrong in detail, will remain a monument to its author's genius. In view of recent criticisms of zonal palæontology, it cannot be emphasised too strongly that modern detailed work is not a mere splitting up of existing zones into minute subdivisions but an amplification of the very incompletely understood Jurassic record.

It seems to us contrary to all Mr. Buckman says in his chronology, to assume identity of the refigured ammonite of Langius (1708) with Sowerby's *Ammonites bucklandi*. His generic classification also cannot be accepted. The genus Ammonites s.s., dating from 1876, has for type *Ammonites bisulcatus*, Bruguière, and the first definite representation of this form is d'Orbigny's. At any rate, this has since been taken as lectotype of Ammonites, Bruguière emend. Meek. It would have been more profitable to clear up the confusion caused by Mr. Buckman's restriction of Harpoceras to *Ammonites falcifer*, and the reference of its genotype, namely, *Ammonites serpentinus*, to the new genus Hildoceratoides.

Atomtheorie des festen Zustandes (*Dynamik der Kristallgitter*). Von Max Born. Zweite Auflage. (Fortschritte der mathematischen Wissenschaften in Monographien, Heft 4.) Pp. vi+527-789. (Leipzig und Berlin: B. G. Teubner, 1923.) 3*s*. 8*d*.

THE author produced his "Dynamik der Kristallgitter" in 1915 as one of the monographs of Blumenthal's "Fortschritte der mathematischen Wissenschaften." This led to an invitation to write an article for the Mathematical Encyclopædia. Before this could be carried out, Prof. Born had accumulated material for a second edition of his monograph; and as time did not allow of the performance of the double task, he produced the present work to do duty both as an article for the Encyclopædia and as a second edition of his earlier work. The "Dynamik" has been completely re-written and expanded from 122 to 260 pages.

The "Atomtheorie" is to all intents and purposes a new book, rather than a second edition of the old, though on the same lines. It has been adapted to encyclopædia purposes by the addition of a large

number of references and accounts of earlier work on the same subject. The attempt to make the book do double duty is perhaps as good a success as could have been expected, though at times a sudden transition from the encyclopædia to the text-book style, or vice versa, is rather startling.

It is to the mathematical physicist that the author makes his appeal, rather than to the crystallographer. His purpose is to explain the phenomena of elasticity, piezo-electricity, radiation, electrostatic and electromagnetic potential, etc., in the light of such modern ideas as the quantum and X-ray diffraction, basing his work on assumptions about the interaction of atoms the positions of which form simple or interlacing space-lattices.

The book is not easy reading, but it will be a valuable and interesting addition to the library of any reader of the class for which Prof. Born is writing. H. H.

Palgrave's Dictionary of Political Economy. Edited by Henry Higgs. Vol. 2: F-M. Pp. xix+962. (London: Macmillan and Co., Ltd., 1923.) 36*s.* net.

"PALGRAVE'S Dictionary of Political Economy" is so well known that it is unnecessary to introduce the new edition, which is edited by Mr. Henry Higgs, who rendered some assistance to Palgrave when the work first came out thirty years ago. Mr. Higgs has wisely decided to introduce very few changes into the text as it stood; he has relegated to an appendix additions to the more important articles. In some instances, as in the case of "Index Numbers" by Prof. F. Y. Edgeworth, he has been fortunate enough to obtain these additions from the pen of the writer who provided the article for the original work.

Volume 2 is the first to appear, and the others will follow in due course. Had the whole of the work been planned for the first time at present, its character might have been very different. But it speaks much for the far-sightedness of Palgrave that his work should still appeal. A few minor changes have been introduced into the articles in the body of the book, and among the more important of those that have been continued in the appendix may be mentioned factory legislation, French and German finance, and recent tendencies in economic thought (French, German, and Italian). As in the body of the book, so in the appendix, a good deal of space is devoted to biographies of well-known economists. Needless to say, too, the new articles are furnished with bibliographies. The general index at the end has been retained, and the new material has, of course, been incorporated. The present edition will be found as useful as ever; and good as was the reputation of the work, in its new guise that reputation has been enhanced.

Eighth Scientific Report on the Investigations of the Imperial Cancer Research Fund. Pp. vi+142+62 plates. (London: Taylor and Francis, 1923.) 20*s.*

THIS report maintains the high standard of its predecessors. It contains ten separate papers, most of which are reprints. Some of these deal with the behaviour and character of cells already cancerous, while a second group deals with the changes which the cells undergo in becoming cancerous. Of peculiar interest and importance is the paper by Dr. A. H. Drew on the growth and differentiation in tissue cultures, for he clearly shows that when cultivated free from connective-tissue elements, tissues and tumours grow as undifferentiated sheets. If, however, connective tissue be added to such growths, differentiation sets in. The connective tissue may be derived from any organ. Thus, the presence of connective tissue from heart will cause the formation of acini in a mammary cancer or the formation of tubules in cultures of kidney. These remarkable results constitute a definite and important advance in our knowledge of the biology of the cancer cell.

A considerable part of the report is occupied by the exhaustive paper of Dr. Alexander Scott on the occupation dermatoses of the paraffin workers of the Scottish shale oil industry. This is the fruit of twenty-four years' labour in the shale district, during part of which time every workman was examined every three months, and it constitutes a unique record for a single observer. The perusal of the report of the Imperial Cancer Research Fund shows clearly that the Director and his co-workers have set themselves high ideals in the study of the problems of cancer, and in certain branches have been rewarded with success.

(1) *Leib und Seele: eine Untersuchung über das psychophysische Grundproblem.* Von Hans Driesch. Dritte Auflage. Pp. viii+115. (Leipzig: Emmanuel Reinicke, 1923.) 2*s.* 6*d.*

(2) *Wissen und Denken: ein Prolegomenon zu aller Philosophie.* Von Hans Driesch. Zweite durch anastatischen Druck hergestellte Auflage mit Ergänzungen als Anhang. Pp. vi+152. (Leipzig: Emmanuel Reinicke, 1922.) 3*s.* 9*d.*

THE third edition of Prof. Driesch's study of the psychophysical problem does not appear to be altered from the second (1920). The second edition was considerably enlarged from the first and developed the theory of the nature of self-hood. The most valuable feature of Prof. Driesch's method in investigating the question of psycho-physical parallelism is the realistic way in which he examines the facts and exposes the paradoxes which result from any attempt to work out an exact parallelism between ultimate physical and psychical elements. His well-known vitalistic theory of "entelechy" precludes the possibility of an exact correspondence.

Chemistry and Physics for Botany Students. By Dr. E. R. Spratt. Pp. vi+196. (London: University Tutorial Press, Ltd., 1923.) 3*s.*

To quote from Dr. E. R. Spratt's preface, "a preliminary knowledge of the elementary principles of Chemistry and Physics is essential to the proper understanding of the life-processes of both plants and animals." Dr. Spratt apparently intends to meet this need, but the book scarcely justifies the addition to its title of "for Botany Students." It appears to be an average course of elementary chemistry with some physics, in which is inserted an occasional paragraph referring to plants. The experiments described throughout are such as any student of chemistry would be expected to perform, and little attempt is made to show their relation to processes of plant life.

Letters to the Editor.

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

The Influence of Temperature on the Action of Insulin.

PROF. MACLEOD, in his address on insulin, reported in the *Lancet*, 1923, ii. pp. 198-204, at the eleventh International Congress of Physiology, while pointing out that frogs can resist "massive" doses of insulin, directed attention also to Krogh's observation that insulin convulsions actually do occur in frogs three or four days after injection, but suggested no explanation of this apparently remarkable fact. Is insulin itself affected by low temperature, or is the carbohydrate and fat metabolism of a frog so low as compared with a mammal that insulin takes longer to act? The following experiments throw some light on the problem.

In the first experiment four frogs (±10 gm.) were placed the day before the injection at each of the following temperatures: 30·5° C., 25° C., 20° C., ±15° C. (room) and 6°-8° C. (ice-chest). Three at each temperature were injected with insulin: 0·45, 1·2 and 3 R.U. (rabbit-units) of insulin respectively. The fourth was left as control. Those at 30° were all dead within 14 hours, while the control at that temperature lived for two days (and sometimes longer in later experiments); at 25° convulsions had developed in 24 to 27 hours; at 20° convulsions appeared in 43 to 49 hours; at 15° in 60 to 70 hours; and at 7° in 120 to 144 hours (5 to 6 days). This experiment has been repeated four times with slight modifications but substantially the same results.

Although there is considerable variation in the general condition of "winter" frogs, which sometimes tended to obscure the results in particular cases, it is clear that *dose* as such has much less influence than temperature on the action of insulin. Frogs at 7° injected with 3 R.U. develop convulsions no more quickly than if injected with 0·45 R.U. At 30°, on the other hand, a slight effect of dose was seen: frogs with 3 R.U. usually died in about 10 hours, while those with 0·45 R.U. lived for 13 to 14 hours. But at 25° the differential effect of such doses as these was scarcely noticeable, and might be less than that produced by differences in individual susceptibility, for twice at 25° frogs with the weaker doses developed spasms before those of the stronger.

This result suggests that the activity of insulin itself is not essentially altered by temperature, but that its speed of action is dependent upon the metabolic rate of the animal itself. That no difference in the activity of insulin is made by temperature can only be definitely shown, however, by determining the minimal convulsion dose at various temperatures. Experiments with this end in view are in progress. One of us (J. S. H.) by experiments on the metamorphosis of axolotls at different temperatures has arrived at similar conclusions regarding the action of thyroid extract.

This conclusion is substantiated by another experiment, the results of which are given in the appended table (Table I.).

Thus insulin must be continuously exerting *some* effect at low temperatures, since the longer an animal is left at a low temperature, the shorter is the time elapsing before the onset of convulsions when it is transferred to a high temperature. Insulin, it appears therefore, acts only as rapidly as the tissues, by virtue of their metabolic rate, are capable of being affected by it.

Further, if one plots the rate of action of insulin on frogs (reciprocal of time to convulsions) at various temperatures against the corresponding curve given by Krogh ("Respiratory Exchange in Man and Animals," Longmans, 1914) for oxygen consumption, one finds that they coincide in a most surprising way.

TABLE I.

Dose 1·2 R.U. All placed at 7° C. at start.

Frog No.	Time after which removed to 25° C.	Time of appearance of spasms after transference to 25° C.	Notes.
	(Hours.)	(Hours.)	
1.	24	18·5	
2.	48	13	
3.	72	11	
4.	96	9	
5.	120	11	No. 5 was a well-nourished female, the rest thin males.
6.	control	—	

If this insulin curve is extrapolated (or a calculation made by assuming a temperature coefficient of about 2), it appears that insulin should bring on convulsions in frogs at 37° in 1½ to 2½ hours. In rabbits, moderate doses bring on convulsions in ½ to 1 hour. That is, although a frog cannot continue existence at a temperature of more than 31°, yet if it could, its behaviour with regard to the onset of insulin convulsions would be nearly that of a mammal.

Since insulin convulsions in frogs have not been hitherto described, we may add a word concerning them. After 24 hours at 25° an insulin frog becomes, like an injected mammal before convulsions, intensely excitable. With the slightest stimulus it makes a tremendously rapid succession of attempts at leaping, which, however, are largely abortive as regards progression. In this stage also the frog appears quite blind. About an hour after this stage of hyperexcitability, a small stimulus—*e.g.*, the mere removal of the frog's container from the incubator—causes a violent spasm. First the hind limbs tremble energetically for about 20 seconds, gradually becoming completely extended and close together; at the same time the fore limbs become folded rigidly against the body, but much lower down than in the sex grasp of the male frog, the eyes are retracted far into their sockets, and for perhaps 5 to 10 seconds the frog remains rigid and stiff in complete extension. A few seconds later collapse follows and the frog becomes inexcitable by any stimulus whatsoever. Yet after ten minutes it may have quite recovered and to a casual observer be indistinguishable from a normal frog. To obtain a typical spasm again in the same animal one must, however, allow it to rest for at least half an hour. Frogs in convulsions may be restored by injection of 0·5 c.c. of 5 per cent. glucose; the effects of which, however, may wear off in 6 to 12 hours.

In respect of the origin of insulin spasms, Macleod concludes from Olmsted and Logan's evidence[1] that the toxic condition resulting from an overdose of insulin acts, in the cat, upon the cells of the medulla and pons; attention is also directed to the similarity between the insulin spasm and an asphyxial convulsion, and the suggestion is made that depressed oxidation may be the common cause. In frogs, insulin spasms must arise from the cord as well as

[1] *Amer. Journ. Physiol.*, vol. 66, pp. 437-444, 1923.

from the medulla, for we have found that convulsions —though less intense—still occur after the brain has been pithed. We have not as yet been able to induce asphyxial spasms in a frog, and therefore cannot compare them with insulin spasms.

It may be added that physiologists desirous of giving a class demonstration of the action of insulin should find in frogs a cheap and convenient material.

JULIAN S. HUXLEY.
JOHN F. FULTON.

The Museum, Oxford, January 22.

Formation of Mammato-Cloud.

IN seeking for a satisfactory explanation of the formation of mammato-cloud, it is natural to attach great weight to the fact that this formation is frequently associated with neighbouring thunderstorms or other evidences of unstable conditions.

In one of the earliest published notes on mammato-cloud, Clouston ("Popular Weather Prognostics," p. 15) states that this formation is, in Orkney, followed by a gale within a period of twenty-four hours. It appears to be not infrequent in those islands, and I have heard a personal description by the observer of an occurrence of mammato-cloud there many years ago, when seven waterspouts were seen on the same day. It is not surprising, therefore, that one turns in the search for an explanation to an examination of the possible causes of instability in the atmosphere.

So far as I am aware, the first clear statement of the way in which instability may arise in the atmosphere is that given by Sir Napier Shaw in "Forecasting Weather," page 172, 1911 edition. Among the causes there examined is the one to which Dr. Simpson directs attention in his letter in NATURE of January 19. I may say that, with Sir Napier Shaw's statement in mind, I was attracted by a similar explanation of mammato-cloud when I read Mr. Dobson's letter (NATURE, December 1, 1923), except that I imagined the vertical temperature gradient in the dry air beneath the cloud to be necessarily less than the "dry adiabatic" rate and little greater than the "saturated adiabatic" rate. A restrictive condition of this kind is necessary if the bulging mammato-cloud is not to break violently through and bring the "air of the cloud" suddenly down below the dry air. In fact I am now inclined to think that the restriction must be even more marked and that the dry air beneath the cloud needs to be actually colder than the air in the cloud (*vide infra*).

It is clear that the development of instability at the lower surface of the cloud cannot be regarded as both a necessary and sufficient condition for the formation of mammato-cloud. There are many occasions when the potential temperature in the cloud becomes less than that in the air below without causing mammato-cloud. Some other condition is required. One condition may be practical identity of horizontal motion in the cloud and in the air beneath it. Usually there does not appear to be much horizontal motion when mammato-cloud is formed. Another necessary condition may be practical absence of turbulence: if there were appreciable turbulence the lower surface of the cloud would be much more irregular than it appears actually to be.

The lower part of a thick cloud layer probably contains appreciably more "fog" than the major part of the layer; and it may be only when this condition is highly developed and evaporation can take place without exhausting the condensed water present in the air, that the well-defined surface of a mammato-cloud can be maintained. The special characteristic of the mammato-cloud is the smoothness and regularity of the apparently spherical segments bulging from the cloud layer.

If instability alone were required one would expect the frequent occurrence of mammato-formation on the upper surface of a cloud whenever that is lifted appreciably. This latter process is the complementary method of producing instability: raising a cloud gives instability above the cloud, lowering a cloud gives instability below the cloud.

I have not been able to discover any true mammato-formation on the upper surface of cloud sheets in the photographs taken from aeroplanes by Capt. Douglas and Lieut. Sessions in France in 1918. It may be that the upper surface would not be raised in spherical bulges, but would be depressed in spherical dimples which would not be readily detected in photographs. There are, however, several photographs in which cumuli are seen bulging upwards from a cloud sheet: and Capt. Douglas wrote, in a note on such a case (August 28, 1918):

"The cumulus only shows boldly if there is little or no inversion above the clouds; if there is a definite inversion of (say) 3° F. or more, the cumuli below only cause a bulge which may rise 2000 feet or more but has gentle slopes."

The question naturally presents itself: Why do we not get cumulus protruding similar distances through the lower surface when instability arises there instead of getting the mammato form? One reason is that evaporation would prevent a very large extension of a cumulus form in a downwards direction: it would also probably lead to ragged edges: and there is sometimes a kind of mammato formation which has ragged edges (Clouston, *loc. cit.*).

To return to Dr. Simpson's explanation, if the cloud sheet is descending the condensed water content will be decreasing and precipitation will not occur. Precipitation does not as a rule fall from the mammato form itself: but it does not appear to be excluded (*Met. Zeit.*, 1922, p. 123), and in such cases the cloud could not be slowly descending.

It seems possible that in some cases at least the formation of the mammato-cloud requires stability at the lower surface of the cloud: the regular and well-defined edge of the best examples suggests a stable surface of separation: and it appears to have been assumed usually that an inversion of temperature did occur at the lower surface of the cloud, the air in the cloud being warmer than the air immediately beneath it (Wegener, "Thermodynamik der Atmos." p. 148).

An inversion of this kind would supervene if there were ascent of cloud over an appreciable area (cf. *Met. Zeit.*, 1920, p. 220), the air above and beneath the cloud being drier (absolutely) than the air in the cloud layer. In such a case instability would arise at the upper surface of the layer and stability at the lower surface. The air from above would break into the cloud: but there would be no break through the inversion at the lower surface of the cloud: the air beneath the cloud would always remain colder than the air in the cloud, even if the ascent went far enough to produce saturation in the former.

There could, however, be a bulging of the cloud into the air beneath it. The lower part of the cloud with the condensed water in it, reinforced undoubtedly in some cases by ice crystals settling from the upper part of the cloud, may be in effect a mixture having a greater density than air of the same temperature in which no condensation has occurred: and the increased density might even in some cases exceed the density in the colder air just beneath the cloud. Once a bulge started, local evaporation at the surface would intensify the downward tendency, but the effect of

the general stability of the system would be in the opposite direction and this would keep the bulges within moderate limits.

The general ascent of the cloud would lead to precipitation if it were continued far enough : so that this explanation would meet two of the difficulties not met by the assumption of a general descent of the cloud, namely, the occurrence at times of an inversion at the lower surface and the occasional occurrence of precipitation from the mammato-cloud.

E. GOLD.

8 Hurst Close, N.W.11,
January 30.

A Plea for Continuous Fundamental Research on the Problems of River Pollution.

THE difficulty in deciding a status of pollution in narrow waters is well illustrated by Prof. Meek's letter in NATURE of November 17, and the present writers hold that it is necessary to search widely and deeply before it is likely that the information desired will be obtained. Indeed, the first result of the formation of local sub-committees for the investigation of river pollution referred to by Prof. Meek has been to bring out the lack of critical and co-ordinated information regarding the biological, physical, and chemical conditions in fresh-water streams, rivers, and in estuaries. The absence of this kind of information must render much work on the conditions in polluted waters inconclusive or even futile. The present letter is therefore written to demonstrate in a general way the necessity for organised continuous work on the biological, physical, and chemical conditions in streams, rivers, and estuaries, *whether polluted or not.*

The effects of pollution on streams are undoubtedly of a varied nature ; they may be immediate and result at once in killing the fresh-water animals, including fish, or may be slow and not cause any obvious death of fish life, resulting nevertheless in denuding the locality of fish. Again, the effects may be suspected, but not known, or may be nil. It is also to be borne in mind that usually no action can be taken against an effluent until it can be proved to be harmful biologically in its resultant effects. All recent large-scale inquiries into cases of alleged pollution of the second or third degrees have demonstrated that lack of precise critical information which is necessary to the finding of a clear positive or negative conclusion.

The fundamental fact, however, with regard to pollution is that in practice it has to be allowed in some form. When pollution results at once in the death of fishes the source of pollution can easily be stopped, but even then the practical question remains of defining a degree of pollution which can be permitted. In many cases there are nothing but doubtful empirical data available for the purpose of defining a permissible pollution. In these cases accurate knowledge of the local conditions of mixing of the water, or indeed of analogous conditions elsewhere, would be invaluable for estimating approximately the elementary facts with regard to the dilution of the polluting effluent at given distances from the polluting source. In a similar way definite information regarding the animals, plants, and bacteria living in unpolluted local streams, or analogous streams, might be invaluable as an aid in determining the degree of pollution effect in a given stream at different points from the polluting source.

These general considerations point to the necessity for (1) determinations of the method and rate of mixing of waters, under different conditions of flood, in streams, rivers, and estuaries, and an investigation of the mode and rates of mixing in different streams with the view of finding out facts of general application. (2) The determination of the commonest animals, plants, and bacteria in several different unpolluted waters the chemical and physical properties of which are also well known, again with the view of eliciting facts of general application. Investigations of this nature could be begun immediately and should be recorded together in some predetermined publication.

In approaching the question as to whether a given river or stream area is polluted or not, one of the first problems is to find out what are the normal organisms present or likely to be present in a given locality, and particularly whether normally the river or stream would be suitable for fish life ; this information is to a great extent unknown and dependent on a knowledge of the general hydrographic conditions in a given area. Having obtained information on these points, it would be possible to investigate to what extent the pollution had affected the life in the waters under investigation.

Now if the general investigation mentioned above were to be carried out, there is good reason to believe that a body of fundamental information would be at hand to apply to the particular problems of polluted waters and to give some hope of arriving at definite conclusions.

The effects of intermittent pollution may, however, be sudden, and be quickly covered up by the rapid recovery of the life in a particular area, hence the necessity for speedy investigation at the outset of the pollution ; indeed, if the pollution were intermittent with a concealed harmful effect the damage done by the polluting substance might be covered up by the rapid recovery of the stream after the temporary effect of the pollution had disappeared. The following example of recovery in an estuary (in sea water) after a known pollution had occurred affords a useful illustration of such an occurrence.

On May 11, 1918, a vessel carrying a cargo of copper sulphate was stranded on the coast of Cornwall close to Padstow and eventually taken into Padstow Docks. A large amount of copper sulphate got into the river and resulted in the death of seaweed and various animals. Mr. St. G. Sargeant, a member of the Cornwall Fishery Committee representing Padstow at that time, stated that all seaweed on the rocks and the foreshore as well as all the limpets and mussels were killed. A large proportion of the cockles on the Padstow cockle beds was also destroyed, whilst a few salmon smolts were found dead on the foreshore. It was also stated that some dead lobsters were found in the pots near the position of the stranding of the vessel. It was believed at that time that practically all the cockles had been killed, and the practical problem arose of restocking the beds. In October 1919 the cockle beds were examined by Dr. Orton and found to be exceedingly well stocked with tiny specimens. He observed also the presence of large cockles certainly more than one year old ; therefore, even at that period, the beds had recovered in health and the problem of restocking needed no longer to be considered. In 1921, after the beds had been closed as recommended, there were present in the beds a sufficient number of marketable cockles to make it worth while to engage a number of unemployed men for about a month in collecting them. This illustration of the effects of pollution and recovery should afford a useful indication of what is likely to occur *undetected* in fresh water.

The problem of pollution research is, therefore, mainly that of the relation of the living organism to its environment. For this reason the problem

is of importance alike academically from the point of view of fundamental research, and practically and economically from the point of view of preserving the fisheries and permitting harmless waste effluent. Actual research work on the subject involves, however, a large amount of correlated biological, hydrographical, and chemical field work supplemented by work in laboratories, and requires the collaboration of specialists in those branches of inquiry. The main problem is, however, clearly a biological one.

It is submitted that regular work on the general conditions of both unpolluted and polluted local streams, rivers, and estuaries should be begun at once with the view of detecting or disproving pollution effects, and of building up a body of information on which can be founded practical observations to determine ultimately what degree of dilution should be brought about to make waste effluents harmless, since the prevention of pollution is the aim of all.

It is thus clear that financial support for researches of the kind noted above can be claimed equally from these bodies interested in fostering fundamental researches of any kind, from those manufacturers interested in the use of rivers for waste effluents, as well as from those interested in the preservation of healthy fishing runs, such as County Councils, local Fishery Boards, and Angling Societies.

J. H. ORTON.
W. H. LEWIS.

Plymouth and Exeter,
January 16.

The Vector Quantum.

THE shift, recently discovered by A. H. Compton, in the spectral lines due to the scattering process, or rather the explanation of the shift proposed (*Phys. Rev.* p. 483, vol. 21, No. 5, May 1923) by Compton on the basis of the scattering of one quantum by one electron, furnishes considerable support for a corpuscular theory of radiation. On the basis of a corpuscular theory, an effect, recently discovered by the present writer (NATURE, September 8, 1923) takes on a new significance. The effect was discovered by taking photographs by Wilson's cloud expansion method, of the tracks of photo-electrons ejected by plane polarised X-rays. Such photographs bring out the fact that most of the photo-electrons are ejected nearly parallel to the electric force of the radiation. Variations in direction of ejection on all sides of the electric force may be accounted for by the initial momentum of the electron in its atomic orbit.

Now the " electric force " of a polarised radiation is a term deriving most of its meaning from the classical wave theory. On a corpuscular theory, why should the quantum eject the photo-electron sideways out of the atom ? Evidently, if we are to conceive of the quantum of radiant energy as a corpuscle of forward momentum $h\nu/c$, as Compton's theory would seem to indicate, we are obliged to conclude that such a corpuscle is not a mere scalar bundle of energy, but possesses a sideways vector property. For, in delivering its energy to the photo-electron, the quantum explodes, so to speak, at right angles to its direction of motion and in a definite plane. Furthermore, from polarisation phenomena, we conclude that such a " vector quantum " once started on its way maintains its vectorial properties constant in direction. Thus we arrive at a conception of the vector quantum as a corpuscle of energy proceeding with the velocity of light, having a forward momentum $h\nu/c$ and possessing the vector property, which it maintains constant in direction as it proceeds, of imparting its energy by a sideways impulse.

On such a view we should naturally look for some evidence of a reaction to the sideways impulse which the vector quantum exerts upon the photo-electron. With a concentrated vector bundle of energy torn from its source and out in space alone we could scarcely expect the ether or the source of the quantum to be a likely seat for the reaction to exert itself upon. This seems to leave us with the atomic nucleus or another electron as the only seat for the reaction impulse.

If another electron acts as the seat to the reaction impulse, it will receive a momentum equal and opposite to that of the photo-electron and about the same energy as the photo-electron. We should then get two photo-electrons having about the same range and starting near the same point. Rather striking confirmation of this view is given by some photographs recently published (Proc. Roy. Soc., fig. 22, plate 12, vol. 104, August 1923) by C. T. R. Wilson. This and other photographs show strange pairs of associated tracks having about the same range and starting near the same point. This confirmation is rendered particularly striking by a remark of Wilson's, " There is, as with pairs of the preceding class, a great tendency for the line joining the points of origins of the two members of a pair to be nearly perpendicular to the primary X-ray beam."

If, on the other hand, the atomic nucleus suffers the reaction impulse, it will receive an equal and opposite momentum to that of the photo-electron, but, since its mass is of the order of 2000 times that of the photo-electron, its energy from the vector quantum would only be of the order of 1/2000 of that of the photo-electron. This should require the introduction of a small term into Einstein's photo-electric equation to take account of the kinetic energy given to the nucleus.

FRANK W. BUBB.

Washington University, Saint Louis,
December 27.

Rapid Variations of the Earth's Potential Gradient.

IN the course of experiments on atmospherics carried out for the Radio Research Board, it has been found that many of these disturbances include a semi-permanent net change of the earth's potential gradient of the order of 0·1 volt per metre. It is natural to consider this change of field as representing the electrostatic effect of the thundercloud, the discharge of which causes an atmospheric. Measurements of the sign and magnitude of this change of field have been made by observing the alteration of the total electric charge on an exposed aerial system of high capacity (cf. C. T. R. Wilson, Proc. Roy. Soc. A, vol. 92, p. 555, 1916). It is estimated that these observations were made at least 200 kilometres from the thundercloud in question, in which case we may be fairly certain that the sign of the electric field change is indicative of the sign of the total electric moment destroyed in the discharge. It is found that the field changes in question are predominantly of one sign, representing the destruction of a field directed towards the earth. The ratio of the number of field changes of this sign to those of the opposite sign so far observed is about 300 to 1.

It thus must be concluded that, whatever the disposition of the positive and negative charges dissipated in the discharge, the resultant electric moment of these charges with respect to the earth is predominantly positive.

It might at first sight appear that these results are not in agreement with Mr. C. T. R. Wilson's measurements of the electrostatic field changes made at short

distances from lightning flashes, as he found a preponderance of field changes in the opposite direction; but this difference is most probably due to the fact that a thundercloud is bi-polar, as Mr. Wilson suggested, in which case the sign of the electric field change in regions near the thundercloud is determined almost solely by the sign of the lower charge dissipated in the discharge.

E. V. APPLETON.
R. A. WATSON WATT.
J. F. HERD.

January 31.

The Spectrum of Manganese.

IN an interesting paper, M. A. Catalán (Phil. Trans., A 223, 1922, p. 127) has found series and terms in the manganese arc spectrum. He has also found "Multiplets," which are combinations of multiple terms.

With the help of the theory of A. Landé (*Zeit. f. Phys.* 15, pp. 189 and 206), E. Back has succeeded in determining the types of the greater part of these multiple terms. It is also possible to calculate the *values* of these terms.

Considering Table IV. on p. 159 of Catalán's work, we see from the triplet separations that the first four multiplets are combinations involving the known terms P and (P+C). By these we can easily get the two new quintuple terms:

$D_1' = 42885{\cdot}2$		$D_1''' = 12730{\cdot}2$	
	229·7		4·8
$D_2' = 655{\cdot}5$		$D_2''' = 725{\cdot}4$	
	169·5		3·5
$D_3' = 486{\cdot}0$		$D_3''' = 721{\cdot}9$	
	116·9		2·5
$D_4' = 369{\cdot}1$		$D_4''' = 719{\cdot}4$	
	68·8		1·4
$D_5' = 300{\cdot}5$		$D_5''' = 718{\cdot}0$	

We see that they are "inverted" terms, *i.e.* $D_1 > D_2 > \ldots$, as Sommerfeld has already remarked (*Ann. der Phys.* 70, p. 48).

Fortunately the remaining five "Multiplets," according to their quintuplet separations, are combinations with the above calculated D′-terms, and we can easily calculate the other terms. The nine multiplets may then be designated:

I.	(P+C) − D‴	V.	D′ − P″
II.	P − D‴	VI.	D′ − D″
III.	D′ − P	VII.	D′ − D‴
IV.	D′ − (P+C)	VIII.	D′ − F
		IX.	$D' - D^{IV}$

The symbols P, (P+C), P″, D′, D″, F are confirmed by the work of Back. The remaining ones can be denominated with considerable certainty as P‴, D‴, D^{IV}. The new terms are all inverted. They are:

$P_1'' = 14943{\cdot}6$		$P_1''' = 10049{\cdot}4$			
	162·2		124·3		
$P_2'' = 781{\cdot}4$		$P_2''' = 9925{\cdot}2$			
	103·0		86·7		
$P_3'' = 678{\cdot}3$		$P_3''' = 9838{\cdot}5$			
$D_1'' = 18148{\cdot}1$		$D_1^{IV} = 11769{\cdot}6$		$F_1 = 16624{\cdot}2$	
	143·2		58·0		115·3
$D_2'' = 004{\cdot}9$		$D_2^{IV} = 711{\cdot}6$		$F_2 = 508{\cdot}9$	
	121·1		44·9		95·5
$D_3'' = 17883{\cdot}8$		$D_3^{IV} = 666{\cdot}7$		$F_3 = 413{\cdot}4$	
	89·8		30·1		71·4
$D_4'' = 794{\cdot}0$		$D_4^{IV} = 636{\cdot}6$		$F_4 = 342{\cdot}0$	
	55·1		17·1		49·0
$D_5'' = 738{\cdot}9$		$D_5^{IV} = 619{\cdot}5$		$F_5 = 293{\cdot}0$	
					28·5
				$F_6 = 264{\cdot}5$	

It is interesting to note that the new term D′ is greater than the greatest known P-term; it should therefore represent a metastable state of the atom. (Like the greatest d-terms in Ca^+, Sr^+, Ba^+, see, *e.g.*, the figs. of Bohr, *Ann. der Phys.* 71, p. 287.) So long as all the terms of manganese are not known, this is of course not absolutely certain.

It should be of interest to seek for still other combinations of these new terms.

S. GOUDSMIT.

University of Leyden,
Instituut voor
Theoretische Natuurkunde.

Monazite Sands and other Sources of Thoria.

THE issue of NATURE for November 10, 1923, contains an article entitled "The Imperial Institute and the Development of Overseas Resources," in which, as a claim to the high value of the work of the Institute, the following statement is made: "The discovery of the monazite sands of Ceylon has destroyed the former German monopoly based on Brazilian material."

According to the Annual Colonial Reports on Ceylon, the treatment of the monazite sands of the island commenced in 1918; and from these reports and other sources it is estimated that the total production of refined monazite sand in Ceylon from 1918 to the end of 1922, when the works were closed down, was 235 tons only. During the same years, the Travancore deposits of the South Indian Coast have yielded 7166 tons; the total from 1914 to the end of 1922 was 12,711 tons of refined monazite sand.

It may be left to the reader to judge as to what extent the Imperial Institute and the development of the deposits of Ceylon were responsible for the destruction of the German monopoly. The following table from "The Mineral Industry during 1922," page 485, will help him:

WORLD'S PRODUCTION OF MONAZITE SAND.
(In metric tons.)

	Brazil (*a*).	United States.	Travancore, India.	Ceylon.
1910	5345	44·3	Nil	..
1911	3627	1·6	819	..
1912	3344	0·6	1135	..
1913	1415	Nil	1234	..
1914	599	Nil	1185	..
1915	439	16·1	1108	..
1916	Nil	16·5	1292	..
1917	1136	34·7	1940	..
1918	499	(*b*)	2117	20
1919	146	(*b*)	2057	40
1920	1153	(*b*)	1667	70
1921	..	(*b*)	1280	70 (*c*)

(*a*) Exports. (*b*) Less than three producers, no statistics published. (*c*) Estimated.

E. H. PASCOE,
Director.
Geological Survey of India, December 11.

THE apparent inconsistency between the statistics quoted by Dr. Pascoe and the statement to which he refers can be explained only by fuller reference to the contributions of the Imperial Institute to the development of the rare earth industry. It should be mentioned that in accordance with general usage, as, for example, in the annual article in "Mineral Industry," monazite sand was used to cover other sources of thoria. In 1903–4 the present writer was endeavouring to secure an output for the monazite of another

part of the Empire, but found it was impossible owing to the German monopoly. Shortly afterwards the discovery in Ceylon of thorite and thorianite, with more than 75 per cent. of thoria, and of a monazite which is unusually rich in thoria, first gave British manufacturers a commercially useful independent source of thoria. In 1906 a sudden rise in prices due to German manipulation led to more active search. English manufacturers, according to "Mineral Industry," 1906, p. 586, "hitherto dependent upon German firms for their supplies, now have hopes that the discoveries of monazite and thorianite in Ceylon and the Transvaal will allow them to avail themselves of an opportunity to obtain an independent supply of raw material."

The Imperial Institute wrote to the Government of India urging, in view of the geological similarity to Ceylon, a further search in southern India for monazite sands; and English manufacturers, stimulated by the Ceylon discoveries, joined in the search. The Geological Survey of India was, of course, fully aware of the importance of monazite, and its officers have made interesting additions to knowledge of the Indian occurrences. It was, however, a prospector, representing the London Cosmopolitan Mining Syndicate, who in 1909 found the rich monazite deposits on the coast of Travancore. The opening up of these deposits, with their 46-50 per cent. of monazite, was, however, for a time prejudicial to the English industry; for they fell under German control, and before the War the material was supplied to German firms at 4*l.* a ton, while English purchasers were charged 36*l.* a ton. In face of this competition the Ceylon deposits could not be profitably worked. Similarly, in the United States, which had once produced the world's largest supply of monazite, production ceased in 1913, and, though it was resumed to a small extent during the War, it stopped again in 1918.

The subsequent discoveries of monazite sands by the surveys organised by the Imperial Institute in Northern Nigeria, Southern Nigeria, and Nyasaland, have also proved of no immediate commercial use in competition with the deposits along the coasts of Travancore and Brazil. It was, however, the Ceylon discoveries from 1904 to 1906 which first gave British manufacturers an independent source of thoria—for five tons of thorite and thorianite were sold in England in 1905 at prices up to 1700*l.* per ton—stimulated the search in likely localities in other parts of the Empire, and thus led to the overthrow of the German monopoly.

THE WRITER OF THE ARTICLE.

Geological Museum, London.

FOR a considerable time, geologists have been much inconvenienced by the fact that only a portion of the collections in the Geological Museum, Jermyn Street, are now accessible, on account of an enormous structure in the building, said to be supporting the roof. I have just paid a visit to the museum and find that the building is entirely closed, and consequently the maps and specimens I wished to consult in connexion with a local question of water supply are not available, and unfortunately these maps are not in any other Institution. On this account, therefore, I have made a fruitless journey.

In order to avoid doing so again, I got into communication with the office by means of the telephone, and to my surprise was unable to ascertain when it would be possible for any one to visit the building, as I am informed the roof is not safe, and consequently visitors are not permitted. Presumably it does not matter if the roof falls on the members of the staff, who are still using the building. Surely it should be possible for the public to be informed of the probable date at which the treasures in the museum may again be available. T. SHEPPARD.

The Museums, Hull.

Foot-and-Mouth Disease.

MAY I briefly supplement my letter on this subject in NATURE of February 2? I should like to ask if it is known whether many of the particular grazing-grounds of cattle among which independent outbreaks of this disease have occurred had been re-converted from arable to pastoral land lately; for example, since the intensive crop-production of the War-time? Further, if any such agreement should be apparent, whether any particular crop, or type of crop, more than another had been under cultivation? If information upon these points is available or could be obtained, consideration of the data afforded might, perhaps, yield useful results bearing on the view I have indicated.

I may add, as perhaps worthy of note, that the great outbreak of 1883 followed upon a period of consecutive bad seasons, as a result of which (and of various economic factors) much land had been allowed to go out of cultivation. H. M. WOODCOCK.

London, February 4.

Tubular Cavities in Sarsen Stones.

IN referring to Mr. Carus-Wilson's interesting note on tubular cavities in sarsen stones (March 3, 1923, p. 292) in my letter in NATURE of August 18, p. 239, which Mr. Carus-Wilson comments upon in the issue of September 1, p. 324, my object was to offer a suggestion as to the meaning of similar structures in general, based on observations made in Australia.

The importance of dune accumulation, with its structural features, is, however, so marked along the Victorian and South Australian coasts that its method of invading coastal vegetation, and its application in this respect to ancient geological formations of like character, is well worth emphasising, and has perhaps hitherto scarcely been sufficiently appreciated.

Since Nature works in many different ways, we can often catch the elusive truth by carefully watching "processes"; and because the encrusting of plant stems and roots is such a feature of coastal invasion by sand it is worth indicating this for further observation.

In regard to Mr. Carus-Wilson's question respecting terrestrial evidence sealed up in the limestone, bones of marsupials, such as those of Procoptodon (one of the extinct kangaroos), Phascolomys (the wombat), and Perameles (the bandicoot), are frequently discovered in the older and newer dunes around the coast. FREDERICK CHAPMAN.

National Museum, Melbourne,
December 10.

An Early Migrant.

WILL you kindly allow me to place on record, as of interest to ornithological readers, that I observed quite clearly a house-martin vigorously flying about yesterday (February 5) near North Acton.

HENRY O. FORBES.

Deanway, Beaconsfield,
February 6.

Heat Transmission and Wall Insulation.

By Dr. EZER GRIFFITHS.

THE practical man's insistence on simple "overall" coefficients has led to the accumulation of lengthy tables of empirical data for use in calculating the heat transmitted through such structures as cold stores, etc., but little attention has been devoted to a scientific study of the basic facts concerning the heat transfer. Consequently, the interesting phenomena presented by even the most elementary case—that of a heated surface placed vertically—have passed unnoticed until recently.

Here it is scarcely necessary to emphasise the fact that no simple coefficient will, under all conditions, permit of the calculation of the heat transmitted from the air inside to the air outside through a wall. The problem naturally resolves itself into a determination of the true thermal conductivity of the material and of the laws governing the transfer of heat from a surface to the surrounding air.

CONDUCTION OF HEAT THROUGH THE WALL MATERIAL.

In the case of a cold stores, the walls of which are made of considerable thicknesses of highly insulating material, it is the pure thermal conduction through

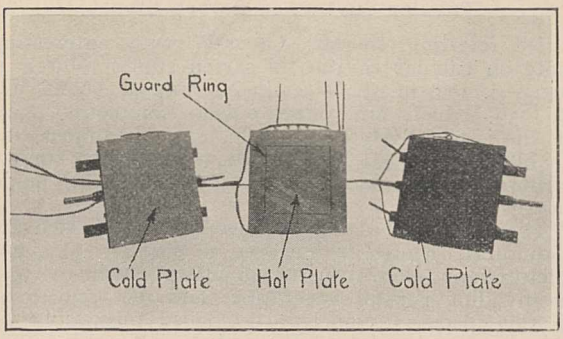


FIG. 1.

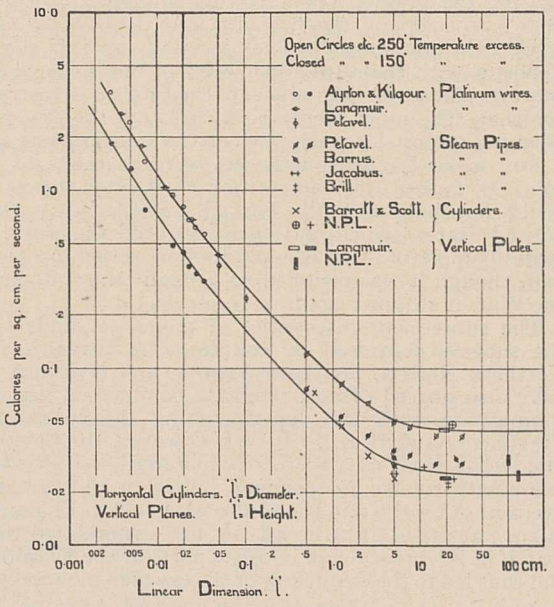
the wall material which is the important factor to be considered. Under the auspices of the Food Investigation Board a wide range of materials has been studied in recent years at the National Physical Laboratory, Teddington. Special apparatus has to be devised for making tests on these materials of low conductivity.

Of the many forms of apparatus devised for this work, that shown in the photograph (Fig. 1) has been found to be particularly convenient for carrying out the tests. Essentially it is a hot plate with "guard ring" around, which is inserted between two cold plates, with the material under test sandwiched in between. The resistor elements are made of nichrome strip threaded through suitably spaced holes in a sheet of micanite. Both hot plate element and "guard ring" element are carried on the one sheet of micanite.

The metal plates are of flat aluminium, the central area being entirely separated from the guard ring by a narrow gap. Insulation from the winding is effected by sheets of micanite. A series of copper constantan thermoelements are attached to the inner surfaces of the metal plates by rivets, and the couple wires are carried out in grooves milled in the plates. Thus the faces of the hot face and guard ring are free from protuberances.

The cold faces are made up of two surface plates of standard type. Each cold surface is maintained at a constant temperature by water circulation, and the surface plates are converted into hollow boxes by closing the back of each by a water-tight cover. Cuts are made in the webs of the surface plates, so as to permit of water or cold brine circulation. A series of small holes, into which thermocouples are inserted, are drilled in the plates parallel to the surfaces to various depths.

When the apparatus is used for powders and granulated material, the plates are kept apart by distant pieces, while solid test samples in the form of slabs are pressed in between the hot and cold plates. In the



EFFECT OF SIZE AND CURVATURE ON HEAT LOSS BY CONVECTION.

FIG. 2.

latter case, in order to eliminate the effect of contact resistance at the boundary between the surfaces of the metal and those of the test specimen, a set of disc thermocouples are placed on the faces of the samples. These couples are electrically insulated from the metal plates by the interposition of a single layer of blotting-paper on each face.

The thermocouples then give the actual temperatures of the hot and cold faces of the specimens, and the couples permanently fixed in the apparatus are used merely for adjusting the temperature of the "guard ring" to exact equality with that of the hot plate.[1]

[1] Data for various insulating and building materials have been published in the following reports and papers:—Special Report No. 5 of the Food Investigation Board on "Heat Insulators." Special Report No. 7 of the Building Research Board on "Heat Transmission through Walls, Concretes and Plasters." Trans. of the Faraday Society, vol. xviii., part 2, Dec. 1922, "Some Materials of Low Thermal Conductivity."

TRANSMISSION OF HEAT FROM THE WALL SURFACE TO AIR.

The magnitude of the heat interchange between a hot surface and the medium in which it is situated is determined by the shape and orientation of the surface and the physical properties of the surrounding medium, such as its viscosity, density, specific heat, etc. The problem of calculating the actual quantity of heat emitted per unit area in any particular case is extremely complex, involving a combination of the Fourier equations of heat conduction with those of hydrodynamics. Even in the case of a plane surface, set vertically, the simplifying assumptions which have to be adopted to obtain a mathematical solution seriously restrict the usefulness of the results. Hence it has generally been found necessary to resort to an experimental investigation.

Taking for simplicity the case of a heated surface in air at ordinary temperatures and pressures, experiments were made to determine the variation of natural convection with (1) the temperature excess, (2) the dimensions of the hot object in the case of a horizontal cylinder the length of which is large compared with its diameter, and (3) the height in the case of a vertical surface.

The object of these experiments was the elucidation of the laws governing convection, and not the study of the specific case of the walls of a cold stores.

Horizontal Cylinders of Various Diameters.—It is found that the rate of heat loss per unit area depends upon the diameter for cylinders of diameters less than 20 cm. In Fig. 2 experimental results have been collected from various sources, corrected in a uniform manner for radiation and reduced to a standard temperature.[2] They refer to diameters varying from a few mils up to 30 cm. Owing to the wide range of diameters covered (10,000-fold), it is necessary to employ a logarithmic scale.

Effect of Temperature.—The law connecting the rate of heat loss by convection and the temperature was determined by experiments made with a polished aluminium surface 50 in. × 50 in., made up of two plates with a resistance grid clamped between them. It was found that the rate of heat loss varied approximately as the 5/4th power of the temperature excess of the surface above that of the surroundings. As will be shown later, the rate of heat loss is a function of both temperature and dimensions of the hot object.

INFLUENCE OF THE HEIGHT OF THE WALL ON THE CONVECTION.

Vertical Surfaces.—Experiments have been made on vertical surfaces of various dimensions. It would be expected from general considerations that with any given vertical surface at a uniform temperature the heat loss by convection from the upper portion would be reduced, since the upper portions would be swept, not by cold air as in the lower portion, but by air already warmed.

For similar reasons it might be anticipated that the average heat loss per unit area from vertical surfaces would be relatively less for those of greater height. Lorenz, in working out the mathematical theory, deduced that the average heat loss per unit area for the entire surface would vary inversely as the fourth root of the height.

The experiments to be described demonstrate the fact that the phenomenon was not so simple as that postulated by Lorenz, and that the height effect cannot be represented by the simple $h^{-\frac{1}{4}}$ law.

The experiments took two forms: in one series a study was made of the heat loss from various elements of a vertical surface built up of separate adjacent units, and in the other the average heat loss per unit area was deduced from a study of the over-all effects determined by experiments on vertical surfaces of different heights.

(a) *Experiments on Wall constituted of Separate Elements.*—Each of the 25 elements constituting a 9 ft. high wall was separately heated and the energy supply controlled so that all the sections were at practically the same temperature. The form of the

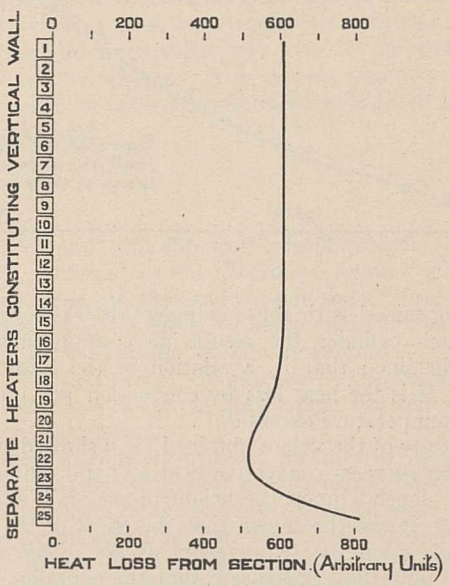


FIG. 3.

curve connecting heat loss per unit area and height is shown graphically in Fig. 3. It will be observed that the heat loss decreases with increasing height up to a certain point where it is a minimum, and then increases again and ultimately reaches an approximately steady value. The only plausible explanation of this minimum is that the stream line motion of the air persists up to a certain point only, beyond which turbulence sets in.

Confirmation of this theory was obtained by exploring the distribution of velocity and temperature in the convection stream past the plate by the aid of a linear type hot wire anemometer and resistance thermometer. It was found that above a certain height the strata nearest the plate did not increase appreciably either in temperature or in velocity. Consequently, they are not themselves carrying away the heat from the upper heaters, but are merely transmitting this heat to the outer layers, which by their increase in temperature and velocity carry it away. In this case the method of heat transmission through the close-lying strata can scarcely be pure conduction through stream-line layers, for the heat transfer is greater than gaseous conduction

[2] Some data for various vertical plane surfaces are also added.

could ordinarily effect. Thus probably the motion of the air is turbulent, resembling rolling, any particle in effect alternately proceeding to the hot plate and then to outer cooler air in its progress upwards, thus actually carrying away the heat at a rate greater than could be the case if this turbulence were absent.

(b) *Variation with Total Height and with Temperature Excess.*—To investigate the matter further, a long electrically-heated cylinder was set up vertically and the heat loss was measured for various steady temperatures. The experiment was repeated with cylinders of different lengths obtained by cutting down the original cylinder, thus reducing the height, but leaving other details unchanged.

On plotting on logarithmetic paper the experimental

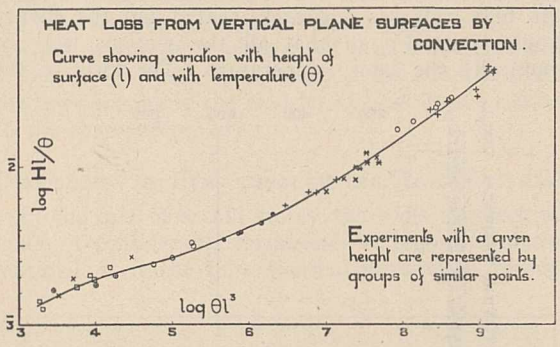


FIG. 4.

data obtained with these cylinders, it was found that for each cylinder the results gave approximately a straight line; that is, a relation of the form $H \propto \theta^n$, where H is the heat loss by convection per unit area for a temperature excess $\theta°$ C.

A study of the values obtained for n showed that the relation between convective heat loss and temperature excess depends upon the height of the wall, and, conversely, it may be shown that the effect of the height depends upon the temperature excess. This pointed to the important conclusion that the equation of heat loss cannot be expressed in such a form that the height and temperature excess are separate factors, but that these variables must be suitably grouped together.

Now the appropriate grouping of the variables may be deduced from the Principle of Similitude, following the general lines of Rayleigh's treatment for convection in a stream of fluid (NATURE, vol. 95, p. 66, 1915). Solving the "dimensional" equations, we find, when only the temperature and size of the hot body are variable, that

$$H = (\theta/l)\, F(\theta l^3)$$

where H is the heat loss per unit area per unit time;
θ = temperature excess of body;
l = linear dimensions of the body;
F denotes an unknown function of (θl^3).

The above formula is applicable only to bodies of similar shape, that is to say, the length, width, and depth of which are always in the same proportion. But with sufficiently wide vertical planes obviously the width will not appreciably affect the heat loss H per unit area, and it may, therefore, be assumed that the formula will also apply to these cases if it is taken to represent the height of the vertical surface. If the above grouping of variables is correct, it follows that points plotted for vertical surfaces with Hl/θ as ordinate and θl^3 as abscissa will all lie on one line, in spite of the fact that different heights (l) and different temperature excess θ are used. In Fig. 4, to cover the wide range, logarithmic values have been plotted, and it shows how well the points lie on a smooth curve.

The point of inflexion implies that there is a certain height for which the heat loss per unit area is a maximum or a minimum. The experiments on the wall composed of separate elements show that the minimum can be observed by direct experiment.

Another feature of the curve is that at its upper extremity it approximates to the form:

$$Hl/\theta = (\theta l^3)^{\frac{1}{3}},$$

i.e. $H \propto \theta^{\frac{4}{3}}$, and so is independent of the height and varies with the temperature according to a $\theta^{\frac{4}{3}}$ law. This is also confirmed by direct experiment. Hence there is strong support for the theory employed in correlating the rate of heat loss with the temperature excess and height.

The detailed account of these experiments will be found in Special Report No. 9 of the Food Investigation Board, entitled "The Transmission of Heat by Radiation and Convection," by E. Griffiths and A. H. Davis.

Local Immunity in Infectious Diseases.

THE usually accepted view that protection against pathogenic bacteria is due to the development of specific antibodies in the blood is disputed by Prof. Besredka of the Pasteur Institute. It is true that after recovery from any infection, or after inoculation with a vaccine consisting of the killed bacteria which cause this infection, the blood acquires properties which it did not possess before; for example, the power of clumping the bacteria or even killing or dissolving them. It was very natural to suppose that the development of these bodies in the blood is directly responsible for recovery from any infection or the failure of the particular organism to gain a footing in successfully vaccinated individuals. Prof. Besredka realised, however, that in certain cases a definite protection exists without the occurrence of such bodies in the blood, and he was led to the belief that their appearance is a secondary and not a necessary sequel to a protection acquired by the special cells which the particular organism preferred.

In the case of anthrax, to which the guinea-pig is very susceptible indeed, Prof. Besredka has proved by ingenious experiments that inoculation of the killed *Bacillus anthracis* into the peritoneal cavity or tissues other than the skin, is not followed by the development of antibodies in the blood, and that no protection against subsequent inoculation of the skin with living organisms is obtained. If, however, the killed organisms are applied to the skin, or, in other words, if the skin is vaccinated, a definite immunity is acquired and the guinea-pigs, which previously would have contracted a virulent infection by the inoculation

of the skin with a very small dose of living bacilli, now are resistant to very large doses. This immunity is not associated with the appearance of antibodies in the blood. It is evident, therefore, that in order to obtain immunity against anthrax it is necessary to increase the resisting power of the special tissue, namely, the skin which the *Bacillus anthracis* favoured.

Prof. Besredka then turned his attention to other diseases, such as cholera, typhoid and dysentery, the organisms of which attack the lining cells of the intestine. If the same principle maintains in these diseases, then in order to produce an immunity it would be best to vaccinate the intestinal wall by bringing the vaccine of killed organisms in direct contact with it. Experiments on animals have shown that such an immunity can be obtained by administering the vaccines by the mouth instead of injecting them subcutaneously by the usually accepted method. Such an immunity, according to Prof. Besredka, is the direct result of the action of the vaccines on the intestinal cells, and not of their absorption into the blood.

Having obtained these results in animal experiments, attention was directed to human beings, and already certain data have been collected which can be interpreted as indicating that, during outbreaks of typhoid and dysentery, those who come in contact with the sick can be protected by the ingestion of tablets of killed bacteria. Arrangements have been made by the Health Section of the League of Nations to carry out an investigation on a much larger scale in the case of outbreaks of cholera in Russia. Another application of this principle which is being investigated is the possibility of vaccinating the skin of human beings against staphylococci, the cause of boils and furuncles. In these cases the organisms develop exclusively in the skin, and already evidence is accumulating that protection and even cure can be obtained by applying vaccines to the skin in place of inoculating them subcutaneously according to the generally accepted procedure.

Prof. Besredka's views are undoubtedly revolutionary and, should they ultimately prove sound, are of the greatest practical importance. The inoculation of vaccines subcutaneously is followed by considerable local reaction and discomfort, and sometimes by actual illness, whereas their local applications to the skin or their oral administration give rise to practically no unpleasant symptoms. It is evident that it would be much easier to induce people to be vaccinated in these circumstances.

Obituary.

PROF. MARCUS M. HARTOG.

BY the death of Prof. Marcus Manuel Hartog in France, at the age of seventy-five years, biological science loses a remarkably accomplished and enthusiastic worker. After a school education in London, he went up to Trinity College, Cambridge, and in 1874 was placed in the first class in the Natural Science Tripos. To many of his old friends it has seemed that if Hartog had had the chance of remaining in Cambridge a year or two after he took his degree to initiate and develop some line of research, he might have attained a position of the highest distinction among the group of Cambridge scientific men of that period; but having married a few months after graduation, he accepted the post of assistant to the Director of the Peradenya Gardens in Ceylon and never resided again in Cambridge. On his return from Ceylon in 1877 he was appointed demonstrator and lecturer in natural history in the Owens College, Manchester, a post which he held until he was appointed to the chair of natural history in Queen's College, Cork, in 1882.

The writings of Prof. Hartog on biological subjects are so widely scattered in English and foreign periodicals that it would be difficult to make a complete list of them, but it may be said that the principal subject which seemed to dominate his mind was the mechanical or chemical conception of some of the more important vital processes. For dealing with such subjects Hartog was particularly well equipped, having a wide knowledge of both botany and zoology and a love of dealing with abstruse philosophical problems. His explanation of the cytoplasmic figure of the dividing cell, published in the Proceedings of the Royal Society in 1904, as a strain figure under the action of a dual force analogous to magnetism, which he called "mitokinetic force," was the result of a long series of careful experiments and profound philosophical consideration. His two papers published in the *Quarterly Journal of Microscopical Science* in 1891 and 1904 on some "Problems of Reproduction" included valuable criticisms and summaries of the results of the researches by various authors of that period, enlightened by the results of his own special work on the developing egg-cell and his keen critical powers.

Hartog was an enthusiastic member of the British Association, and at almost every meeting held within the British Isles he read a short paper on some investigation upon which he had been engaged during the year. At the Bradford meeting in 1900 he discussed the bearing of his discovery of the presence of a peptic zymase in the developing embryos of the frog and the chick, and expressed the conclusion derived from it that a cell which only accumulates reserve material has no need constantly to readjust its surface to its volume, but when a zymase is formed and it is able to use its reserves, the need for augmented surface asserts itself, and we get cell division.

There is not much from Hartog's pen on systematic zoology, but from the time when he was a demonstrator in zoology in Manchester he took a special interest in the Acinetaria, and at different periods he made several communications on the species and on the structure of this small group of Protozoa. Students of zoology are also indebted to him for the excellent accounts he wrote of the Protozoa and Rotifera for the "Cambridge Natural History."

Without in any way underrating the value of the work Hartog was able to accomplish during a long and active life, it may be felt that had he not been constantly harassed by his manifold duties as professor of three subjects and the want of adequate assistance and resources, his record would have been much greater and more important. He retired from the chair in Cork

in 1921 and went to live at Meudon near Paris, where he died on January 21 last. He leaves a widow, one son, and one daughter, the wife of Prof. W. Cra p of the University of Birmingham.

PROF. H. J. HAMBURGER.

HARTOG JACOB HAMBURGER was born at Alkmaar, a small town in the north of Holland, on March 9, 1859, and received his early scientific education from Dr. J. D. Boeke at the "Hoogere Burgerschool," where he was the most distinguished pupil of that eminent teacher. From school he passed to the University of Utrecht in 1879 and, as a student of chemistry, obtained his doctorate four years later. Trained as he was in the severe discipline of physics and chemistry (knowledge to stand in good stead later), other, and perhaps wider questions attracted him, for we find the subject of his thesis was "The Estimation of Urea in Urine."

During this period Hamburger was appointed assistant to Donders for physiological chemistry and to Engelmann for physiology and histology. From them, and through association with them, he obtained his first insight into, and that lifelong love of biological investigation which formed his subsequent work. One particular incident is worth recalling. In 1883 Donders attended a meeting at Amsterdam where de Vries delivered a lecture on plasmolysis. Returning to Utrecht, Donders told his young assistant about it, and the latter immediately applied himself to the somewhat analogous problem of hæmolysis, a question which, extended to the broader aspect of permeability, formed the basis of more than twenty-five years' steady and brilliant research.

After working with Donders and Engelmann for seven years, Hamburger obtained his doctorate of medicine, and in January 1888 he became lecturer in physiology in the Veterinary School at Utrecht, where he remained for thirteen years and occupied himself with such problems as respiration, red blood cells, lymph, and permeability. In 1891 he married Miss F. C. Gosschalk, who was a constant help to him, especially perhaps on the literary side of his activities.

The year 1901 saw Hamburger's appointment, in succession to Huizinga, to the chair of physiology at Groningen, a post he held to the end. Once more we find his outlook expressed in the subject of his inaugural lecture on December 28 of that year, namely, "Physical Chemistry in Medical Science," a subject singularly appropriate to his own research work. Thanks to the personality and assiduity of the new professor a modern Institute of Physiology was erected to replace the building originally equipped during the time of van Deen. This institute is still regarded as a model, and the final tribute of respect of his fellow-workers was reflected in the election of Hamburger as president of the International Physiological Congress, which he received at Groningen in 1913.

The contributions of such an arduous worker as Hamburger cannot be detailed here, but one can note his largest and most ambitious publication, "Osmotische Druck und Ionenlehre in der medizinischen Wissenschaften," produced between 1901 and 1904, only a short time after the fundamental work of Svante Arrhenius on ionic dissociation in liquid media. This and his "Physikalische chemischen Untersuchungen über Phagocyten" are quoted as revealing in no uncertain way the conception of the chemist and the physicist in the scientific objective of Hamburger. Even in the latest work from his laboratory on the elusive question of the biological behaviour of stereoisomeric sugars, one can see the desire to seek explanation on similar lines. A summary by himself of his latest views will be found in the *Lancet*, 1921, ii. pp. 1039 *et seq.*

An attitude such as this must necessarily, and perhaps correctly, entail opposition, but inspection will show the ingenious and simple (and by being simple all the more ingenious) experiments devised by Hamburger and by his school. As an antagonist he was kindly, and the writer treasures several long and careful letters from him on a point raised in conversation regarding some of his work. Such tolerance and patience was characteristic. His own and other countries bore witness to his scientific attainments. Member of the Royal Academy, Amsterdam, he was the recipient of honorary degrees, and a welcome lecturer in England and in America. In terms of years alone he was not an old man; he was but sixty-five; however, after the death of his wife last November he lost much of his wonted enthusiasm for work, his optimism disappeared, his health broke down, and on January 4 he passed away.

Holland as a country is singularly fertile as a source of men of genius. Not the least of this brilliant company was Hamburger. Those of us who were privileged to count him a friend know too well the loss that science has suffered. Physiology is not quite the same without him. J. A. H.

M. ARNAUD DE GRAMONT.

BY the death of Arnaud de Gramont on October 31 last, at the age of sixty-two years, spectroscopy has suffered a loss which it can ill afford. The chief feature of M. de Gramont's work was the investigation of the best means of producing spectra of various types and of the characteristics of the spectra yielded by substances under different modes of excitation. In this somewhat restricted but extremely important department of spectroscopy, he probably achieved more than any other single worker. His earliest efforts were devoted to synthetic chemistry and pyroelectricity, but he soon turned his attention to the subject with which his name is always associated. Spark spectra were the subject of most of his researches, and he early succeeded in devising a method of producing the spark spectrum of a liquid, uncontaminated by the lines of the metallic electrodes employed. Following the work of Schuster and Hemsalech on the effect of self-induction on the spectrum of an electric spark, de Gramont pursued the subject still further, particularly with regard to the spectra of compounds—the so-called "dissociation spectra." He gave great attention to the spectroscopic examination of minerals, embodying the results of his investigations in a very valuable book on the subject.

One of the most useful of the experimental processes which we owe to him is a convenient method

of obtaining the spectra of refractory materials, such as silicates. The substance is mixed with sodium carbonate, placed on platinum foil heated by a Mekker burner, and sparked. Perhaps his best-known work is the investigation of the *raies ultimes* of the elements; *i.e.* the spectrum lines which are most persistent when an element is gradually reduced in quantity. The presence of the *raies ultimes* is the readiest criterion of the presence of an impurity in a substance.

Spectroscopy at the present time is developing more rapidly on the theoretical than on the practical side, because the theoretical workers are more numerous. The loss of M. de Gramont is, therefore, particularly to be deplored. He leaves in the minds and hearts of those who knew him a memory cherished no less because of his noble character and kindly disposition than because of his scientific eminence.

WE regret to announce the following deaths:

Capt. Alfred Bertrand, an honorary corresponding member of the Royal Geographical Society and of the Royal Scottish Geographical Society, a well-known African traveller, on January 30, aged sixty-eight.

Sir Kennedy Dalziel, formerly professor of medical jurisprudence and public health, and also of surgery, at Anderson's College, Glasgow, on February 10, aged sixty-two.

Dr. H. Rashdall, Dean of Carlisle, the author of numerous philosophical works, on February 9, aged sixty-five.

Current Topics and Events.

QUITE recently a Committee, on which science was not represented, recommended curtailment of the operations of the Imperial Institute, including the closing of the public exhibition galleries, which contain representative collections of the natural products of the British Dominions and Colonies, and the reduction of its laboratory work to merely preliminary investigations. It is interesting in this connexion to see that the Dutch have opened recently a Colonial Institute in Amsterdam, which is to carry on for the Dutch Colonies work similar in type to that which the Imperial Institute has conducted for so many years for the British Empire. The new Institute is a handsome building containing excellent collections of Dutch Colonial produce, partly derived from the old Colonial Museum at Haarlem, which has been merged in the new organisation. Extensive laboratories have also been provided in which these products will be investigated systematically. The maintenance of the Institute is secured by annual grants from the Ministries of the Colonies and the Interior and the Municipality of Amsterdam. This Institute has long been under consideration in Holland, and before the War a number of the most earnest advocates for its establishment visited the Imperial Institute and accounts of the operations of the latter played a considerable part in propaganda for the opening of a similar institution in Holland. But in Holland scientific matters are dealt with by scientific men, and as a result the Dutch have, in Java and Sumatra, tropical agricultural industries, such as cinchona-planting, which other countries cannot hope to compete with, and in addition they are able in these Colonies to start the cultivation of such things as tea, rubber, and the oil palm, and by the superiority of their methods to attract British capital away from British Colonies, and to compete seriously with the latter even when their entry into the industry is belated.

VISITORS to the Royal Society's soirée in 1900 and also in 1921 will recall, perhaps, an exhibit of a large enclosed box with peep-holes at either end, through which one saw a painted representation of the interior of a Dutch house, approximately of seventeenth century date. This box belonged to the late Sir Henry Howorth. The authorities of the National Gallery, who deem the box of high interest, have received it as a gift from Col. Howorth, the former owner's son. The chief interest of the interior, apart from its character as a painting, is that it is an extraordinary *tour de force* in perspective, since the picture is painted on three planes and there are no lenses in the holes. Sir Henry Howorth always considered the portrayal of the interior to be the most remarkable example of the application of the scientific principles of perspective extant.

THE British Science Guild is inaugurating on Monday, February 18, a science news service, to which a number of lay journals have already subscribed. It is intended that the service shall provide a weekly signed article dealing with some subject of special interest and a weekly column of science notes. It will also furnish reports of scientific progress. The possibilities of such a service doing useful work for science in promoting the dissemination of accurate information on scientific work are indeed great, but its success must depend on the extent to which it secures the co-operation of men of science. To this end, the Guild is asking for correspondents in the various laboratories throughout the country, in order that it may be possible to keep the public informed of the work that is being done by British men of science. Scientific workers who would be prepared to act as correspondents for the laboratories in which they are working are requested to communicate with Mr. Gordon D. Knox, 2 Guilford Street, London, W.C.1.

WE learn from *Science* that a Metric Standards Bill, providing for gradual adoption in the United States of the metric units of weights and measures in commerce, has been introduced in the House of Representatives by Mr. F. A. Britten, of Illinois, and in the Senate by Mr. E. F. Ladd, of North Dakota. More than 100,000 petitions, directly representing several millions of voters, and urging adoption of world units for weighing and measuring, have been prepared. According to the provisions of the Britten-Ladd bill, the buying and selling of goods, wares and merchandise will be in terms of the metric units after a period of ten years. Manufacturers

are to use whatever measures they choose in production, the bill providing "That nothing in this Act shall be understood or construed as applying to the construction or use in the arts, manufacture or industry of any specification or drawing, tool, machine, or other appliance or implement designed, constructed, or graduated in any desired system." This safeguards manufacturing interests. Many great industrial concerns are stated to be urging metric legislation on this basis.

THE Ministry of Agriculture and Fisheries has instituted at the Reaseheath School of Agriculture, Nantwich, Cheshire, a series of breeding experiments on the effects of inbreeding and outbreeding on the egg-laying qualities of poultry. The experiments are to be carried out as a scheme of the National Poultry Institute, by a sub-committee nominated by the National Poultry Council, and consisting of eight practical poultry breeders from the northern counties with Prof. S. J. Hickson as chairman. Experiments are to be made with white leghorns, Rhode Island reds and white wyandottes. The extensive experiments of Pearl, Harris and others on the inheritance of fecundity in fowls shows that the subject is complex and by no means fully understood. Part of this work indicates that various hereditary factors influencing fecundity are involved, some of which appear to be transmitted by the males to a portion of their female offspring. It is therefore probable that difficulties may be met with in distinguishing between these inherited factors and any direct effects of inbreeding.

M. D'ARSONVAL gave a short description of the Ampere testing laboratory for high voltages at the meeting of the Paris Academy of Sciences on December 10. The laboratory, which is built in Paris, is 18 metres in height, 20 metres broad, and 36 metres long. There are no windows, as darkness is necessary to see when faint coronas appear on the electrodes. A synchronous motor of 190 h.p. is driven from the public supply mains and drives a 500 volt alternator at a frequency of 50. Three large air-cooled single phase alternators are connected with this alternator, each giving a secondary voltage of 375,000. These transformers can be connected in parallel when large power is required. Their windings are so arranged that they can also be connected in cascade or in star. When connected in cascade an effective voltage of a million is obtained between one of the terminals and earth. This gives a crest voltage of 1·4 million, as the voltage wave is sine shaped. Connected in star a three phase voltage equal to 660,000 is obtained, so that the most modern three phase insulators for use on lines at 220,000 volts can be tested with a factor of safety of three. The pressure at the secondary terminals is measured by a spark gap between spherical electrodes. The diameters of the spheres used are 25, 50 or 100 cm., depending on the pressure. Artificial rain is used when chains of insulators are tested at high pressure. There is also a large tank three metres deep filled with oil for tests on the perforation of insulating materials under electric stress.

THE annual general meeting of the Physical Society of London, held on February 8, was marked by the presentation to Prof. H. L. Callendar of the first Duddell Memorial medal. This medal, which was instituted last year, in honour of the late William Du Bois Duddell, is awarded to "persons who have contributed to the advancement of knowledge by the invention or design of scientific instruments or by the discovery of materials used in their construction." Dr. Alexander Russell, the retiring president of the Society, in making the presentation, mentioned briefly the many contributions to the science of heat and allied subjects which Prof. Callendar had made. These included: (1) the electrical resistance thermometer, first communicated to the Royal Society in 1886 and 1887, which affords an accurate instrument for research and a convenient one for industrial purposes. In connexion with this were developed the Callendar-Griffiths bridge and various forms of recorder. (2) The electrical continuous flow calorimeter (invented in 1886, communicated to the British Association in 1897, and more fully described to the Royal Society in 1902), in which the water equivalent is eliminated and the radiation correction simply determined—an instrument which has rendered possible important work on specific heat and other subjects. The method employed therein has been reversed in the compensated electric air flowmeter (recently described by the Aeronautical Research Committee), which gives direct readings independent of temperature and pressure. (3) The compensated air thermometer described before the Royal Society in 1891, and the radio balance described before the Physical Society in 1910. (4) The Callendar steam equation enunciated to the Royal Society in 1900, and kindred researches on steam. (5) Researches on internal combustion engines, leading, amongst other things, to the design of the Watson high speed indicator for such engines. (6) A number of papers on thermometric scales, radiation, vapour pressure, and kindred subjects communicated to the Royal and Physical Societies, the *Philosophical Magazine*, the "Encyclopædia Britannica," etc. Prof. Callendar was warmly acclaimed on receiving the medal.

IN the course of three lectures on advanced psychology delivered at University College on February 4, 6, and 7, Dr. Morton Prince said that his views differed widely from those of his friends the psychoanalysts. He showed how to all perception there is a background of emotions, secondary images, ideas, and neurograms, which compose the settings and root-dispositions. Differences in these settings, which lie in the twilight zone and in the ultramarginal zone or co-conscious, determine differences in conscious awareness. Under hypnosis the setting can be divorced from ideas and perceptions. For example, "the hand of the doctor" can change into "somebody's dead hand." Thus the egocentric (private) meaning is determined by the setting. When a person has had two or more distinct and incompatible experiences of life, the settings and root-dispositions arising therefrom form two or more co-conscious

personalities. Therapy consists in synthesising these dissociated selves into one by altering the setting. For example, a woman had a phobia of towers and steeples. Under hypnotism and by automatic writing the phobia was revealed as hate for church bells. They rang when her mother died. Her history further revealed fear that she had been the cause of her mother's death. Dr. Prince was able to show to her own satisfaction that she could not have been guilty, and thus changed the co-conscious setting of her conscious memories, ideas, and perceptions. This procedure freed the subject from the phobia. From his experiments with visions and hallucinations, particularly with those artificially induced, Dr. Prince believes, in opposition to the psycho-analysts, who regard them as regressions to childish modes of thinking, that they are highly complicated mental processes comparable in every way with conscious processes. In fact, the dissociated "selves," the phenomena of the "unconscious" and of multiple personality, are but different traits of character that have not been reconciled.

MAJOR A. G. CHURCH, secretary of the National Union of Scientific Workers, has been appointed Parliamentary private secretary to Mr. Sidney Webb, president of the Board of Trade.

THE name of Sir Otto John Beit appears in the list of resignation honours recommended by the late Government as having been created baronet for services rendered to the Imperial College of Science and Technology at South Kensington.

APPLICATIONS are invited from honours graduates in chemistry for two posts at the Fuel Research Station, East Greenwich, viz. those of an assistant chemist and a junior assistant chemist. Applications have to be made in writing by March 1 to the Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1.

A JUNIOR technical assistant for wireless experimental work is required at the Royal Aircraft Establishment, South Farnborough, Hants. Candidates must have had technical training to the standard of an honours degree, and some experience in electrical engineering research or physics. Applications for the post, marked A. 24, should be sent to the Superintendent.

APPLICATIONS are invited by the Department of Scientific and Industrial Research for the position of director of research into building materials and methods of construction. Candidates should possess high general scientific qualifications, with research and architectural-engineering experience. The latest date for the receipt of applications (which should be addressed to the Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1) is Saturday, March 1.

SIR JOHN BLAND-SUTTON, president of the Royal College of Surgeons; Dr. James Colquhoun Irvine, principal and vice-chancellor of the University of St. Andrews; and Mr. William Barclay Squire, have been elected members of the Athenæum Club under the provisions of Rule II. of the Club, which empowers the annual election by the Committee of a certain number of persons "of distinguished eminence in Science, Literature, the Arts, or for public service."

THE following committee has been appointed by the Postmaster General to consider and advise him without delay on the policy to be adopted as regards the Imperial wireless services so as to protect and facilitate public interest: Mr. Robert Donald (chairman), Mr. F. J. Brown, Prof. W. H. Eccles, Sir Drummond D. Fraser, and Sir Henry H. Slesser. Mr. W. E. Weston, of the Post Office, will be secretary to the committee.

PROF. ALBERT SAUVEUR, of Harvard University, has been awarded the Bessemer gold medal of the Iron and Steel Institute for 1924, in recognition of his eminent services in the advancement of the science of the metallurgy of iron and steel. Prof. Sauveur hopes to make the journey to London in order to receive the medal at the hands of Sir William H. Ellis, who succeeds to the presidency at the annual meeting of the Institute on May 8-9.

AT a recent meeting of the executive committee of the Empire Cotton Growing Corporation, Mr. F. R. Parnell, economic botanist to the Government of Madras, was appointed to a post as plant breeder under the Corporation. He will proceed to South Africa shortly to work under Mr. S. Milligan, who has resigned his post as agricultural adviser to the Government of India to take up an appointment with the Corporation, to advise the Government of the Union of South Africa on all matters connected with cotton growing.

IT may be a sign of the times that a Secretary of State should arrange for a lecture on pure science to be delivered at his office, and that the Prime Minister should attend the lecture and address the meeting. This was the case, however, at the lecture given at the India Office on February 9 by Sir Jagadis C. Bose, who outlined the results of some of his well-known work on vital phenomena in plants, and illustrated the lecture with experiments. The Prime Minister, speaking as an old friend of the lecturer, paid a tribute to his achievements as a scientific worker. The growth of the Bose Institute, founded in Calcutta by the lecturer, proved also that India possesses men of great public spirit; and he suggested that action similar to that of Sir Jagadis Bose might well be imitated in Great Britain, which is greatly in need of such manifestations of genuine patriotism. From the distinguished company present Mr. Bernard Shaw, in characteristic remarks, referred to the circumstance of the presence, at a scientific lecture, of a Prime Minister and a Secretary of State for India, both of them apparently interested in science and able to talk about it.

A COMMITTEE, consisting of Mr. E. G. Pretyman (chairman), Mr. A. Batchelor, Mr. H. German, and Dr. W. R. Smith, has been appointed by the Minister of Agriculture to examine into the circumstances of the recent outbreak of foot-and-mouth disease; to

review and report upon the slaughter policy and the procedure adopted by the Ministry of Agriculture; to advise whether any further precautions should be taken to guard against the introduction and spread of the disease; and to consider whether a scheme of insurance can be devised as an alternative to the existing system of compensation for slaughtered animals. Mr. S. A. Piggott, of the Ministry of Agriculture, will be secretary to the committee. With regard to the question of scientific investigation the Minister is awaiting the report of Sir William Leishman, who was invited by the late Government to consider the problem and to advise as to what further scientific investigations and experiments might usefully be undertaken.

THE annual meetings of the Geological, Paleontological, and Mineralogical Societies of America were held in Washington, D.C., at the close of last year. The respective presidential addresses were: David White, gravity observations from the point of view of local geology; T. Wayland Vaughan, criteria and status of correlation and classification of Tertiary deposits; E. T. Wherry, the surface of a crystal. Among the larger subjects discussed were: Earth-movements and mountain-building, glacial and Pleistocene geology of North America, geology of Mongolia and the Tsin-Ling-Shan in China, and various stratigraphic problems. The Paleontological Society held a symposium on the correlation of American Tertiary formations with those of Europe, and discussed some of the older palæozoic rocks of North America. At its business meeting Dr. F. A. Bather, of the British Museum, was elected to honorary membership as a correspondent.

THE losses in the Arctic sustained by the Norwegian Meteorological Service in obtaining weather information for the rest of the world to use in drawing daily synoptic charts are referred to in the *Meteorological Magazine* for December by Dr. G. C. Simpson, director of the British Meteorological Office. Last year, prior to September, three men in the Service lost their lives in the Arctic, and further losses of ships and lives have come to hand. In the autumn of 1922 the ship *Annie* reached Mygbugten and commenced a series of weather messages from Greenland which has proved so useful to the British Weather Office. The Norwegians have also maintained weather observations at Jan Mayen, and in July 1923 the ship *Conrad Holmboe* was sent with provisions and men for the stations at Jan Mayen and Mygbugten. After visiting Jan Mayen, the *Conrad Holmboe* in trying to reach Mygbugten was seriously damaged by ice. The *Annie* had left Mygbugten, and nothing more was heard from her. A relief ship *Polaruly* finally brought the damaged *Conrad Holmboe* to Iceland, little more than a wreck but with the fourteen men on board all safe and sound. Afterwards the *Polaruly* in trying to find the *Annie* was involved in disaster, foundering in a storm between Iceland and Greenland. The captain and three men were drowned, but the rest of the crew were saved by a British trawler. When the weather permits, a new relief expedition will be sent to the aid of the *Annie*, the condition of which is causing great anxiety.

IN his presidential address to the American Association for the Advancement of Science delivered at the Cincinnati meeting on December 27, Prof. J. Playfair McMurrich (*Science*, Dec. 28, 1923, p. 521) refers to various incidents in the development of American science during the period of the history of the Association since its beginning in 1848. He points out that in the history of the Association two other Canadian men of science besides himself have been elected to the position of president, Prof. T. Sterry Hunt in 1870 and Sir William Dawson in 1882. In the latter part of his address he goes on to consider the development of evolutionary opinion during this period. The publication of the "Origin of Species" in 1859 was shortly followed by the Civil War, during which period meetings were suspended, so it was not until 1872 that Asa Gray, in a presidential address to the Association, expressed belief in organic transformation. Reference is made to the views of Agassiz, Dana, Huxley, Gegenbaur, Fritz Müller, Weismann, Galton, Mendel, and modern workers. The problem of evolution has changed from the origin of species to that of variations, and in the meantime embryological development and the phenomena of heredity have been analysed from the morphological and physiological points of view. The most recent phases are in genetics and in attempts to alter the germplasm experimentally.

MESSRS. LONGMANS AND CO. have in the press a second series of J. G. Millais's "Rhododendrons and the Various Hybrids." The work will contain 17 coloured plates by Miss Beatrice Parsons, Miss Winifred Walker, and Miss Lilian Snelling; 14 collotype plates; and numerous illustrations from photographs.

UNDER the title of "The Study of Earthquakes," the *Quarterly Review* for January contains a popularly written account by Prof. H. H. Turner of the most recent development of seismology. The chief points of interest in the article are the contrast drawn between the methods of investigation of a recent earthquake, such as the Californian earthquake of 1906, and of one that occurred nearly half a century earlier (the Neapolitan earthquake of 1857); the influence of the time of occurrence of a great earthquake on the destruction by subsequent fires; the various phases of earthquake-motion; the method of locating the epicentre; and the connexion between the depth of the focus and the intensity of the earthquake at the surface.

The World's Health is a monthly review published by the League of Red Cross Societies in three editions, English, French, and Spanish. It deals in non-technical language with problems of medical aid and public health work in all countries. In the November number (vol. iv., No. 11) the question of training public-health nurses by Red Cross Societies is discussed and different views are expressed, some advocating this procedure, others doubting its expediency.

MESSRS. W. HEFFER AND SONS, LTD., Cambridge, announce the publication in February of the two following books by Dr. T. S. P. Strangeways: "Tissue

Culture in Relation to Growth and Differentiation," in which numerous experiments and observations on animal tissues grown *in vitro* will be described, and their bearing on fundamental problems in connexion with growth and differentiation discussed, and "The Technique of Tissue Culture *in vitro*," which will aim at giving a full description of the setting up and sterilisation of the apparatus required, and detailed instructions for the preparation both of the medium and the method used for the implantation of the tissues. Methods for staining the cultures both *intra vitam* and after fixation will also be described.

PUBLICATION No. 555, issued by Messrs. Cooke, Troughton and Simms, Ltd., contains descriptions of a full range of surveying and other field instruments manufactured by the firm, and also certain of their other products of general interest to those connected with civil and railway engineering work. Many of the instruments described represent a combination of the best points of various patterns formerly manufactured in competition by the two firms, T. Cooke and Sons, Ltd., and Troughton and Simms, Ltd., now merged under one constitution, and illustrate the many developments that have taken place during recent years in the design and construction of surveying instruments. The present publication is more than a catalogue. It contains an interesting chapter on the history of the two firms and refers to several instruments of historic importance, *e.g.* the Troughton dividing engine (1793), now in the Science Museum, South Kensington, and the Cooke instruments used in the British Antarctic Expedition (1910–11). Other chapters deal with subjects of a more practical nature, *e.g.* optical systems, stadia lines, collimation and eccentricity errors, and the adjustment of instruments. Thus the catalogue becomes quite a useful text-book.

ERRATUM.—In NATURE of February 9, p. 212, col. 1, line 9, for "Sir Francis Darwin" read "Sir Horace Darwin."

Our Astronomical Column.

TOTAL ECLIPSE OF THE MOON.—There are two total eclipses of the moon in 1924, both partially visible in London. In that of February 20, totality ends at $4^h\ 57^m$ P.M., some 25 minutes before sunset. The moon will rise about half eclipsed, the last contact with the umbra occurring at $5^h\ 58^m$. A smokiness due to the penumbra will be quite perceptible for about 20 minutes after this. It is, of course, quite useless to attempt to observe the last contact with the penumbra, which occurs at $7^h\ 1^m$, since the diminution of light in the outer portion of the penumbra is quite imperceptible.

FREQUENCY OF TOTAL SOLAR ECLIPSES.—Rev. W. Rigge discusses the question of the frequency of total solar eclipses at a particular station in *Popular Astronomy* for January, with special reference to his own station Omaha. He fails to find a single totality there in the past four or the coming two centuries. The nearest approach of the moon's shadow was 23 miles.

He also examines the numbers for London and Rome in the interval A.D. 600–1800, using the maps recently published by J. Fr. Schroeter. He finds two totalities in London (in 878 and 1715) and three for Rome. The writer of this note, in a rough investigation made several years ago, found about 3 totalities in 1000 years for a given point on the earth's surface. The number in a country of considerable size is of course much greater. On the average there is one totality every 70 years in the British Isles; the present blank period of 203 years, from 1724 to 1927, is of very unusual length.

COMETS.—Since the detection of D'Arrest's comet Mr. H. E. Wood has re-examined some plates taken in September last, and has succeeded in finding two faint images of it in the following positions:

G.M.T.	R.A. 1923·0.	S. Decl. 1923·0.
Sept. $5^d\ 6^h\ 53^m\ 21{\cdot}3^s$	$17^h\ 34^m\ 28^s$	$15^\circ\ 33'\ 34''$
$7\ 6\ 20\ 33{\cdot}2$	$17\ 39\ 57$	$16\ 31\ 54$

These will be of great use in helping to determine the present orbit. The estimated magnitude was 14, whereas on November 10 it was 11, although the distance from sun and earth was then much greater. It is clear then that some remarkable physical change caused the comet's brightness to increase fiftyfold in the interim. This may be compared with the remarkable fluctuations of light exhibited by Holmes's Comet in 1892.

Mr. F. J. Morshead, of New Plymouth, New Zealand, independently found the Comet Bernard-Dubiago on November 6 in the field with γ Trianguli Australis (R.A. $15^h\ 11^m\ 41^s$, S. Decl. $68^\circ\ 24'$). He described it as faint. Clouds and moonlight prevented further observations until November 29; on November 30 it was in the field with ϵ^2 Arae (R.A. $16^h\ 56^m\ 59^s$, S. Decl. $53^\circ\ 7'$) and moving towards θ Scorpii. New Zealand does not receive the Copenhagen telegrams, so no intimation of the previous discovery was available.

DARK NEBULÆ.—Prof. G. E. Hale contributes an interesting article on Barnard's Dark Nebulæ to the January issue of *Scribner's Magazine*. It begins with Sir W. Herschel's astonishment on finding what he called "a hole in heaven." This is the region near Rho Ophiuchi. A photograph taken by Prof. Barnard with the Bruce telescope is reproduced, and makes Herschel's wonder easy to understand. In immediate juxtaposition to rich galactic starfields is a large black starless region of complicated form. Barnard is shown at work with this instrument, and some other dark markings are reproduced, both from Bruce plates and from those taken with the 100-inch Hooker telescope. Hale notes that both he and Barnard originally shared Herschel's view that these regions were "holes in heaven," but were gradually brought to look on them as obscuring clouds of dust; this is sometimes faintly luminous, as in the Pleiades nebulæ, which have been found to have spectra similar to those of the adjacent stars, so that they are presumably shining by reflection. The suggestion is made that the diameters of the dust-particles are of the order of a wave-length of light, so that radiation pressure, especially near stars of types B and A, becomes very effective. The clouds are supposed to have masses hundreds of times that of the sun, and to be held together by mutual gravitation. An enormous cloud is supposed to cover most of the constellation Orion; the great nebula is "chiefly a superficial fluorescence of the gaseous elements in a small region" of the cloud; perhaps excited by the radiation of the trapezium stars.

Research Items.

PROGRESS AND DECAY IN CIVILISATIONS.—A suggestive application of anthropological theory to the problems of history and sociology is made by Mr. Christopher Dawson in an attempt to account for the phenomena of progress and decay in ancient and modern civilisations which appears in the January number of the *Sociological Review*. He adopts the view to which the late Dr. Rivers was led by his observation in Melanesia, that the introduction of new racial or cultural elements is essential to progress, and suggests further that the cycle of approximately ten centuries, which has been observed in cases where such an introduction has taken place, may represent the period which elapses before the stimulus is completely exhausted. On the other hand, Hellenic and Roman culture both perished when apparently at the height of their power. This arose from the neglect and extinction of the fundamental cultural type. Rome, which was essentially an agrarian state, became commercial and urban and exhausted itself in attempting to live by war and plunder.

PLEISTOCENE DEPOSITS OF THE PORTSMOUTH DISTRICT.—In "The Pleistocene Deposits of the Portsmouth District and their Relation to Man," Dr. L. S. Palmer and Lt.-Col. J. H. Cooke (Proc. Geol. Assn., vol. xxxiv.) give the results of their examination of between forty and fifty exposures in the 15, 50, and 100 feet terraces which rise in the Portsmouth district from the sea northward. Coombe-rock is found in some form or other in all levels. This ancient name for the rubble which is found in the main Brighton valley was adopted by Clement Reid in 1887 for similar deposits elsewhere, and is generally used now for a heterogeneous series of deposits comparable in variety with the clay-with-flints of the higher parts of the chalk downs. The authors give five distinct types of deposit as exhibited in the terraces; namely, alluvium, brick-earth, coombe-rock or rubble-head, stratified river-gravel or raised beach pebbles, sands (æolian and fluviatile). Sections are given of a number of exposures, and Mr. A. S. Kennard and Mr. B. B. Woodward add a useful appendix on the mollusca of Portfield, near Chichester. The paper contains much of interest relating to the flint implements of the district. Acheulian forms occur more abundantly than any other type. The authors are of opinion that the evidence that they have accumulated justifies them in coupling Acheulian man with the Riss-Würm interglacial epoch, Mousterian man with the Würm, Aurignacian man with the Achen recession of the northern ice, and Neolithic man with the submerged forests, this arrangement being confirmed both by geological deposit and fossil content.

THE PEARL ORGAN OF THE GOLDFISH.—Mr. T. Tozawa (*Annal. Zool. Jap.*, vol. x., No. 6, pp. 253-263) gives an account of an experimental study of the so-called pearl organs of the goldfish. These organs appear as small white conical warts, in the male only, on the operculum, and on the rays of the dorsal, pectoral, and anal fins. They increase in numbers and size with the age of the fish up to six years, after which there is a decline. They appear during the breeding season from March to September, are most numerous in April, and are periodically shed and reformed at the same spots after an interval of from three to ten days. Their formation is due to a thickening of an area of epidermal cells, the result of hypertrophy, over which the pearl organ itself is formed by cornification of the superficial cells. The author performed several castration experiments and as a result concludes that the cornification process is greatly influenced by the substances (hormones ?) produced from the testis, absence or decrease of which suppresses or retards pearl organ formation.

MOLLUSCA DAMAGING BRICKWORK.—Dr. Annandale (Jour. Asiat. Soc. Bengal, N.S., vol. xviii., No. 10, 1922, p. 555) records the interesting fact that the Pholad, *Martesia fluminalis*, was found to be the cause of injury to the brickwork at the entrance to one of the dry docks at Calcutta. The molluscs had only been able to attack those parts of the wall at which the glaze on the bricks had been worn away or abraded, and had fortunately all been killed off after penetrating to a depth of about half an inch. Dr. Annandale is of opinion that these molluscs would ultimately have destroyed all the brickwork, and believes that the larvæ were assisted in getting a hold in the first place by the inequalities produced on the surface of the bricks by the falling out of small pieces of cinder incorporated in their substance, thereby exposing a small unglazed area. The species usually bores in wood or sandstone. The burrows made by the borers were rapidly inhabited by other lamellibranchs, for which they formed suitable shelter, the presence of the latter helping in the destruction already started by the Pholad.

NEMATODE PARASITES OF PLANTS.—Part 4 of the collected papers issued from the Department of Helminthology of the London School of Tropical Medicine contains reprints of fourteen papers by workers in that Department. Several of these communications have been already noticed in these columns, and reference can now be made only to two others. Dr. T. Goodey gives an account of his observations on quiescence and revivescence in the nematodes *Tylenchus tritici* and *T. dipsaci*. When wheat galls caused by *Tylenchus tritici* are soaked for some hours in water they swell and finally liberate thousands of the larvæ of this nematode in the first stage of development. Such larvæ, if alive, are capable of movement and are thus able to infect germinating wheat plants when galls are sown along with healthy seed. The statement originally made by Baker (1771) that the larvæ are capable of resuming their activity after having been dormant for a period of twenty-seven years has been repeated by later writers. Dr. Goodey gives evidence which shows that larvæ may retain the power of revivescence for a period of about nine years. Dr. Goodey contributes a useful review of the members of the nematode genus Aphelenchus which cause disease in cultivated plants. The structural details and biology of each species and the disease due to it are dealt with, and the suggestion is made that some form of heat-treatment of infective soils is likely to give the best results, comparatively low temperatures being lethal to the parasites.

SOUTHERN HEMISPHERE METEOROLOGICAL CORRELATIONS.—The correlationships subsisting in the Southern Hemisphere between the weather elements of South America and the Antarctic have been the subject of many papers by Mr. R. C. Mossman, the most recent of which, on "Indian Monsoon Rainfall in relation to South American Weather, 1875–1914," constitutes vol. xxiii., Part VI., of the Memoirs of the Indian Meteorological Department. A detailed comparison is made for each of the forty years between the departures from the normal of pressure, temperature, and rainfall at various places in South America,

including the South Orkneys, and the corresponding departures of Indian Monsoon rainfall, with the view of throwing further light on the relationship previously discovered, namely, that years of high pressure in the Argentine and Chile, with much ice off South America, correspond with years of good rainfall in India. It is also known that there is a high positive correlation between winter temperature at the South Orkneys and rainfall in the Argentine after an interval of 3 to 4 years, and an equally marked negative correlation after an interval of 2¼ years. From this pair of correlations it is concluded that if it becomes possible to correlate the simultaneous rainfall and pressure conditions in South America, a long warning should be available of a year of very deficient Monsoon rainfall. The chief difficulty about the seasonal correlation method is that we have hitherto found only a few of the correlations which must exist, but as more of them are found and co-ordinated with others, the physical mechanism underlying them will become clearer and the problem of seasonal forecasting increasingly tractable.

COMMERCIAL SYNTHESIS OF METHYL ALCOHOL.—The synthesis of methyl alcohol from carbon monoxide and hydrogen, which has been carried out on a small scale in scientific laboratories, is now performed on a very large technical scale by the Badische Anilin and Sodafabrik at Ludwigshafen. To promote this reaction the two gases are mixed under high pressure and at a high temperature in the presence of a catalyst, the process being similar to the synthesis of ammonia from nitrogen and hydrogen. The Leuna Works, near Merseburg, manufactures at present sufficient methyl alcohol for German requirements, and the works are in a position to meet the technical consumption of other industrial countries. Closely connected with this process is the manufacture of formaldehyde, which at present is being used in large quantities for the making of artificial resins. As the direct synthesis of formaldehyde is difficult, methyl alcohol is first made and then oxidised to formaldehyde by conveying the vapour over red-hot copper.

MATHEMATICS IN AMERICA.—In his presidential address, reprinted in *Science* of January 4, to Section A of the American Association, in December 1923, Prof. G. A. Miller gave an account of the development of mathematics in America during the last seventy-five years. When the Association was founded in 1848 various European mathematicians then living had produced work which outranked the best American contributions to mathematical knowledge up to that time. Neither did Americans take any active part in the development of the science, which was proceeding rapidly in Europe, during the next 30 years. A stimulus to progress was given by the enthusiasm of Prof. J. J. Sylvester, whose first course of lectures on the Galois theory of equations, at Johns Hopkins University in 1882, was responsible for inaugurating American activity in this field and in group theory. Other fields in which American mathematicians have rendered outstanding service to world progress in the last forty years are postulates and the calculus of variations. But the greatest mathematical monuments which America has raised during the period under consideration are its series of periodicals, beginning with the American *Journal of Mathematics* in 1878. The actual mathematical advances made by Americans during the last 75 years are conspicuous but not satisfying. American mathematicians have not yet attained as high a relative standing as that already belonging to some other sections of the American Association, such as the astronomers and geologists.

LOW VOLTAGE ARC IN HELIUM.—The production of an arc, at voltages lower than the ionisation voltage, has been explained by supposing that the voltage employed imparts a velocity to the electrons, which enables them to "excite" the atoms of the gas with which they collide, and a second electron striking an excited atom is then able to ionise it. According to Franck, the normal parhelium is changed into metastable orthohelium by inelastic collision with an electron, the kinetic energy of which is due to a "fall" through 19·77 volts; the next inelastic collision is at 20·55 volts and, according to Lyman, gives the line 600·5 Å. Compton, Lilly, and Olmstead have, however, maintained the helium arc down to 8 volts, and although Miss A. C. Davies has explained this by assuming that, when the arc is started at 20 volts, a certain number of excited atoms are produced, which remain unaltered when the arc burns below this voltage, this does not agree with Kannenstine's value for the life of the metastable helium atom, which is 0·0024 sec. Messrs. R. Bär, M. von Laue and E. Mayer, in the *Zeitschrift für Physik*, Dec. 17, 1923, describe experiments which show that the continuation of the arc in helium at voltages lower than 20 is caused by electrical oscillations, due to self-induction in the circuit. The vibration frequency of these oscillations cannot be calculated, using Thomson's formula, from the conditions in the external circuit, but depends also on the conditions in the tube in which the arc is formed. Under different conditions the frequency was found to vary between 3×10^4 and 3×10^5 vibrations per second, while the maximum voltage was in all cases higher than 20 volts, and may reach 22 or even 27 volts, when the arc is being maintained by a 16-volt battery through a suitable inductance.

ELECTRICITY IN MINES.—Prof. W. M. Thornton read an interesting paper on researches on the safe use of electricity in coal mines to the Institution of Electrical Engineers on January 31. The author has investigated for many years the limiting electrical conditions under which ignition of coal dust and fire damp may occur and he obtains some definite conclusions. Alternating current is always far safer than direct current so far as lighting is concerned. Many accidents occur from poor lighting at the working surface face. By means of specially constructed generators, giving a current with a frequency of 150 at 200 volts, satisfactory lighting could be provided while the numerical value of the current would have to exceed 23 amperes before the spark made on breaking the circuit would cause an explosion. On the other hand, with direct currents an explosion would occur at half an ampere. The great colliery disaster at Lenghenydd in South Wales in 1913, when the death-roll was 439, the greatest on record, directed attention to the sparks produced in signalling bells as a possible source of explosion. The sparks from signalling bells can now be made inert in various ways and one or other of these methods is compulsory. Prof. Thornton showed to the meeting his safety lamps in action. They gave an alarm signal when the mixture of gas and air approached a dangerous value. One of the difficulties in applying electricity to mining is the provision of an efficient earth underground with which all exposed pieces of metal in the circuit or motors must be connected so as to prevent the risk of shock to the miners. The author uses an earth plate in the shape of a hollow cone with its vertex pointing downwards. The cone is embedded in the earth and sufficient water is admitted to fill it. Periodical tests are made of the earth resistance and when it is too high more water is poured on the ground above it. The device is simple and effective.

Recent Genetics.

THAT genetical conceptions continue to permeate modern botany and zoology in many directions is shown by recent work. Genetics and cytology can no longer be regarded as special subjects of which the naturalist can afford to be ignorant. They are making their influence increasingly felt in every phase, not only of experimental biology, but also of systematic and descriptive work. This will be true in a larger sense as further genetic analysis throws more light on the nature of the inherited varietal and specific differences.

One of the plants which has been most prolific in genetic results in the hands of Bateson and his co-labourers is *Primula sinensis*. Experiments with it began soon after the discovery of Mendel's results. After being carried on for many years by the late R. P. Gregory, they have been continued at the Merton Laboratory, and a paper (*Journ. of Genetics*, vol. 13, No. 2), to which the names of Gregory, Miss D. de Winton, and Bateson are attached, recounts many new results. Some 18 pairs of characters have been investigated, relating to forms of the leaf and corolla, colours of petals and stigma, the extent of the "eye" of the flower, the heterostyle condition, and single and double flowers. Interesting interactions between factors have been observed. Thus not only is crimping of the leaf margin associated with fringing of the petals, but the factors governing the extent of the yellow eye and the character of the leaf margin interact with each other.

Various new forms have appeared or have been acquired in connexion with the experiments. Thus a variety called Lee's, which appeared spontaneously in a private garden, differs in crimping, colour, shape of flower, and eye-structure from any known variety, and all these changes apparently result from the loss (or change) of a single factor. The known leaf forms include ivy, tongue, palm, oak, fern, and crimped, the last four representing three pairs of unlinked factors recessive to palm-leaf. In the F_2 of a cross a new "Harlequin" type appeared, whether as a single individual or more is not stated. It has some petals paler and smaller than the others, and behaves as a simple recessive.

Two linkage groups have been found, one containing four factors, the other two, and their cross-over relations have been determined. It is found that the degree of linkage for the first group differs greatly in the male and female sides of the same plants. Examples are already known in which the general behaviour of the chromosomes is different in the pollen and embryo sac formation, and it appears that this may also extend to the behaviour of individual chromosome pairs with relation to each other.

In a discussion of the history of *P. sinensis* and other species (*P. obconica* and *P. malacoides*) which have given rise to many new forms in cultivation, it is concluded that the new types have arisen through "spontaneous variation," and not as a result of crossing. Indeed, none of these species has been artificially crossed successfully.

To turn for a moment to animals, the stream of Drosophila results is unabated. Recent publications on the genetics of this fly include a good-sized volume on the third-chromosome group of characters.[1] Similar studies of the first or sex-linked and the second series of characters have already appeared. The number of mutations now recognised in *Drosophila melanogaster* is about 400. In the present work the history of the discovery and the genetic behaviour of each mutant in the third group is given, the whole making a formidable array of refined genetical data. Chromosome maps have been constructed from the cross-over percentages and used successfully as a basis for prediction, and crossing-over frequencies are found to vary consistently with age and temperature. It has also been shown that mutant conditions occur which modify or may nearly suppress or even increase the crossing-over in one or all the chromosomes, or in one region of a chromosome. By selecting out such genes the offspring may show a return to the standard amount of crossing-over. A number of genetic peculiarities are associated with the factors which appear to be located about the middle region of chromosomes II. and III. There are reasons for suggesting here that these long chromosomes are really two chromosomes united end-to-end. This hypothesis has cytological evidence in its favour, and would also help to explain the genetic facts.

In a study of *Drosophila virilis*,[2] which has 6 pairs of chromosomes instead of 4, the stock was derived almost entirely from a single pair, and has been kept in the laboratory for eight years. Already a number of mutations have appeared, and they fall into 6 linkage groups, numbering respectively 18 (sex-linked), 4, 6, 3, 5, and 2 characters. As in *D. melanogaster*, crossing-over occurs only in the female, and the Y-chromosome appears to be functionless. At least four of the mutations, namely, yellow (body colour), forked (bristles), crossveinless, and confluent (veins), are parallel to those of *D. melanogaster* and show similar linkage relations. In another species, *D. simulans*, five such parallel mutations have been studied. In *D. Willistoni*, with 3 pairs of chromosomes, there are only 3 linkage groups. All these facts strengthen greatly the view that an exact parallel can be traced between chromatin morphology and hereditary behaviour.

Mavor has recently found (*Science*, April 27, p. 503) that when Drosophila females are treated with X-rays for even 3 or 4 minutes, non-disjunction of the X-chromosomes may be produced in either of the maturation divisions, leading to the production of XXY females more frequently than they normally occur. He also finds (Proc. Soc. Expl. Biol. and Med., vol. 20, p. 335) that a brief treatment lessens the frequency of crossing-over between the X-chromosomes for six days afterwards, while (Mavor and Svenson, *Science*, August 17, p. 124) it *increases* the frequency of crossing-over in the second chromosome. This indicates different effects on the individual chromosomes.

Bateson [3] was apparently the first to apply genetic conceptions to the distinctions between species. He showed how the differences between certain species of North American woodpeckers and warblers might be interpreted in terms of two or three pairs of unit factors, but pointed out difficulties in applying that interpretation. The writer applied similar conceptions to a number of plant species [4] in various families, and also to the North American screech-owls.[5] That such conceptions are becoming of increasing value to the systematist is shown by a recent paper of Chapman,[6] in which he applies the current conceptions of

[1] Bridges, C. B., and T. H. Morgan, 1923. The third-chromosome group of mutant characters in *Drosophila melanogaster*. Carnegie Publ. No. 327, pp. 251, figs. 37, pls. 3. Price 3 dollars.

[2] Metz, C. W., Mildred S. Moses, and Eleanor D. Mason, 1923. Genetic studies on *Drosophila virilis*, with considerations on the genetics of other species of Drosophila. Carnegie Publ. No. 328, pp. 94, figs. 17, pls. 5. Price 1.75 dollars.

[3] "Problems of Genetics," 1913.

[4] Gates, R. R., On pairs of species. *Bot. Gazette*, vol. 61, pp. 177-212, 1919.

[5] Gates, R. R., The mutation theory and the species concept. *Amer. Nat.*, vol. 51, pp. 577-595, 1917.

[6] Chapman, Frank M., 1923. Mutation among birds of the genus Buarremon. Bull. Amer. Mus. Nat. Hist., vol. 48, Art. 9, pp. 35, pls. 4.

mutation to a study of the distribution and relationships of certain finches of the genus Buarremon in Central and South America. He regards isolation as the most important external factor in the establishment of local varieties which arise through mutation, and believes that this interpretation affords a clue to the origin of many distinguishing marks in birds. The first example he cites is that of *B. brunneinuchus*, which extends from the mountains of Mexico down the Andes for a distance of some 5000 miles to Chile, in a zone which is often only a mile wide. Throughout this range no geographic races or sub-species have been recognised by ornithologists, but in the isolated Chimbo Valley in Ecuador a local species, *B. inornatus*, occurs. It differs in having no black pectoral band or collar and in having larger white areas below. A single specimen of *B. brunneinuchus* without the black collar is known. It was described in 1884 from Mexico, and is considered to be a mutant which only required isolation to produce a species like *B. inornatus*.

It is suggested in the same way that *B. poliophrys*, which occurs in Peru and has a black pectoral band, has been derived from *B. assimilis*, which is found in the Andes of Venezuela, Colombia, and Ecuador, and has no black band. In support of this view, one specimen of *B. assimilis* in a series from Quito was found to have a complete black band, and is believed to be a mutant. Similarly *B. borelli* of northern Argentina has no pectoral band and is believed to have been derived by a loss mutation from *B. fimbriatus* of Bolivia, which *has* a band. Dr. Chapman points out that various terms in descriptive ornithology, such as superciliary stripe, nuchal band, wing bars, malar streak, pectoral band, etc., are of service because of parallel mutations in the colour markings of many birds. The appearance of such mutations seems to be independent of environment; they are unaffected by selection but are perpetuated by isolation. No doubt the application of these and similar genetic conceptions will be a valuable aid to animal and plant systematists in the analysis of the specific and varietal differences with which they have to deal.

As illustrating the practical value of genetics we may cite a recent paper by Mr. G. L. Kottur on cotton breeding (Mem. Dept. Agric. India, Botany, vol. 12, No. 3), which gives an account of crosses between Indian varieties or *Gossypium neglectum* and *G. herbaceum*, and extends the earlier results of Fyson and others. *G. neglectum* types are easily grown (early), high yielding, high ginning, but with very short fibre. *G. herbaceum* is widely grown but requires a long growing period, and the types with good staple have a low ginning percentage. Four generations of crosses between these forms bring out many facts of inheritance, the most important of which is that ginning quality is inherited independently of length of fibre (long staple being dominant over short), and that it should therefore be possible to produce a type combining high ginning percentage with long white fibre. Such a type would add greatly to the value of the cotton crop in India. R. R. G.

Scientific Instruments and Research.

IN an article on "Industrial Research" (NATURE, December 1, p. 781) we referred briefly to the relation between Research Associations and the private research laboratories of individual concerns. It is encouraging to note that some firms, while participating in the work of the Research Association of their trade, have at the same time actively maintained their own research laboratories. Among these must be included the firm of Messrs. Adam Hilger Ltd., of 75A Camden Road, London, N.W.1. The work accomplished by the staff of the research department of this company during the past five years forms a very valuable record. The results of much of this work have been communicated in the usual way to various scientific societies; but the firm has gone further than this in having prepared and published several useful volumes by workers associated with the laboratory. These have been referred to in our columns at the time of their appearance, and include "Tables of Refractive Indices—Oils, Fats, and Waxes," compiled by R. Kanthack and edited by Dr. J. N. Goldsmith, "Report on the Quantum Theory of Spectra," by Dr. L. Silberstein, and "Wave-length Tables for Spectrum Analysis," by F. Twyman. A monograph on "Elements of Vector Algebra," by Dr. Silberstein, was also prepared for publication at the instance of and with the assistance of the firm.

In a lengthy list of papers published in scientific journals by the staff of the laboratory, we notice "An Interferometer for Testing Camera Lenses" (Trans. Opt. Soc., xxii. 4; *Phil. Mag.*, xlii., Nov. 1921), and "The Hilger Microscope Interferometer" (Trans. Opt. Soc., xxiv. 4; Journ. Opt. Soc. Amer., vii. 8), in which descriptions are given by Mr. Twyman of new instruments which are of great value in the examination of various types of lenses. As might be expected in work issued by a firm which specialises in the production of the best types of interferometric, refractometric and polarising apparatus, many of the research papers contain results of work rendered possible by such apparatus. The research staff has developed methods of measuring small variations in refractive indices of transparent substances, which has resulted in papers in the Transactions of the Optical Society and the Journal of the Society of Glass Technology dealing with variations in refractive index near the surface of glass melts, throughout meltings of optical glass, and in optical glass after chilling or tempering. Measurements made by Mr. Twyman and Mr. Dalladay of the stresses produced at the surface of glass by grinding with loose abrasive and by cutting with a diamond have increased our knowledge of the mechanism of glass grinding and polishing. Mention should also be made of the method described by Mr. Twyman and Mr. Perry (Proc. Phys. Soc., xxxiv., Part iv.) of determining the stress-optical coefficients, and of the paper by Mr. Simeon (Proc. R.S., A 104) in which are recorded shorter wave-lengths in the carbon arc spectrum than had hitherto been measured.

Of a different nature, but important from a practical point of view, is Mr. Twyman's paper (Trans. Soc. Glass Tech., vol. 6) describing a new method for controlling the annealing of glassware by means of a sample of the glass to be annealed.

Papers by Dr. Silberstein issued during the period under review include a note on the dispersion of diamond (*Phil. Mag.*, xxxvii., Apl. 1919), a supplementary chapter to his book on "Projective Vector Algebra" (*Phil. Mag.*, xxxviii., July 1919), and an investigation of the spectrum corresponding to an atomic system with a non-spherical nucleus (*Phil. Mag.*, xxxix., January 1920).

We have not detailed all the papers, but the above list will indicate the nature and value of the work done. The firm is to be congratulated on the enterprise and activity it has shown in this direction. Its efforts are all the more praiseworthy since they have been continued over a period in which the economic conditions in the scientific instrument industry have not been of the most favourable nature.

The Japanese Earthquake of September 1.

OWING perhaps to the destruction of printing presses in Tokyo, no printed reports on the earthquake seem to have reached Great Britain. The following details are given in a letter from Prof. S. Fujiwhara, of the Central Meteorological Observatory at Tokyo, to Sir Napier Shaw, who kindly lent the letter.

The area of destructive motion is about one degree square. The area swept by fire was about 12 square miles in Tokyo and 3 square miles in Yokohama. The number of houses burnt in Tokyo was about 320,000. As Prof. Fujiwhara remarks, it was probably the greatest fire that has ever occurred in the world. In all probability, there will never be another like it, for there now exists no great wooden city such as Tokyo was before the earthquake. Wooden houses suffered little from the actual earthquake, while brick buildings proved unusually dangerous. Iron-concrete buildings, however, resisted both earthquake and fire, and the Tokyo of the future will probably be a city of iron-concrete material.

It has been ascertained by actual soundings that the floor of Sagami Bay has sunk by from 70 to 100 fathoms, while the coast has risen by from 1 to 5 metres, the area in which these changes of elevation occurred being nearly the same as the area of destructive shock.

The first and greatest shock occurred at 11 h. 58 m. 44 s. A.M. During the daytime, the wind was from the S.W., and the observatory for the time was safe. But about 8 P.M. the wind shifted to the W. and then to the N.N.W., and at 11.55 P.M. the main building caught fire and burnt out in less than two hours. Most of the recording instruments had already been broken by the shock. "I think," says Prof. Fujiwhara, "it would be worth to report that our brave observers continued the hourly observations during the fire. No single observation was lost." The air temperature rose 5° to 6° C. above the value otherwise expected. At 11 P.M. the maximum wind velocity was about fifty miles an hour. The maximum temperature in the screen, about 40 metres from the main building, was 42·4° C. "From the data we can easily see that the furious wind, which blew from N.N.W. and so intense that nearly all important buildings in this vicinity were lost during this wind, was caused by the fire." It is satisfactory to be able to add that, though the losses in books and material are serious, the members of the observatory staff are all safe.

Since the above was written, the *Monthly Bulletin* for last September of the Imperial Marine Observatory at Kobe (Japan) has been received. It contains the times and other elements of 107 after-shocks of the great earthquake which occurred during that month. The most important of these after-shocks were recorded on September 1 at 5 h. 23 m. 28 s. (G.M.T.), September 2, at 2 h. 47 m. 44 s. (the greatest of all) and 9 h. 28 m. 0 s. C. D.

Photoelectric Conductivity of Crystals.

IN the *Zeitschrift für Physik* of June 29, B. Gudden and R. Pohl describe additional work done by them on crystal conductivity. Crystals are divided into two groups: (1) those with optical dispersion pointing to considerable mobility of the electrons, and having, in the region of transparency, a refractive index greater than two; (2) those in which photoelectric action takes place only when impurities are present, which may exist as single molecules or as colloidal particles; examples of this are blue or green fluor spar, quartz as yellow citrine or violet amethyst, rock salt. Group (1) is divided into two sub-groups: (*a*) the active absorption of light takes place only in the "ground" material (diamond, zinc blende, sulphur, selenium, etc.); in (*b*) it takes place partly in the ground material and partly in the impurities (alkaline earths and zinc sulphide with centres of phosphorescence).

In their previous papers the authors have shown the importance of the so-called primary current, due to the starting of a movement of the released electrons towards the anode, without any "inertia" effect, such as is caused at a later stage by the space charge produced by the almost stationary positive ions. With pure flawless crystals of group (1*a*) the mechanism appears to be as follows: the electrons travel quickly to the anode, possibly jumping from atom to atom. The positions of the positive charges change gradually in the electric field, under the action of thermal movements or of light of long wave-length, towards the cathode. The time required for the completion of this change is measured by hours in the case of diamond, and by seconds in the case of zinc blende. The double layers at the electrodes remain unchanged for several hours in the dark; but disappear when illuminated, owing to a photoelectric current in the reverse direction. Current passes into or out of the electrodes only after a certain density of the surface charge has been reached.

In group (1) impurities diminish the photoelectric effect and make it impossible to distinguish between primary and secondary current; the current diminishes with the time, increases slower than the incident light energy, and cannot be saturated by increased voltage; the "output" is less than the quantum equivalent, while the authors find these quantities are equal for group (1*a*); the additive law which holds for group (1*a*) does not do so for group (1*b*). In the case of a twin crystal the dividing surface interferes with the flow of the primary current.

In the second division of group (2) there is no positive space charge, no law of addition, and the number of electrons is less by several orders of magnitude than the quantum equivalent of the absorbed light energy. It is possible to imagine that an electron broken off from a particle starts to move towards the anode, but unites with another impurity particle after going a short distance, instead of reaching the anode as in group (1*a*). It may be that in pure crystals of group (2), electrons, if produced by X-rays, can travel to the anode. Experiments in this direction are in progress.

University and Educational Intelligence.

BIRMINGHAM.—Dr. W. J. Hickinbottom has been appointed assistant lecturer in chemistry.

The Council has approved of the establishment of a Board of Mining Research.

The secretaryship will shortly become vacant, owing to the retirement of Mr. G. H. Morley, who was appointed in 1880. Applications for the post, accompanied by twelve copies of not more than three testimonials, must be received by the present secretary by, at latest, February 28. The person appointed will begin his duties on June 1.

CAMBRIDGE.—Mr. F. J. W. Roughton, Trinity College, has been elected University lecturer in biochemistry. The following grants have been made by the Special Board of Biology and Geology from

the Gordon Wigan Fund: to the Philosophical Society, 35*l.* for illustrations; to Dr. A. Harker, 30*l.* for a cabinet and slides of rock sections for teaching purposes; to Prof. R. C. Punnett, 50*l.* for plant breeding; to the Museum of Zoology, 50*l.* for a case; to Prof. J. S. Gardiner, 30*l.* for an incubator; and to Prof. A. C. Seward, 25*l.* for sections of fossil plants.

The professor of pathology is to be assigned to the Special Board for Biology and Geology instead of to the Special Board for Medicine.

Applications are invited for the John Lucas Walker studentship in pathology, which is of the annual value of 300*l.*, and tenable, under certain conditions, for three years. The applications, accompanied by copies of papers containing published work, testimonials and references, should be sent before May 1 to Prof. H. R. Dean, the Pathological Laboratory of the Medical School.

EDINBURGH.—Following quickly on the announcement last month of the offer of a gift of 50,000*l.* from the Rockefeller Trustees for the purpose of financing a clinical laboratory, are intimations of two bequests which were reported at the last meeting of the University Court: (1) A bequest by the late Mr. Thomas McKie, who died in 1909, of the residue of his estate, amounting to about 48,000*l.*, to develop and encourage scientific, medical, and surgical research, the teaching and study of the English language and literature, and the teaching and study of modern languages, particularly French, German, and Italian. (2) A bequest by the late Miss J. L. Small, daughter of Mr. John Small, a former librarian of the University, of 5000*l.*, one half of the income of which is to be applied in the purchase of books for the Library, and the remaining half for the general purposes of the Library.

LEEDS.—Mr. H. G. Evelyn White, lecturer in classics and classical archæology, has been invited to undertake for the season 1924–25 the field-direction of an archæological expedition in Egypt. The expedition is promoted by the University of Michigan and the Smithsonian Institution of Washington as part of a comprehensive programme for research in the Near East, and will carry out excavations on Græco-Roman sites in the Fayyûm and Middle Egypt.

LONDON.—Applications are invited for the Graham scholarship in pathology, value 300*l.* per annum and tenable in the first instance for two years. The scholarship was established to enable "a young man to continue his pathological researches and at the same time to secure his services to the School of Advanced Medical Studies connected with University College Hospital as a teacher under the direction of the professor of pathology." Candidates (who need not be connected with any medical school of the University of London) can obtain further information as to the scholarship from Prof. A. E. Boycott, University College Hospital Medical School, after having made an appointment. Applications for the scholarship, marked "Graham Scholarship," should be received by, at latest, the first post of March 3, by the Principal Officer, University of London, South Kensington, S.W.7.

A course of six free public lectures on "Practical Hydraulic Engineering Problems in connexion with Navigation" will be given at the Institution of Civil Engineers at 5 o'clock on February 25, 27 and 29 and March 17, 19 and 21, by Mr. O. C. A. Van Lidth de Jeude. The lectures will be in English.

MANCHESTER.—On Friday, February 1, a bust of Prof. H. B. Dixon was unveiled in the Chemical Theatre by Dr. H. G. Colman. The bust is the work of Mr. John Millard and has been fixed to the wall of the theatre, which also carries the plaques of Sir Edward Frankland and Sir Henry Roscoe.

A large number of old students of Prof. Dixon have subscribed to a testimonial fund, the bulk of which is to be devoted to establishing bursaries for the assistance of students of chemistry in the University who need help in completing their courses.

THE "Colonial University," inaugurated at Antwerp on November 22 by the King of the Belgians, originated as the École Coloniale Supérieure in 1920. It comprises three faculties: political and administrative sciences, tropical medicine, and natural sciences. The first of these is based on the already existing courses of the École Coloniale; the school of tropical medicine, at Brussels, is to be moved to Antwerp to form the second; while the third will find its nucleus in the group of scientific workers attached to the Musée de Tervueren.

A SEYMOUR COMAN research fund for the purpose of bridging the gap between laboratory research in the fundamental sciences as applied to medicine, and clinical investigations, has been established in the University of Chicago, as the result of a bequest of Seymour Coman, of Chicago, who left the residue of his estate to the University. According to *Science*, the income will be used for the institution of three Seymour Coman research fellowships of 400*l.*-600*l.* a year each, one in the domain of chemistry applied to medicine, one in preventive medicine, and one in physiology. Candidates for these fellowships must have attained their doctorates.

THE annual distribution of prizes was held at the Sir John Cass Technical Institute on Wednesday, January 30, when the prizes and certificates were distributed by Sir William Bragg, the Director of the Royal Institution. The chairman of the governing body, the Rev. J. F. Marr, in giving a summary of the work of the Institute, stated that an outstanding characteristic of the past session had been the earnestness of the students and the regularity of their attendance. A total of 41 students had been successful at the examinations of the University of London, 5 of whom obtained the degree of M.Sc. by research carried out at the Institute. Twenty-two students had been engaged in research work during the session and 17 original investigations had been published, bringing the total number of papers issued from the Institute to 137. Following the distribution of the awards, Sir William Bragg delivered an address on "Research Work and its Applications." The address was devoted particularly to the nature and objects of research. Emphasis was laid on the new era of research work marked by munificent gifts such as those of Sir Alfred Yarrow to the Royal Society, of the Rockefeller Trustees to University College, and by the stimulus given by the Government Department of Scientific and Industrial Research. Research work brings out self-reliance, the faculty of selection and judgment of evidence, and develops a sound study of previous investigations. The valuable faculty of selection is one of the most important lessons to be learnt in connexion with research. A good research student may be likened to a fire which, on a match being put to it, burns without being touched again. Those who devote their time to research are always hoping to add something to human knowledge and to human interest. It is our duty and our gain always to explore, and the spirit of research therefore is something which we should try to foster and incorporate in the nation's life. Concluding, Sir William Bragg said that research is not a religion, but the act of one. It implies a certain faith in the beauty and the purpose of the universe; that whatever there is in the world is really meant for us to see if only we can see it.

Early Science at the Royal Society.

February 10, 1663. Mr. Hooke being called in, and desired to suggest some experiments that might be acceptable and useful to the public, suggested, that the experiment of land-carriage, and of a speedy conveying of intelligence, might be considered of.

1669. Three dwarf oaks, with cups or acorns in them (received from Mr. Winthrop, of Connecticut), whereof two were given to Mr. Charles Howard, and one to Mr. Evelyn to plant them here.

1685. Sir Robert Gordon said he had seen the 1oooth part of a grain weighed.

February 11, 1662. To recommend to Dr. Wren from the Society the continuance of the observations of the eclipses of Jupiter's satellites. The eclipse of the moon of Feb. 12th was directed to be observed by as many as had conveniency.

1674. Dr. Croune read a discourse how flying is performed by birds. Some said, that it would be of real use to contrive something for flying, if it were but to raise a man so high, as to fly over a wall, and the besiegers of a town to carry and bring back intelligence.

February 12, 1661. Dr. Wren proposed black-lead as a better means than oil for preserving the pivots of the wheels of watches or clocks from grating or wearing out.

1672. Being Ash-wednesday, the Society did not meet.

1673. The Society inspected the dog upon whom the experiment had been made with Mr. Lister's styptic water, and found the dog very well and the wound in a manner quite healed up.

1679. Mr. Houghton presented several prints of the line of the Norfolk family, as also the copper plate itself; and a pane of glass on which the picture of the first duke of Norfolk was drawn.

February 13, 1660. The Danish Ambassador visited the Society, being introduced by Mr. Evelyn.

1667. The experiments appointed for the next meeting were:—The wind-gathering vessel.—The cutting out the tympanum of a dog's ear.—Shining wood and fish.—Weighing mineral bodies.

1678. The Society again entered upon a debate concerning the causes and reason of the motion of the mercury in the barometer.

1683. Mr. Paget gave in a paper of the force of heat upon magnetical bodies.

February 14, 1666. Dr. Croune's chariot was produced, and generally approved of by the members; only some fence was proposed to be made for the coachman against the kicking of the horses.

1677. Mentioned, a letter from Mr. Halley from Saint Helena as to his observation of the last visible conjunction of the Sun and Mercury.

February 15, 1664. Mr. Pepys was unanimously elected and admitted. It was ordered that a body be procured at the next sessions and that Dr. Charlton endeavour to get a meeting of some physicians of the society, in order to consider of experiments and inquiries.

1676. Mr. Oldenburg produced the sequel of Mr. Leewenhoeck's letter concerning the great plenty of very little animals observed in rain, well, sea, and snow-water.

1681. Sir Christopher Wren in the chair. Mr. Flamstead having cavilled against the method shewn by Mr. Hooke of describing a parabola, the Society desired it again. Upon which the president declared it was true and certain.

February 16, 1670. Mr. Hooke produced a model of a little box to be thrust into the body of a tree, bored, to find out the ascent and descent of the sap.

Societies and Academies.

LONDON.

Royal Society, February 7.—G. Udny **Yule**: A mathematical theory of evolution based on the conclusions of Dr. F. C. Willis, F.R.S. The fundamental assumptions are that: (1) Within any species, in any interval of time, an "accident" may happen that brings about "specific mutation," *i.e.* the throwing of a new form, regarded as a new species within the same genus; (2) within any genus, in any interval of time, an "accident" may happen that brings about "generic mutation," *i.e.* the throwing of a new form so different from the parent that it will be placed in a new genus. Both chances are taken as invariable within the group considered and constant for all time. Sections I.-III. of the paper lead up to the expression for frequency-distribution of size of genus at any given time. In Section IV. the expression is tested on data for four cases, and gives very good agreement with facts, but there are serious difficulties of interpretation. In Section V., frequency-distributions of age for genera of a given size are determined. Approximately for large genera after infinite time, the mean age varies as the logarithm of the number of species, but the dispersion is considerable. When time is limited, primordial and derived genera form distinct groups. Finally in Section VI. an attempt is made to estimate the doubling period for species in flowering plants, which is placed at probably some two or three million years, the present rate of production of specific mutations probably lying between 1 in 15 and 1 in 30 years, among all flowering plants on the whole surface of the globe.—L. B. **Winter** and W. **Smith**: Studies on carbohydrate metabolism. I. Variations in the nature of the blood sugar. Marked differences exist between the blood sugar of normal persons and those suffering from diabetes mellitus. The sugar was extracted from considerable quantities of blood and a comparison made between the observed optical rotation (P) and that calculated from the reducing power of the carbohydrate, on the basis that glucose is the only reducing substance present (C). In diabetic cases, P is usually greater than C, and is increased by mild hydrolysis with weak hydrochloric acid, whereas C is unaltered. This may be evidence for the existence of complex sugars in diabetic blood. Similar substances are present in the blood of rabbits after injection of either adrenaline or thyroid alone. Injection of thyroid and adrenaline together usually causes an increase in the total blood sugar, but no change from the normal; P is low and complex sugars are absent. After injection of insulin into rabbits the blood sugar is dextro-rotary, but has no copper reducing power. Insulin convulsions in rabbits are relieved by adrenaline alone or by a mixture of thyroid and adrenaline.—J. W. **Pickering** and J. A. **Hewitt**: The action of "peptone" and of nucleic acids on the coagulability of the blood. Intravascular injection of Witte's "peptone" into tortoises deprived of hepatic activity inhibits coagulation of blood subsequently shed. Addition of moderate concentrations of "peptone" to blood of the tortoise *in vitro* causes prolonged inhibition of clotting, provided the blood has not been in contact with damaged tissues. As regards rats, partly pigmented animals are more resistant to the anti-coagulant action of peptone and to its toxic effect on the heart than are animals with completely pigmented fur. Albino rats are still more resistant. The rapid intravascular injection or addition *in vitro* of thymus or yeast nucleic acids inhibits coagula-

tion of blood shed from cats and rats which have been deprived of hepatic activity. Serial intravascular injections of thymus nucleic acid into cats or rats deprived of hepatic activity produce hypercoagulability followed by tolerance, culminating in immunity to the anticoagulant action of nucleic acid. Immunisation can be produced with material free from protein. Anticoagulant action of thymus nucleic acid is exhibited during the presence and absence of platelets. It is suggested that nucleic acid inhibits clotting by union with plasma components, forming a more stable complex than that existent in normal circulating blood.—E. C. **Grey**: The latent fermenting powers of bacteria. Pts. I., II., and III. There cannot be a host of essentially different anzymes. The mechanism by which succinic acid is split into two parts cannot differ fundamentally from the mechanism by which glucose is split into two parts to form lactic acid, or three parts to form acetic acid, or into two parts to form a mixture of succinic acid and acetic acid or alcohol. It is not conceivable that the addition of formates can change one enzyme into another, as the lactic-acid-forming enzyme into an acetic-acid-forming enzyme, unless both have a common basis.

Aristotelian Society, January 21.—Prof. T. Percy Nunn, president, in the chair.—H. Wildon **Carr**: Human intercourse by means of speech. All the biological theories of the evolution of man infer that speech must in its origin have been an invention. The usual inference is that a new race of Hominidæ, at an early period of its emergence by evolution, discovered that natural cries could be adapted and modified and moulded into an instrument of discourse. In like manner all philosophies of language treat words as the conventional use of a material means of conveying meanings from mind to mind. Against these theories the view put forward is: that invention is the distinctive mark of intellect, and that therefore it characterises the development of speech, but it does not account for its origin; that further, it is the artificiality of the higher forms of speech which hides from us both the nature of speech itself and its origin. The origin of speech is in the nature of human mentality. Reason in its human form could not exist without speech. The concept of reason implies discourse, for reason is an activity directed from within outwards. Speech is expression. Self-expression is already speech though the individual mind have no audience but itself. It is this self-expression which becomes communicable, not on the analogy of physical objects passing from hand to hand, but on the analogy of a sympathetic emotion which, in passing from individual to individual, never ceases to be self-expression in the individuals who experience and communicate it.

February 4.—Viscount Haldane in the chair.—K. J. **Spalding**: The presuppositions of philosophy. Philosophy involves two cognate presuppositions. First, that thought is a nature incapable of satisfaction in a world which it does no more than recognise and uncomprehendingly accept, that is, in a world conceived as independent of thought's own nature; second, that thought has or may acquire the power of satisfying itself in a world adjusted and accommodated to itself. These presuppositions imply an essential relation between thought and being, a congruence between them which thought cannot think away nor being contradict. Thought cannot think nothing. This was pointed out by Plato when he named the faculty related to non-existence, ignorance (ἄγνοια). Equally it is not in the nature of being to exist independently of thought. This proposition seems less self-evident than the other, but it was forcibly presented by Berkeley, and a great part of the historical arguments of modern philosophy insist on the fundamental importance of its recognition.

Geological Society, January 23.—Prof. A. C. Seward, president, in the chair.—A. Smith **Woodward**: On a Hybodont shark (Tristychius) from the Calciferous Sandstone Series of Eskdale (Dumfriesshire). The portions of Carboniferous elasmobranchs hitherto studied seem to represent groups which are very different from those of the Mesozoic and Kainozoic eras. A specimen of Tristychius in the Royal Scottish Museum, from the Calciferous Sandstone of Eskdale, more nearly conforms to the Mesozoic Hybodont type. It shows the head, abdominal region, pectoral fin, and dorsal fins. The cartilages are only superficially calcified in small tesseræ. The teeth, of the form commonly named Lophodus (Romanowsky), are arranged as in Hybodus, but in slightly more numerous transverse series. The notochord must have been persistent, and the short slender ribs are as in Hybodus. In the pectoral fin there are two basal cartilages, as in Cestracion and some other recent sharks; but there seems to be no extension of the fin-membrane beyond the radial cartilages. The specimen is unique, but apparently suffices to show that elasmobranchs of nearly the modern type were beginning to arise in the Carboniferous Period.—W. S. **Boulton**: On a recently discovered breccia-bed underlying Nechells (Birmingham), and its relations to the Red Rocks of the district. A recent boring for water at Nechells Gasworks (Birmingham) has revealed an unexpected succession of rocks. The Keuper Sandstone (272 feet thick) rests unconformably upon a coarse breccia (Nechells Breccia) 350 feet thick, which in turn rests unconformably on Hamstead Beds. The breccia consists of angular fragments and lumps derived for the greater part from Cambrian quartzite and sandy limestone with some decomposed volcanic rocks; and in the lower portion, the fragments are calcareous sandstone of the type of the underlying Hamstead Beds. Fossils, belonging to the horizon just below the Olenellus Limestone at Comley (Shropshire) and to the horizon of the Hyolithus Beds at the top of the Hartshill Quartzite of Nuneaton, have been collected from lumps of the sandy limestone in the breccia. The Nechells Breccia was probably derived from an old land-surface very near Birmingham, probably on the south-east. Breccias seem to occur at intervals in a belt 40 miles long from north-east to south-west, all, so far as known, unconformable to the beds below them, and to the Trias above. Generally speaking, the material was derived from rocks which increase in age from north to south. The following grouping of the pre-Triassic Red Rocks of the Midlands is suggested: (3) Clent beds (Breccias), (2) Corley beds (the Calcareous Conglomerate group), (1) Keele beds. The age of the Corley Beds, which follow conformably upon the Keele, is still uncertain, and may eventually prove to be Permian. The Clent beds, in which the Nechells Breccia is included, are Permian.

Royal Microscopical Society (Industrial Applications Section), January 23.—Sir Robert A. Hadfield in the chair.—J. W. **Bamfylde**: Some failures in steel as revealed by the microscope and recorded by photography. Three cases of failure in railway material are described, in which the causes were investigated by macroscopical and microscopical methods. A new form of metallurgical objective is discussed, in which oblique light from all sides is employed. It can be used even with high-power objectives such as the 2 mm. oil immersion.—H. B.

Milner: The use of the microscope in the petroleum industry. Sub-surface correlation of the rocks in oil-bearing territory, as indicative of structure, has come to be more and more dependent on the precise methods of micropalæontology and micropetrology, especially the latter. Similarly, the microscopical investigation of impregnated (bitumenised) rocks is of great practical importance. The microscope is being employed on the refining side in a number of specialised operations including those concerned with decolorisation of oil, the use of certain filters such as fullers' earth, "floridin," charcoal, and bauxite, and in the study of oil-films and oil-blending. The microscope is also of service in dealing with greases, lubricants, "loaded" greases, and other impregnated textile materials used for roofing, insulation, and sheathing purposes, and for asphaltic rubber and asphaltic cement.

Linnean Society, January 24.—Dr. A. B. Rendle, president, in the chair.—F. **Howarth**: The sexuality of Ustilago. The sporidia of the smuts of barley and oats, *Ustilago Hordei* and *U. Avenæ*, can be divided into two groups. Those of one group will not conjugate amongst themselves but will readily do so with those of the other group. The strains appear to be identical morphologically but different physiologically. Conjugation will take place on a gelatine or agar gel medium with 1 per cent. malt extract, but not in the absence of oxygen nor in an atmosphere of carbon-dioxide, nitrogen, or hydrogen. Conjugation occurs best on a neutral or slightly alkaline medium; beyond a small range on the acid or alkaline side conjugation is inhibited.—J. R. **Norman**: The Greenland halibut (*Reinhardtius hippoglossoides*). This fish is apparently new to the British fauna. A specimen was caught off the south coast of Ireland, latitude 52° 30′ N., at 170 fathoms. Normally it is an arctic and sub-arctic species. From its nearest relative, the common halibut, it differs especially in the plumper body, larger mouth and stronger teeth, in the left eye being on the upper surface of the head and the dorsal fin commencing behind it, and in being coloured on both sides. In the young, however, the blind side is colourless. It appears to be discarding the habits characteristic of the order, and has regained to a certain extent its original symmetry.—J. **Ramsbottom**: The fungus flora of British woodlands. Apart from the part played by microfungi which pass at least a portion of their life-history in the soil and are concerned in soil fertility, there have to be considered the perennating mycelia of the larger fungi and the relation of these to the mycorrhiza of trees. Moreover, since fungi are either saprophytes or parasites, each association of the higher plants has its characteristic fungus constituents.

Physical Society, January 25.—Dr. Alexander Russell in the chair.—E. A. **Milne**: Recent work in stellar physics. A review of the relation of stellar spectra to modern spectral theory, with reference to giant and dwarf stars and to recent additions to our knowledge of stellar temperatures. Methods of deducing certain atomic quantities from astrophysical evidence were suggested.

DUBLIN.

Royal Irish Academy, January 28.—Prof. Sydney Young, president, in the chair.—G. P. **Farran**: Seventh report on the fishes of the Irish Atlantic Slope. Eleven species of Macrurid fishes (Coryphænoididæ) were taken in the course of fishery investigations on the west coast of Ireland down to 800 fathoms. Tabulation of vertical distribution shows that three species do not extend locally beyond a depth of 750 fathoms. The range of the remainder reaches to greater depths than were explored. One northern species, *Trachyrhynchus Murrayi*, is recorded from off the Irish coast for the first time. Another species, formerly identified as *Macrurus Mediterraneus*, is referred to *Coryphænoides Murrayi*.

Royal Dublin Society, January 29.—Prof. E. A. Werner in the chair.—W. R. G. **Atkins** and Marie V. **Lebour**: The habitats of *Limnæa truncatula* and *L. pereger* in relation to hydrogen ion concentration. The habitats of *L. pereger* and *L. truncatula* appear to differ in the fact that whereas the former is truly a water-snail, and can endure even somewhat stagnant water, the latter is amphibious, and can live either in shallow, well-aerated water or on moist land, or even on cliffs in a region of high humidity. The observed ranges for the two species are almost identical as regards acidity and salt content, those for *L. pereger* being P_H 6·6 to 7·7 and $C = 72\text{-}227 \times 10^{-6}$ at 0° C., and for *L. truncatula*, P_H 6·4-7·8 and $C = 59\text{-}294 \times 10^{-6}$. The records do not include upland waters of very low salt content, with conductivity $20\text{-}30 \times 10^{-6}$, nor regions of high acidity, more acid than P_H 6·4 for water or P_H 5·8 for land records.—H. H. **Poole**: A telephone method of photo-electric photometry for use at sea. The current driven by a high-tension battery through a Kunz photo-electric cell, exposed to the light to be measured, is passed through a resistance of about 50,000 ohms. The potential difference between the ends of the latter is balanced against a potentiometer. In place of a galvanometer, the balanced circuit includes the primary of a two-valve low-frequency amplifier (the output circuit of which is connected to a pair of telephones), and also a special form of interrupter, which breaks the circuit several hundred times per second, and causes a sound in the telephones whenever the system is unbalanced. A condenser of capacity about 0·5 microfarad is placed in parallel with the amplifier and the interrupter. This alternately charges and discharges, and adds greatly to the sensitiveness of the arrangement, which works well with illuminations between 10 and 10,000 metre candles. It is hoped to employ this method in conjunction with Dr. Atkins of the Marine Biological Laboratory, Plymouth, for measurements of the penetration of light into sea-water.

MANCHESTER.

Literary and Philosophical Society, December 18.—Prof. H. B. Dixon, president, in the chair.—A. M. **Williams**: Surface tension, surface energy, and the surface layer.

January 22.—M. L. **Becker**: Medieval metallurgy. Prior to the sixteenth century very little of practical value to the metallurgist had been published, although many of the most beautiful examples of art metal work date from that period. Owing to difficulties of transport in the Middle Ages all steps in the industry, from the supply of fuel and the mining, to the founding or forging of the metal, tended to concentrate at one place, namely, the source of the metal. Georgius Agricola, a physician of Saxony, was the first to give a comprehensive technical description of the methods employed by miners and smelters. Agricola's work "De Re Metallica," published in 1556, is of great importance; he deals with locating metallic veins; removing water, ventilating and hauling in mines; ore dressing, crushing and smelting, etc. Although the practices referred to were mostly those of Central Europe, yet there is every reason to believe that

these represented the best and most efficient of the day, except for iron and steel production, which appears to have been more advanced in England.

PARIS.

Academy of Sciences, January 21.—M. Guillaume Bigourdan in the chair.—Henri **Lebesgue**: The conditions of regularity, conditions of irregularity, conditions of impossibility in the problem of Dirichlet.—André **Blondel**: The influence of the harmonics of the retardations of phase on the distribution of the cranks in an explosion motor with several cylinders. The influence of elastic connexions and of damping.—W. **Kilian**: The structure of the subalpine chains of Dauphiny.—Louis **Chomard**: Discontinuous groups of movements.—Pierre **Humbert**: A class of polynomials.—Rolf **Nevanlinna**: Meromorphic functions.—P. J. **Myrberg**: A theorem on continued fractions.—Michel **Collinet**: The internal energy of an elastic body.—C. **Parvulesco**: The constitution of star clusters. The star clusters in Perseus, and any others in which the distribution of the types of spectrum follow the same law, as judged from the photographic appearance, present a stratified structure having the heaviest stars clustered round the centre and the smaller masses removed to the periphery of the cluster. In any group of stars of varying masses, the law of distribution of the stars, as well as that of their velocities, will not remain unchanged unless the cluster is stratified.—L. **Bochet**: The law of corresponding states of van der Waals. A discussion of the validity of the reduced equation of state of van der Waals.—A. **Perot**: Experimental verification of the principle of Wladimir Michelson, and of the Doppler-Fizeau principle. Description of construction and use of apparatus, with results quantitatively verifying the principles of W. Michelson and of Doppler-Fizeau.—M. and L. de **Broglie**: The experimental verification of the projections of electrons, predicted from the diffusion of X-rays, by the considerations of Compton and Debye. The condensation method, although capable of showing that some of the trajectories correspond well to the effects predicted by Compton, is not suitable for quantitative verification. A possible method is outlined.—V. **Dolejsek**: The identification of the lines of the N series.—G. **Athanasiu**: The electromotive forces produced by light on metals immersed in solutions of their salts. Electrodes of silver, copper, nickel, cadmium, zinc, undergo changes in solutions of their salts, and the layer thus formed possesses actino-electric properties. The same phenomenon is produced with non-reversible elements.—Pierre **Girard**: Concerning a note of M. Demoussy entitled "On the displacement of acids by diffusion."—P. **Lebeau**: The quantity and the nature of the gases disengaged by solid combustibles under the action of heat and a vacuum: coals. Complete analyses are given of the gases evolved at 1000° C. in a vacuum by ten different samples of coal of different origin, and of volatile matter varying from 23 to 39 per cent. Hydrogen and carbon monoxide appear at 400° C. with a maximum at 700° C. Methane also appears at 400° C. and reaches a maximum at 600° C. Ethane, propane, and ethylene are produced at 500° C.—A. **Wahl** and W. **Hansen**: The constitution of isatane and isatyde.—Mme. Pauline **Ramart**: The general preparation of the diphenylalkylacetates of benzyl by means of sodium amide and the alkyl iodides as well as the corresponding acids. Details are given of the method of working, together with accounts of the properties of three acids of the type $(C_6H_5)_2 . CR . CO_2H$.—John **Pringle** and Pierre **Pruvost**: Observations on the Portland series of the Boulonnais.—G. **Mouret**: The supposed pudding-stones of the Dinantian in the department of Creuse, and the schists of Evaux-les-Bains.—Léon **Moret**: The discovery of Orthophragmines in the "Taveyannaz grit" of the Platé massif (Haute-Savoie) and its consequences.—Ladislas **Gorczynski**: The fraction of the intensity of the solar radiation transmitted, for various wave-lengths, by red Jena glass. The red glass, Jena F. 4512, used by the author in an earlier communication on solar radiation in Siam and Java (*Comptes rendus*, October 22, 1923, p. 754) has been found to transmit 80 per cent. of the total intensity for wave-lengths $0{\cdot}8\mu$ to $2{\cdot}5\mu$. The transmission shows a rapid diminution in the yellow part of the spectrum and becomes opaque for the wave-length $0{\cdot}54\mu$.—L. **Eblé** and J. **Itié**: Values of the magnetic elements at the station of Val-Joyeux (Seine-et-Oise) on January 1, 1924.—René **Souèges**: The embryogeny of the Polygonaceæ. The development of the embryo in *Polygonum aviculare*.—Jules **Offner** and Roger **Heim**: Pleurotus in the alpine meadows. Commenting on recent communications of M. Costantin, the author points out that this mushroom is widely distributed in Savoy. It has been collected near Saint-Jean-de-Maurienne, in the meadows of Villarembert, on Mont Corbier, the Salève, etc. The suggestion of collection and sale for food has already been realised, and there is a regular market for these fungi at Grenoble during the winter. André **Broca**: A pupillometer permitting measurements of the pupil (of the eye) in a restricted light.—Jacques **Couvreux**: The photomotor reflex. The Fick pupillometer, modified by A. Broca (preceding paper), has been used to measure the photomotive reaction of a normal eye adapted to the dark.—Emile **Haas**: Experiments on the sensation of yellow light obtained by mixture of spectra. It is well known that it is possible to reproduce any colour of the spectrum by mixing two colours, suitably selected, in certain proportions: the experiments described prove, in addition, that the identical appearance between the mixture and the simple colour is maintained, whatever may be their intensity, and whatever the duration of time during which the retina is illuminated. F. **Maignon**: Researches on the constitution and mode of action of the biological catalysts or diastases. The effects of electrolysis on the diastases of the pancreatic juice and the amylase of germinated barley. After five days' electrolysis, the mineral constituents of the diastase (chlorine, iron, calcium) are removed and the diastatic action is destroyed.—J. **Legendre**: Variations in the trophism of the Culicidæ.—R. **Herpin**: The periods of epitoquy of some neridians and their relations with the phases of the moon.—Et. **Burnet** and Ch. **Anderson**: The importance of mammitis in goats carrying *M. melitensis*.

Official Publications Received.

Progress of Education in India, 1917–1922. Eighth Quinquennial Review. Vol. 1. By J. A. Richey. Pp. v+241+xxxv. (Calcutta: Government Printing Office.) 1.6 rupees.

Bulletin of the National Research Council. Vol. 6, Part 5, No. 36: Catalogue of Published Bibliographies in Geology, 1896–1920. Compiled by Edward B. Mathews. Pp. 228. 2.50 dollars. Vol. 7, Part 1, No. 37: Thermal Process Time for Canned Food. By Charles Olin Ball. Pp. 76. 1.50 dollars. Vol. 7, Part 2, No. 38: Fellowships and Scholarships for Advanced Work in Science and Technology. Compiled by Research Information Service. Pp. 94. 1 dollar. (Washington, D.C.: National Academy of Sciences.)

Studies from the Plant Physiological Laboratory of Charles University, Prague. Vol. 1. Edited by Prof. Dr. B. Němec. Pp. 119. (Prague.)

Bulletin of the Terrestrial Electric Observatory of Fernando Sanford, Palo Alto, California. Vol. 1: Summary of Observations for the Period May 1920–August 1923. Pp. 32. (Palo Alto, California.)

Meddelanden från Statens Skogsförsöksanstalt. Häfte 20. Pp. iii+476. (Stockholm.) 9 kr.

Koloniaal Instituut te Amsterdam. Mededeeling No. 20, Afdeeling Handelsmuseum No. 5: Klappervezel- en Klappergarennijverheid. Verslag van een in opdracht van het Koloniaal Instituut ingesteld onderzoek naar de klappervezelindustrieën op Ceylon en aan de Malabarkust, met een beschouwing over de mogelijkheid deze industrieën in Nederlandsch Oost-Indië ingang te doen vinden. Door Dr. A. J. Kluyver en Raden Mas Iso Reksohadiprodjo. Pp. xiii+305+18 bijlagen. (Amsterdam: Druk De Bussy.) 5 f.

Crichton Royal Institution, Dumfries. Eighty-fourth Annual Report, for the Year 1923. Pp. 45. (Dumfries.)

Annals of the (Mededelingen van het) Transvaal Museum. Vol. 10, Part 2: Some Additions to the List of South African Mammals, by Austin Roberts; Classification of S. African Birds: Some Additional Notes, by Austin Roberts; A New Genus and Species of Syrphidæ (Diptera) from South Africa, by H. K. Munro. Pp. 59-88+1 plate. Vol. 10, Part 3: Synoptic Check List of the Birds of South Africa, by Austin Roberts. Pp. 89-195+4 plates. (Cambridge: Printed at the University Press.)

Diary of Societies.

SATURDAY, FEBRUARY 16.

SCHOOL NATURE STUDY UNION (in Botanical Theatre, University College), at 3.—Prof. J. A. Thomson: Some Unsolved Problems of Everyday Natural History.

MONDAY, FEBRUARY 18.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Prof. G. McC. Price: Geology in its Relation to Scripture Revelation.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—E. Heawood: The Use of Watermarks in Dating Old Maps.

NATIONAL HEALTH SOCIETY (at Royal Society of Medicine), at 5.—Dr. W. E. Dixon: Alcohol—its Use and Abuse. (Lady Priestley Memorial Lecture).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—C. P. G. Wakeley: Some Actions of Radiations on Living Tissues.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—E. M. Malek and others: Discussion on Electrical Development in France.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—P. Waterhouse: The Charing Cross Bridge.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—C. E. M. Joad, Prof. A. N. Whitehead, and Prof. T. P. Nunn: "The Academic Mind," with reference to Mr. Joad's "Common-sense Theology."

FARADAY SOCIETY (at Chemical Society), at 8.—Principal A. P. Laurie: Suggestions for a Magnetic Theory of Valency.—Prof. T. M. Lowry: The Electronic Theory of Valency. Part IV. The Origin of Acidity.—E. Hatschek and R. H. Humphry: Certain Physical Differences between Sols and Gels of Agar.—Prof. D. C. Henry and A. V. Morris: The Influence of Anions in the Coagulation of a Negative Colloidal Sol.—E. B. R. Prideaux and W. E. Crooks: The Diffusion Potentials of Benzoates and Salicylates and their Modification by a Membrane of Parchment Paper.

TUESDAY, FEBRUARY 19.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. Barcroft: The Respiratory Pigments in Animal Life and their Significance (2).

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—R. Y. Sanders: Foreign Trade and Shipbuilding.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. E. W. Shann: Further Observations on the Myology of the Pectoral Region in Fishes.—H. C. Chadwick: Some Abnormal and Imperfectly Developed Specimens of the Sea-Urchin, *Echinus esculentus*.—P. R. Lowe: The Presence of Broadbills (Eurylæmids) in Africa.—Dr. C. F. Sonntag: The Anatomy, Physiology, and Pathology of the Orang-Outan.

INSTITUTION OF CIVIL ENGINEERS, at 6.—T. R. Nolan: Slips and Washouts on the Hill Section of the Assam-Bengal Railway.—R. D. Walker: Underdrainage and its Application to Railway Work.

INSTITUTION OF MARINE ENGINEERS, INC., at 6.30.—D. H. Owen: Experiments on a Cylindrical Steam Boiler with and without Pre-heated Air.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—P. King: The Camera and the Human Eye—a Comparison.

ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—J. F. Caine, E. A. Marx, and others: Discussion on Some Aspects of Railway Lighting.

ROYAL ANTHROPOLOGICAL INSTITUTE (at Royal Society), at 8.15.—Dr. E. Jones: Psycho-analysis and Anthropology.

WEDNESDAY, FEBRUARY 20.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.—C. B. Trye: The Reconstruction of an Important Bridge on the London, Midland and Scottish Railway.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Prof. S. Chapman: (*a*) The Lunar Atmospheric Tide at Mauritius and Tiflis; (*b*) The Semi-diurnal Oscillation of the Atmosphere.—C. S. Durst: The Relationship between Current and Wind.

ROYAL MICROSCOPICAL SOCIETY, at 7.45.—H. J. Denham: The Contribution of Textile Research to the Theory of Cell Wall Structure.—W. E. Hall: An Apparatus for the Extraction of Micro-organisms from Samples of Water.

ROYAL SOCIETY OF ARTS, at 8.—P. J. Burgess: New Uses for Rubber.

THURSDAY, FEBRUARY 21.

MEDICO-PSYCHOLOGICAL ASSOCIATION (at 11 Chandos Street), at 2.45.—Dr. J. Warnock: Twenty-eight Years' Lunacy Experience in Egypt.

ROYAL SOCIETY, at 4.30.—C. Tate Regan: The Morphology of a Rare Oceanic Fish, *Stylophorus chordatus* Shaw; based on Specimens collected in the Atlantic by the "Dana" Expeditions, 1920–1922.—F. P. Slater: A Sensitive Method for observing Changes of Electrical Conductivity in Single Hygroscopic Fibres.—T. S. P. Strangeways: Observations on the Formation of Bi-Nuclear Cells.—Dr. J. A. Crowther: Some Considerations relative to the Action of X-Rays on Tissue Cells.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir William Bragg: The Crystalline Structure of Organic Substances (3).

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—H. H. Thomas: Aerial Photography and Survey.

INSTITUTION OF MINING AND METALLURGY (at Geological Society of London), at 5.30.—Dr. H. S. Hatfield: Dielectric Separation: A New Method for the Treatment of Ores.—B. W. Holman and St. J. R. C. Shepherd: Dielectric Mineral Separation: Notes on Laboratory Work.—W. S. Patterson and P. F. Summers: The Influence of Certain Fluxes on the Softening Temperature and Fluidity of a Monosilicate Mixture of Lime and Silica.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—T. Dean: The Dalton Plan in Practice.

INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates' Meeting) (at Watergate House, Adelphi), at 7.30.—L. F. Little: The Possibilities of the Two-stroke Engine for Automobile Purposes.

CHEMICAL SOCIETY, at 8.—Prof. T. M. Lowry and E. M. Richards: The Rotatory Dispersive Power of Organic Compounds. Part XI. Octyl Alcohol and Octyl Oxalate.—H. Hunter: Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part XXII. Simple and Complex Rotatory Dispersion.—Prof. T. M. Lowry and J. O. Cutter: (*a*) The Rotatory Dispersive Power of Organic Compounds. Part XII. Borneol, Camphor, and Camphorquinone. Asymmetric Atoms and Asymmetric Molecules. (*b*) The Rotatory Dispersive Power of Organic Compounds. Part XIII. Halogen-derivatives of Camphor. Optical Superposition in the Camphor Series.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE, at 7.45.—Prof. F. Kleine: Demonstration of Various Trypanosomes.—At 8.15.—Prof. F. Kleine: Recent Expedition to Africa to investigate the Action of "Bayer 205."

C.B.C. SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Strand), at 8.—Dr. Maude E. Kerslake: Why we want Clinics.

FRIDAY, FEBRUARY 22.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—G. Temple: A Generalisation of Whitehead's Theory of Relativity.—Dr. H. Petterssen: The Structure of the Atomic Nucleus and the Mechanism of its Disintegration.—Miss Winifred Rolton and R. S. Troop: The Effect of a Magnetic Field on the Surface Tension of a Liquid of High Permeability.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Annual General Meeting: Probable Resumption of Discussion on Repairs and Upkeep of Pneumatic Tools by R. W. Wilson.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—C. P. Crowther: Portraiture with Portable Lighting. (Lantern Lecture.)

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—J. S. Marshall: "Ciment Fondu"—its Manufacture and Special Uses.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. G. Elliot Smith: The Human Brain.

PUBLIC LECTURES.

SATURDAY, FEBRUARY 16.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. C. A. Raisin: Glaciers and Ice-work of the Past.

MONDAY, FEBRUARY 18.

GOLDSMITHS' COLLEGE, at 8.—Dr. A. K. Chalmers: Housing Standards—how they can be raised (Chadwick Lecture.)

WEDNESDAY, FEBRUARY 20.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Dr. M. S. Paterson: The Infectivity of Tuberculosis.

UNIVERSITY COLLEGE, at 5.30.—J. G. Pearce: The Work of Special Libraries and Intelligence Bureaux in Industry.—At 6.—M. Greenwood: The Biometric Study of Cancer.

THURSDAY, FEBRUARY 21.

LONDON SCHOOL OF ECONOMICS, at 5.—Dr. J. H. Clapham: Britain on the Eve of the Railway Age. (Succeeding Lecture on February 28.)

ST. MARY'S HOSPITAL, at 5.—Prof. B. J. Collingwood: Blood. (Succeeding Lectures on February 28, March 6 and 13.)

ST. THOMAS'S HOSPITAL, at 5.—Dr. J. A. Murray: Cancer. (Succeeding Lectures on February 28, March 6 and 13.)

KING'S COLLEGE, at 5.30.—Dr. E. W. Scripture: The Psycho-analysis of the Poet.

UNIVERSITY COLLEGE, at 8.—H. Pringle: Spiritual Values in Education.

FRIDAY, FEBRUARY 22.

LONDON SCHOOL OF ECONOMICS, at 5.—Prof. A. P. Brigham: The Geography of the United States—Regional and National. (Succeeding Lectures on February 26 and 29.)

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Dr. Graham Wallas: The Social Thought of To-morrow.

SATURDAY, FEBRUARY 23.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Animals in the Religion of the Ancient Egyptians.