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The National Need of Scientific Research and Research Workers.

THE Prime Minister, in his speech to the House of Commons on June 29, expressed the view that, to find a way out of our present economic difficulties, one of the essential steps is "to link up science with our industries to-day." Lip service to this ideal can generally be obtained easily in most quarters, whether industrial, scientific, or political. It is when we come to discuss practical methods of realising the ideal that differences of opinion become most marked. The fundamental problem was admirably stated in the annual report of the Committee of the Privy Council for Scientific and Industrial Research for the year 1921–22 (Cmd. 1735):

"The problem before the country, as we see it, is to provide a means which will enable its population of nearly 50,000,000 to live and prosper. It is well recognised that for four-fifths of their food and for a great part of the necessary raw and semi-manufactured materials for industry, the people of these islands are dependent on supplies from overseas. These supplies can only be obtained if this country is able to carry on its exporting industries in future with greater efficiency than the rest of the world, for it is doubtful whether we can compete, either by lowering wages beyond the limits of our competitors, or by securing a much greater human effort than they. If these two avenues are closed, competition, in the end, is confined to greater efficiency resulting from scientific work, for, in the long run, our outstanding business skill and organisation could not make good a deficiency of production or an obvious inferiority in our goods. We consider that scientific and industrial research . . . is an essential factor in the national effort on which the continued maintenance of our present population unquestionably depends."

Two publications of recent issue have redirected attention to certain aspects of this problem. The Research and Inventions Committee of the British Science Guild (6 John St., Adelphi, W.C.2) has issued a report, published as a pamphlet, entitled "Scientific Research Workers and Industry." The National Union of Scientific Workers (25 Victoria St., S.W.1) has recently issued, under the title "On the Encouragement of Fundamental Research," a report of the Research Committee of that body, presented to and adopted by the Council. The two pamphlets are complementary, each to the other; the National Union of Scientific Workers confining itself to "fundamental" research of a purely theoretical nature, the British Science Guild being concerned with scientific research having a direct relation to industry.

The publication of the British Science Guild is an admirable document, from which it is easy to see that great pains have been taken to acquire a solid basis of facts, often in face of great difficulties and of the reluctance or failure of those bodies having the knowledge of the facts to impart them. In a brief introduction and historical summary, it is pointed out that the Duke of Devonshire's Royal Commission on Scientific Instruction and the Advancement of Science set forth in its report, forty-five years ago, the paramount importance of scientific research, and urged the universities to assist in its promotion, stating that it was to the universities that the country must primarily look for its scientific workers. Neither the State nor the older universities, to which the appeal was made, took any serious steps to supplement the inadequate supply of scientific workers. The War opened the eyes of the country at large, and, since the War, developments in education and the establishment of the Department of Scientific and Industrial Research have already done much to foster scientific research and to bring about its better co-ordination with industry. "Undoubtedly," says the Committee, "the supply of scientific workers has been greatly augmented and the question now arises as to the use made of them in industry." It is to this question that the Committee directed its labours and with which its pamphlet deals.

Dealing with the supply of trained scientific research workers, the Committee of the British Science Guild, after an informative statistical statement of the data obtained by its inquiries, comes to the following conclusion: "It appears that Great Britain has now just about reached the pre-War standard of Germany and the United States, judged by the ratio of students to population, but there is no reason to suppose that the other two countries have remained stationary, consequently there is no justification for deciding that we have now raised our educational status to a position worthy of our place among the other nations, and that there is no need for further expansion." It is pointed out, however, that the universities are short of money and expansion in research facilities is consequently curtailed, despite the facts that the total income of the British universities has been more than doubled, while the annual Parliamentary grant is now nearly five times that of the pre-War period.

As to the utilisation of scientific research workers in industry, the chemical and engineering and allied industries probably employ most of the scientific research workers now engaged in industry. An attempt has been made to get scientific research domiciled in other industries by the establishment, under the ægis of the Department of Scientific and Industrial Research, of industrial research associations for a number of important industries. Very valuable work has been done already by these research associations, but, except in one or two instances, they do not appear to the Committee to be very extensively developed, the number of scientific research workers employed by them being comparatively small.

The Committee of the British Science Guild says, however: "The success of the Associations, so far as they have been developed, justifies in our opinion the very fullest extension of their activities." The Committee makes several constructive suggestions to this end. In one of these suggestions it has already been anticipated in fact, namely, that the Government could offer considerable inducement to commercial firms to support research by permitting sums devoted to this purpose to be treated as trade expenses for the purpose of assessment for taxation. By an arrangement with the Department of Scientific and Industrial Research, the Inland Revenue does allow the *annual* subscriptions of industrial firms to research associations to be so treated as a trade expense, and, moreover, the income of the research associations so derived is not subject to income tax.

After pointing out "the vast gap there is, in many cases, between laboratory discovery and the commercial exploitation of a process," a gap often bridged only by years of skilled work, the Committee, in an Appendix, submits a memorandum on a proposed advisory committee on industrial inventions. This committee would consist of experts and would have the following functions:

(i) To examine the claims of inventions and to decide which are of probable industrial value.

(ii) To arrange for the semi-large scale, or complete commercial trial, of these inventions which are passed by the committee.

This is a valuable suggestion. The Conference of Research Associations, at its meeting in July last, discussed the same problem, how to bridge the gulf between laboratory discovery and the large-scale application of the discovery to industry. It is too big a question to be dealt with adequately here and now. In many cases, but not in all, it is mainly a question of financing the large-scale trials needed; and it has been suggested that, over and above the funds available to the research associations for research as generally understood, there should be some development fund out of which grants could be made for this specific purpose of shortening the "lag" between discovery and application.

The Committee of the British Science Guild directs attention also to the scheme adopted in the "A. D. Little" Laboratories in the United States, and suggests that a similar organisation "not in any way in competition with the existing Industrial Research Associations, but as a supplement to their activities," would perform a very useful function in Great Britain.

This publication of the British Science Guild is certainly a most helpful and constructive contribution to the solution of the problem, how "to link up science with our industries to-day." That problem will not be near to solution, however, until our manufacturers generally come to regard scientific research as essential a part and parcel of industrial organisation as are, say, insurance, advertisement, and sales organisation.

We have but little space left to deal fully with the pamphlet issued by the National Union of Scientific Workers. Much of it, perhaps necessarily from the scope of the subject, is rather of the nature of moral exhortation than of concrete proposal, and it reads at times a little tritely. Nor are the authors always successful in "jining their flats." After declaring that the distinction between "pure" science and "applied" science, whether valid or not, is irrelevant to their purpose, they proceed to draw a vital distinction between "fundamental" research and "practical" research, as though this were not pretty much the same thing; and this distinction they base on what must generally be difficult, if not impossible, to determine, the "motives" which inspire the research workers. Who can say what these motives are? Some day perhaps we shall reach that happy state in which it will no longer be worth while to define "pure" and "applied," "fundamental" and "practical," as applied to scientific research. We shall be content to plead for thorough research, confident that if the research be thorough, the "pure" will look after the "applied," and the "practical" will not neglect the "fundamental."

Nevertheless, the National Union of Scientific Workers has performed a most useful service in directing attention to the paramount necessity, apart from any question of its practical application, of scientific research. It points out that the encouragement of research involves the arousing of a right attitude towards research among the general public and the provision of the right atmosphere for the research worker, and makes important suggestions as to financial provision for research.

Birth-Control: Individual and Social Ethics.

The Ethics of Birth-Control. (Report of the Special Committee of the National Council of Public Morals.) Pp. xvi+179. (London: Macmillan and Co., Ltd., 1925.) 2*s*. 6*d*. net.

THIS is a curious publication. The spirit in which the Committee approached its task may be judged from the introductory remarks of the chairman, the Bishop of Winchester. In these he says that many people regret the public discussion now given to such topics as birth-control, and that "in large measure the Committee share that regret."

It is this attitude which is in itself a serious matter. Here is an invention—the mechanical and chemical control of conception—which is one of the few important biological inventions made in historical times. The discovery of anæsthetics and that of various methods of killing or weakening the action of harmful bacteria are the only others that are in the same street with it. It points a practical way to a final satisfactory control by man of his own evolution, since the only other regulators of numbers which are not merely pious wishes are war, pestilence, famine, or overcrowding. Yet a serious body of public men regret, decades after its widespread adoption in practice, that it should be *discussed*.

Many biologists and students of medicine remember the nausea which rewarded their first dissection or their first post-mortem. It is a natural and almost instinctive reaction, and yet it is their duty and their privilege to be able to overcome it and so devote themselves to the search for truth or the relief of suffering. The cases are precisely parallel.

The net result of the Committee's deliberations is that its members continue to sit on the fence. They find that the use of contraceptives may in special medical or even economic circumstances be advisable, but that self-restraint should always be the ideal. One paragraph in especial deserves quoting as a dogmatic statement which to many will seem simply at variance with fact, and at any rate begs the question: "The use of contraceptives is a symptom of the artificial character of our civilisation whereby for large numbers of people a simple healthy normal married life is difficult and in some cases all but impossible." Even from this very moderate condonation of birth-control, a minority, including Canon Lyttelton, dissent. They say that the use of contraceptives is *never* to be condoned, and give as their chief reason that it is unnatural ("a frustration of God's design in Nature").

It would be very interesting to know which of the activities of civilised man the minority would call natural. When I used to meet Canon Lyttelton regularly—when I was under him in Sixth Form at Eton —he (*inter alia*) taught us Latin, Greek, and Divinity, and did his best to stop beagling in the school. Now I would quite respectfully submit that these activities are no more natural—or unnatural—than the practice of birth-control; and one of them—the antipathy to chasing wild animals—though I sympathise with it personally, yet is in direct opposition to one of the most ingrainedly "natural" propensities of humanity.

No: to damn a practice because unnatural is logically, to revert to a senseless Rousseauism. From one point of view civilisation is all unnatural. From another it is all natural, since it all springs from the nature of man: and as a matter of fact, the qualities in it which are usually regarded as more natural are just those which we share with the brutes, not those peculiar to our human dignity, and more often than not need repression instead of encouragement. It is meaningless to judge the practices of civilised man on this basis: they may justly be appraised as right or wrong, or as useful or harmful—but natural or unnatural, no.

Turning to the majority report, we find another defect which is characteristic, unfortunately, of too many idealists, both within and without the Church. They consider what they would like to see in existence, while partly or wholly neglecting what is in existence; and they run to extremes. It is pretty obvious that we should prefer to see more self-control in marital relations rather than more self-indulgence. But they do not seem to have reflected that such self-control as they recommend is not and certainly will not be for centuries "practical politics" for the mass of the human race. Among the distinguished people who gave evidence we find medical men, philosophers, social workers, clergymen, and others: one figure is conspicuously absent, and that is "l'homme moyen sensuel"—the type of the mass for which the Committee aspires to proscribe. For at least half the population for generations to come, the alternative to contraceptive methods is not self-control but the reverse, with as a result excessive child-bearing, with consequent misery, ill-health, poverty and degradation of standards.

Further, if there is one thing that is clear, it is that contraception has come to stay. Sir William Beveridge has made it fairly clear that to no other cause than the improvement of contraceptive methods can the marked drop in the birth-rate which started some fifty years ago be ascribed; for the suggestion of Brownlee that we are dealing with some undefined phenomenon of race-fertility cannot be entertained without much more cogent evidence.

Then our Committee runs to extremes. It may be true, as we said, that *more* marital self-control would be a good thing; but that does not in the least imply, as an elementary acquaintance with logic will convince, that *complete* self-control, save for the deliberate purpose of producing children, is the ideal. It is undoubtedly true that more self-control in the matter of eating would be a good thing, both morally and physically, for the nation; but that does not make complete abstention from food the ideal. A more real parallel is between the two aspects of eating and the two aspects of marital relations. We must eat to live, but we can also enjoy our food for its own sake. So we must practise marital relations to reproduce our species; but we can also find in them a means, as the Quakers put it, of "mutual endearment," or, in the more flaming words of Blake, make of it "that . . . on which the soul unfolds her wing." If we are to refrain from all intercourse save that intended for procreation, we must logically disapprove of all devices, such as good cooking, designed to promote enjoyment of food, instead only of gluttony.

Finally there remains the biological aspect. The drop in the birth-rate has been differential. That of all classes used to be the same: in the last half-century or so the birth-rate of the professional and upper classes has fallen much more than that of the rest of the population. Although this is not such a dysgenic matter as is sometimes made out, since some very good stock, such as those of miners and agricultural labourers, show little drop in fertility, yet it *is* dysgenic: the proportion of desirables is decreasing, of undesirables increasing. The situation must be got in hand. But it is impossible to persuade the classes which have adopted contraceptive methods to drop them by idealistic appeals to self-control. The way to begin to stop the rot is to diffuse these practices equally through all strata of society. Then and only then can we draw breath and look round for more constructive eugenic remedies. But, meanwhile, as Mr. Wells in his letter in NATURE of July 25 suggests, we have no cause to be complacent about our intellectual and social freedom as compared with Tennessee; in the matter of birth-control we are doing a similar thing; we are preventing servants of the State from giving information on a vital topic, largely because of the attitude of certain religious bodies to the topic. Not only this, but while thus preventing the giving of the information where it is most needed, we take not the slightest steps to prevent it being given in a thoroughly unpleasant way, on a commercial basis—to those who can pay for it.

I make no apology for dealing with the subject at such length. We have here one of the most urgent matters of applied science with which our civilisation has been called upon to deal. Let us not bungle it as we bungled the whole human and social side of the application of science to industry at the time of the industrial revolution. I would recommend the separate report signed by Dr. Bond alone of the Committee as embodying a very cautious but a very sane attitude.

This booklet is interesting for much of the evidence which it contains; it is also interesting as showing that the Churches are alive to the existence of the problem. But we must regret that the report on the whole allows the question to fall to the ground between, on the one hand, the stool of "natural" repugnances which ought to have been long ago overcome, and the stool of over-idealism on the other. When all is said and done, there is very little guidance here of a practical or social sort. The "ethics" of the book's title are chiefly individual ethics; the social ethics of the question are less fully and less broadly discussed. The over-concern of the individual for the salvation of his own soul was a characteristic of the Middle Ages. It springs up when there seems to be no prospect of reconciling the organisation of society with religious and moral ideals. To-day we do not feel that as an impossibility—however hard the task obviously will be; we see society as more plastic. We must be very careful not to allow the individual's concern about his own soul to loom so large as to stand in the way of social improvement or to block the social view. It would be an interesting task to try to discover how far the acknowledged lack of grip of the Church on the nation to-day comes from the retention of this spirit, which, however necessary a product of medieval times, is out of place in a society the leading minds of which are upheld by the consciousness that man through knowledge may acquire conscious control of evolution. But that is another story!

J. S. HUXLEY.

Mining and Metallurgy in the British Empire.

Empire Mining and Metallurgical Congress, held in London, June 3-6, 1924. Proceedings. Part 1: General Section of Congress. Edited by the General Secretaries and G. F. Bird and Percy Strzelecki. Pp. xv+474+14 plates. Part 2: Mining. (Section A of Congress.) Edited by the General Secretaries and G. F. Bird and Percy Strzelecki. Pp. xvi+542+25 plates. Part 3: Petroleum. (Section B of Congress.) Edited by the General Secretaries and Dr. A. E. Dunstan. Pp. xvi+239+21 plates. Part 4: Metallurgy of Iron and Steel. (Section C of Congress.) Edited by the General Secretaries and L. P. Sidney. Pp. xiv+296+14 plates. Part 5: Non-ferrous Metallurgy. (Section D of Congress.) Edited by the General Secretaries and G. Shaw Scott. Pp. xii+137. (London: Empire Mining and Metallurgical Congress, 225 City Road, 1925.) Parts 1, 3, 4, 5, 10*s*. 6*d*. each; Part 2, 21*s*.; Set of 5 vols., 42*s*.

THE records of the proceedings of the first Empire Congress of Mining and Metallurgy have now been published in five substantial volumes, which will be found to contain much of interest to every one engaged in any branch of the numerous industries included under the headings mentioned in the titles of the volumes. It must not, however, be supposed that the importance to the British Empire of last year's Congress can be in any way properly gauged by the printed record of its proceedings. The real value of this Congress is to be found rather in its personal touch, in the essential fact that this was the first occasion upon which the men engaged in developing the mineral resources of the British Empire met together in conference, made each other's personal acquaintance and were able to discuss, both formally and informally, the numerous perplexing problems which they are called upon to solve in their daily routine. It may safely be said that the most valuable work that was done at the Congress was the work that will never be published, the heart-to-heart exchange of views for which it afforded so many opportunities, and to which the formal papers, which now lie before us in their permanent form, were so often looked upon mainly in the light of more or less unwelcome interruptions.

The importance of the subject-matters of this Congress can scarcely be overestimated, including as they do the employment in the service of mankind of the mineral wealth of our vast Empire; let it be remembered that the utilisation of the earth's mineral resources embodies human civilisation. The savage can live and does live on the organic products of the earth; but the dawn of civilisation only arose when man began to avail himself of the earth's inorganic products also, and every advance in civilisation and in the amenities of life depends upon the fuller and better use made of mineral resources. The work of mining and metallurgical technologists consists in discovering how to use these resources to the best advantage and how to supply them in the vast quantities and at the comparatively reasonable cost which the complexities of our modern existence imperatively demand. It is for this purpose mainly that the technologist calls upon science to come to his aid, and, as the records before us abundantly show, the application of scientific principles is playing an increasingly important part in helping the development of the mineral resources which Nature has placed at the disposal of mankind; never was there a time when the need for the employment of scientific methods was more urgent, for it would almost appear as though this were the only direction in which it is possible to seek for a remedy against the prevailing creed of work-shyness from which the Empire and Great Britain, in particular, are to-day suffering.

Whatever science and technology may effect, the basal fact remains, that we must necessarily look to labour to carry out the methods which the trained mining engineer and metallurgist may devise. In his recent presidential address to the Iron and Steel Institute, Sir Frederick Mills showed that the cost of production of all ordinary commodities includes from 90 to 95 per cent. labour cost, and this high figure emphasises strikingly the fact that it is labour alone which, in the ultimate resort, determines whether the articles which modern civilisation demands shall or shall not be supplied at a reasonable cost. This point was admirably put quite recently in another presidential address, that of Sir Thomas Holland to the Institution of Mining and Metallurgy, and his words are worth quoting:

"As civilisation, such as we know it, depends absolutely on our being able to rely on supplies of the base metals, each improvement in the treatment of ore adds enormously to the actuarial value of civilised life. On the other hand, every increase in the cost of mining and metallurgical operations renders inaccessible correspondingly our available reserves. As labour is the most important item in our working costs, a trades' union meeting can undo in a morning the results of a generation's research work in ore-dressing and metallurgy."

It is considerations such as these which serve to show the Empire Congress of Mining and Metallurgy in its true light as a bulwark of civilisation, based on the co-operation of those engaged in furnishing humanity with those materials which it has learnt to regard as indispensable to its present comfort and future progress. Towards the attainment of this object, the free interchange of ideas between all English-speaking mining engineers and metallurgists (for it must not be overlooked that, in spite of the title of the Congress, American technologists were good enough to take part in it and to share in the deliberations of their British fellow-workers, to the great delight of the latter) is perhaps the most effective means that could have been devised.

To turn to the published proceedings, it has already been indicated that they form the least important part of the real work of the Congress, in spite of the fact that they contain much information of the greatest use to students of technology. There are five volumes, the first dealing with general subjects, and the four others devoted respectively to mining (coal and metalliferous), petroleum, iron and steel, and the non-ferrous metals. The first volume contains a certain amount of what may be considered as ephemeral matter, records of proceedings, speeches at the Guildhall banquet, etc.; but together with these there are three general papers of very great importance, namely, general reviews of mining and metallurgical practice in three great sections of the British Empire—Canada, Australasia, and South Africa—each of which contains a wealth of information concerning the development of their respective mineral resources which could only have been brought together on such a unique occasion as this Congress presented. Perhaps it may be regretted that the Canadian paper deals somewhat too exclusively with the mining side of the question and that the great metallurgical developments in Canada are not adequately represented.

The mining papers contained in the second volume, with but few exceptions, deal with the broad general problems of mining, such as should properly be considered at an Empire Congress, where detailed discussions of any one particular district are perhaps somewhat out of place. A number of these papers are devoted to a review of general economic conditions, applicable to mining generally, and cover the broad field which more particularly interests such a Congress, whilst it is a highly significant fact that fully half of the papers are devoted to the all-important considerations of the safety, health, and wellbeing of the men engaged in mining operations. It is surely a good sign that although Britain holds to-day the proud position of conducting its mining operations with a higher standard of safety than any other country in the world, we are not content with having reached this stage, but are striving onwards towards a still greater measure of security for the underground worker.

The volume on petroleum may fairly be regarded as one of the best of the series, each paper dealing with one or other aspects of the subject, the economics, the geology, the methods of exploitation, the after-treatment and the storage and transport of the products being each one fully considered, so that this volume presents a complete epitome of the petroleum industry as it exists in the world to-day. It may fairly be asserted that papers such as the above, showing the stage which the development of an industry has attained, are not only the most suitable for presentation to a Congress, but also likely to prove of the greatest permanent value to the future student of the subject.

The volume devoted to iron and steel is necessarily less homogeneous than the last named, because the great complexity and numerous ramifications of this vast industry prevent any similar general treatment of the subject as a whole. There are, however, a number of broad papers which deal particularly with the various principal branches, such as a review of coke manufacture, of fuel economy in general, of blast-furnace practice, of the production of various special steels, and of the economics of the iron and steel industry, whilst two papers describing the progress of the industry in Canada and in India respectively are of very special importance.

The last volume, dealing with the non-ferrous metals, is perhaps the weakest from the point of view of an Empire Congress, but this again is due in a measure to the fact that it is called upon to cover so wide a range. It falls to the lot of but few men to acquire a satisfactory working knowledge of more than one of the many metals included in the non-ferrous group, and hence the presentation of general papers becomes a problem of extreme difficulty. Several of the papers, such as that of Dr. Rosenhain and Mr. Archbutt on the alloys of aluminium, form important contributions to our knowledge of one particular metal, but would perhaps be better suited to the pages of the Journal of the Institute of Metals than to the records of an Imperial Congress, where breadth of vision is of more importance than microscopic accuracy of detail.

It would not be right to conclude this notice without some reference to a matter which, although it occupies but an insignificant place in these volumes, being comprised within two pages of letterpress, will possibly prove to be the most important outcome of the Congress, namely, the foundation of an Empire Council of Mining and Metallurgical Institutions. This Council proposes to act as the organ of co-ordination and co-operation between all these institutions throughout our wide-flung Empire, and, it is hoped, will form a common bond between all British mining engineers and metallurgists. It should enable them more effectively to pool their knowledge and experience and to foster the already existing feelings of true comradeships between them. In this way it should advance still further the development of our Imperial mineral resources, thus playing an important part in strengthening and maintaining the British Empire.

HENRY LOUIS.

The God of Aristotle.

Aristotle's Metaphysics. A Revised Text, with Introduction and Commentary, by Prof. W. D. Ross. Vol. 1, pp. clxvi+366. Vol. 2, pp. iv+528. (Oxford: Clarendon Press; London: Oxford University Press, 1924.) 2 vols. 48*s.* net.

IN preparing this new edition of Aristotle's Metaphysics, Prof. Ross has performed an arduous and a valuable service. From many points of view the Metaphysics may be regarded as the hardest nut which Prof. Ross has in the course of his great undertaking yet had to crack, and it is doubtful whether any of the works of Aristotle which have still to appear will present equal difficulty. In the first place, the text is incredibly corrupt. The earliest MS. we possess is separated from Aristotle by a distance of twelve centuries; some of the books which are included are clearly intended to form part not of this but of a different work, other books necessary to the argument are missing, while there is acute controversy over the correct order of the books we have. Finally, Aristotle's writing bears, even more clearly than in his other works, evidence of being, not a mature treatise, but a series of notes for lectures or jottings preliminary to the preparation of such a treatise, the consequence being that, partly owing to the clipped and allusive character of Aristotle's remarks, partly owing to the gaps caused by the mutilation of the text, the amount of matter that has to be supplied by conjectural emendation is exceptionally large.

The Metaphysics is exceptional, too, in the amount of controversy it has aroused; for the argument—and this is the second great difficulty with which Prof. Ross has had to contend—if of unusual difficulty even for Aristotle, full of contradictions, repetitions, definitions which are neither used nor kept, preliminary statements which have no sequels, and divisions of subject-matter which are elaborately made only to be cut across by later and incompatible divisions. The consequence is that when you have to use what Aristotle did say as a basis on which to conjecture what he may have said, while many guesses are plausible few can be more than guesses; so that different commentators have been able to indulge themselves even more freely than usual in their old trick of seeing in disputed passages confirmation for their own particular views.

Through all this tangle of controversy and conjecture Prof. Ross keeps a clear head. He is sane in suggestion, sensible in judgment; he never advances a view without giving good reasons for it and for the rejection of contrary views, and he displays a knowledge and writes with an authority which fully entitle his edition to be ranked among the nobler works of scholarship. Most valuable is a clear and full statement of the probable views of Socrates and Plato as disclosed by references in Aristotle, of the metaphysical views of Aristotle himself, and of his highly peculiar theology.

I say views advisedly, and not system, for of all works on Metaphysics, Aristotle's is surely the most tentative and empirical. There is no statement of general principles, no ordered advance from agreed premises, but tentative suggestions, fresh starts and reduction of common-sense views to more precise terms. As Prof. Ross puts it, the Metaphysics "expresses not a dogmatic system but the adventures of a mind in its search for truth."

It is matter for surprise that these adventures have attained their enormous celebrity. Taken in the broad, Aristotle's speculations, especially with regard to the profounder truths, unlike those of Plato which give pleasure even when they do not carry conviction, are neither intellectually convincing nor æsthetically satisfying. They owe much of the veneration with which they have been regarded to their somewhat arbitrary selection by the early Catholic Church as a basis for its theology. Aristotle was the first to bring into philosophy the conception of "the prime mover" as the ultimate principle of the universe, a prime mover who was spirit and not matter, and stood at the head of a hierarchy of spiritual essences. This conception seems to have been enough for the Christian fathers. Yet it is surprising that they should have embraced it so readily. Aristotle's cosmology is one of great clumsiness; he announces six different kinds of being as the constituents of his universe, the prime mover, intelligencies actuated by love of him fifty-five in number, the soul of the first heaven, the souls of the fifty-five spheres, the first heaven, and the fifty-five spheres, and he makes no effort to resolve this somewhat grotesque plurality. Furthermore, Aristotle's prime mover was not the creator of the universe, since matter is eternal, nor is he a personal God feeling interests outside his own concerns, nor is he a God of love, since to entertain emotion would be to interrupt contemplation. Contemplation is, indeed, the one pursuit of the prime mover, the objects upon which his intellect is directed being geometrical problems.

In this, and indeed in other respects, Aristotle's prime mover is more like the ancients in the last play of the "Back to Methuselah" Pentateuch than the God of any known religion. They, too, are engaged in the study of mathematics; their creator shares Aristotle's distrust of emotion and his respect for intellectual activity as the end and purpose of existence.

C. E. M. JOAD.

Our Bookshelf.

Allen's Commercial Organic Analysis. Vol. 3: Hydrocarbons, Bitumens, Naphthalene and its Derivatives, Anthracene and its Associates, Phenols, Aromatic Acids, Gallic Acid and its Allies, Phthalic Acid and the Phthaleins, Modern Explosives. Fifth edition, revised and in part rewritten. Edited by Samuel S. Sadtler, Dr. Elbert C. Lathrop, and C. Ainsworth Mitchell. Pp. ix + 732. (London: J. and A. Churchill, 1925.) 30*s*. net.

THIS new volume, while showing many changes in the personnel of the contributors, and some increase in size, very closely follows the ground covered by the corresponding volume in the previous edition published fifteen years ago. The only definite change would appear to be the separation of the text on benzol with its derivatives from bitumens, so that it may be included later with dye-intermediates. With the extra space available, many of the more recent developments in analytical chemistry have received consideration. The newer indicators for hydrogen-ion control and the comparative testing of antiseptics, to mention but two subjects, have received special attention.

In spite of the fact that a large number of slips appear to have escaped the proof-reader, especially among the chemical formulæ (*e.g.* copper sulphate, p. 150, trinitroresorcinol, p. 337, and cellulose trinitrate, p. 598), the very high standard of the fourth edition has been maintained and all the sections have been brought up-to-date.

In the examination of tars, pitches, and oils, American standard methods have been followed. A good account is given of the testing of natural gas in the bitumens section, but in the detailed description of the Orsat-Burrell apparatus the figure appears to have been omitted. The fact that the testing of salicylic acid is given thirty pages and saccharin twenty pages, to take only two examples, gives some idea of the thoroughness with which this standard work is compiled. The explosives section has been doubled in size since the last edition. A big portion of the increase, however, is due to the inclusion of long extracts from the First Report of the Home Office Departmental Committee on the Heat Test (1914). The curious diagrams of this report, with dimensions inserted on simple apparatus to the third and fourth decimal point, are also reproduced. The reference to Silberrad Ablett and Merryman (p. 613) for the estimation of nitroglycerin in cordite, although similarly given in some other text-books, is incorrect; it should read Silberrad, Phillips, and Merriman. The poor reproduction of Will's apparatus (p. 704) makes the lettered description in the text of little value. It is incorrect to dry tetryl by heating above its melting point (p. 641) before determining this constant. Reference is made in the explosives section to the new gelatinisers and stabilisers, such as diethyldiphenylurea and unsymmetrical diphenylurea, which were largely used in Germany during the War in the manufacture of propellants. No method of testing these products is given, as it is stated that no method has hitherto been published.

J. REILLY.

Pathologische Pflanzenanatomie. In ihren Grundzügen dargestellt von Prof. Dr. Ernst Küster. Dritte, neubearbeitete Auflage. Pp. xii + 558. (Jena: Gustav Fischer, 1925.) 24 gold marks.

THE field of pathological plant anatomy is a difficult one to define, and the author has interpreted it in a broad sense. This book, which now appears in a third and enlarged edition, fills much the same place in relation to pathological plant anatomy that Haberlandt's well-known work does to the "physiological anatomy" of normal plant tissues and organs. It is an abundant source of carefully sifted information on the anatomy of pathological growths in their multiform variety. Numerous clear illustrations add greatly to the value of the work.

The special part opens with an account of variegation, which occupies about 40 pages and deals with much of the modern literature of the subject from an anatomical point of view. The second chapter is devoted to etiolation, the effects of the absence particularly of the short rays of the spectrum. Not only the well-known effects on chromatophores and stems are considered, but also the effects of darkness on hair formation, pollen, endodermis, algæ, and fungi. Three other chapters are devoted respectively to intumescences and similar structures involving increase of water content; wound tissues and regeneration; and galls. The last two topics occupy 160 pages and include a consideration of callus, tyloses, wound cork, and gum formation.

The general part is arranged in three sections dealing with the histogenesis, the developmental mechanics and the "ecology" of pathological tissues, making up the greater part of the book. Here the facts are regarded from a more philosophical viewpoint. Such general problems as senescence in plants, inhibitions to development, polarity, abnormal cell divisions, cell fusions and necrosis are considered on the basis of definite facts. The examples cited include anything from "involution" forms of bacteria to abnormal reduction divisions and the splitting of tissues by frost. As regards the *Entwicklungsmechanik* of pathological tissues, the causes discussed are classified as mechanical, osmotic, chemical, radiant energy and correlation. Under the latter head brief reference is made to gigantism and polyploidy, while Haberlandt's theory of wound hormones also receives consideration.

The final section deals "ecologically" with such topics as the healing of wounds, formation of aerenchyma and hydathodes, and with functional adaptation of tissues. The book is a most useful reference work for botanical laboratories, for one frequently finds the facts of pathological histogenesis considered from an unstereotyped point of view. R. R. GATES.

Practical Chemistry by Micro-Methods. By Prof. Egerton Charles Grey. Pp. ix + 124. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin, Marshall and Co., Ltd., 1925.) 4*s.* 6*d.* net.

FORTY years have now elapsed since the appearance of Haushofer's "Microscopic Reactions," and the science of qualitative microchemical analysis, of which it was the sign and portent, seems to have remained indigenous to Central Europe. Behren's "Introduction to Microchemical Analysis," the first edition of which was published in 1899, has become almost a classic, and the text-books of Schoorl and Emich have also achieved a well-earned reputation. Prof. Grey's elementary introduction to microchemical work is, we believe, the first English book to deal with this subject, and in extending a welcome to it, we hope that it will be the means of spreading the use of the microscope in chemical work.

Microchemical reactions are for the most part more decisive than the ordinary microscopic tests; they necessitate greater cleanliness and entail greater economy in time and material. Notwithstanding these facts, we cannot agree with the author that microchemical analysis should be substituted for ordinary analysis in our schools and colleges, though we grant that, at the appropriate stage, nearly every student would gain from such a course as he prescribes. It is a trite criticism that many secondary schools attempt work which is much better left to the university; here is a subject which pupils in their last school year could pursue with great advantage, and with this manual in hand they could work with very little supervision from the teacher. The low price of the book is also a recommendation, and prompts the question if it heralds a new dawn of cheap—and good—printing and publication.

Elements of Physical Biology. By Dr. Alfred J. Lotka. Pp. xxx + 460. (Baltimore, Md.: Williams and Wilkins Co.; London: Baillière, Tindall and Cox, 1925.) 25*s.* net.

FOR a long time methods analogous to those of statistical mechanics have been applied to animal and plant communities. But just as in physical chemistry these methods soon become intolerably cumbrous and may generally be replaced by thermodynamical calculations which ignore the individual molecule, so in the book before us the author has applied to biological problems a treatment of the type familiar in chemical statics and kinetics. These methods are applied to the growth of populations, whether of bacteria, insects, men, or railway engines, and to relationships between different species, for example, between a parasite and one or more hosts. The author has the problem of evolution always before him, and considers analytically the effect on population of a change in the behaviour of individuals.

It must not be supposed, however, that the book is a mere formulation of theories. It contains a vast amount of facts unattainable within the same compass elsewhere. For example, the account of the circulations of hydrogen, carbon, nitrogen, and phosphorus in Nature is the most satisfactory known to the reviewer, and accounts are given of the experimental work of Pearl and his pupils on animal populations, and the statistical results of Willis and Yule on "age and area." No biologist conversant with mathematics can possibly read this book without coming upon many ideas which will be new to him, and many mathematicians will find in it applications and problems of a refreshing novelty.

The Folklore of Fairy-Tale. By Macleod Yearsley. Pp. xiii + 240. (London: Watts and Co., 1924.) 7*s.* 6*d.* net.

IN his brief preface, Mr. Yearsley modestly denies himself any claim to originality. His object is to bring together in a concise and popular form the salient points in the science of fairy-tales. He confines himself, where possible, to those tales which are current in the British Isles or have been introduced and popularised by British writers. His material, therefore, is largely drawn from Grimm and Perrault. In discussing the scarcity of the indigenous *märchen* type in Britain, he follows Hartland in attributing its suppression to the influence of Evangelical Protestanism. On this point he might have enlarged to the advantage of his readers. Hartland's suggestion indicates an important contributory cause; but it by no means entirely explains the facts. Why, for example, do British *märchen*, with one or two exceptions, survive especially in the areas in which revivalism usually flourishes? Mr. Yearsley illustrates his argument throughout with numerous examples and parallels. As many of the sources from which he draws his material are out of print or too technical for the ordinary reader, his book adequately serves the purpose for which it is intended.

An Elementary Chemistry. By E. J. Holmyard. Pp. viii + 424. (London: Edward Arnold and Co., 1925.) 5*s.*

MR. HOLMYARD'S book covers the syllabuses for the various First School Certificate and the London Matriculation Examinations. It is brightly written with a modern outlook, and should appeal to young students. Questions for exercise and useful "Revision Notes" (at the end of the book) are provided. Interesting historical notices, some portraits of famous chemists, and reproductions of manuscripts and pages of famous books enliven the text, and the whole treatment may be commended. The author has evidently appreciated the common difficulties and mistakes of young students, so that his experience may also be of assistance to teachers.

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 Taungs Skull.

IN NATURE of July 4, 1925, p. 11, Sir Arthur Keith has attempted to show first that I called the Taungs skull a "missing link," and secondly, that it is not a "missing link."

As a matter of fact, although I undoubtedly regard the description as an adequate one, I have not used the term "missing link." On the other hand, Sir Arthur Keith in an article entitled "The New Missing Link" in the *British Medical Journal* (February 14, 1925) pointed out that "it is not only a missing link but a very complete and important one." After stating his views so definitely in February, it seems strange that, in July, he should state that "this claim is preposterous."

Despite this reversal of opinion, Sir Arthur tells us that the skull "does show human-like traits in the refinement of its jaws and face which is not met with in young gorillas and chimpanzees at a corresponding age." He appears to have overlooked the fact that in addition to these and other facts brought forward by myself, the temporal bone, sutures, and deciduous and permanent teeth (according to Dr. Robert Broom) also show human-like traits. Moreover, as Prof. Sollas has so ably shown, the whole profile of the skull is entirely different from that in living anthropoids, thus indirectly confirming my discovery that the brain inside the skull-dome which caused this profound difference was very different from the brains inside the skulls of modern apes.

The fact that Sir Arthur was unable to find the *parallel sulcus* depression in the replica cast sent to Wembley illustrates how unsatisfactory the study of the replica can be in the absence of the original.

With reference to the question of endocranial volume, I would state with Prof. Sollas that this "is a matter of only secondary importance." Nothing could exemplify this matter better than the condition of affairs in the Boskop race, where the endocranial volume was in the vicinity of 1950 c.c. (The average European's endocranial volume is 1400-1500 c.c.) Indeed, the world's record in human endocranial volume (2000 c.c.) was discovered in a "boskopoid" skull by Prof. Drennan in a dissecting room subject at Capetown this year. It is well known that the elephant and the whale have brains much larger than those of human beings, but no one has inferred from that that their intelligence is greater. It is fairly certain that size of brain has some relation to size of body, as Dubois has shown. It is highly probable that the australopithecid man-apes were relatively small as compared with the gorilla. It is not the quantity so much as the quality of the brain that is significant.

Sir Arthur is harrowed unduly lest the skull *may* be Pleistocene. It is significant in this connexion that Dr. Broom, who first directed attention to this possibility (of which I was aware before my original paper was sent away), regarded it nevertheless as "the forerunner of such a type as Eoanthropus." It should not need explanation that the Taungs infant, being an infant, was ancestral to nothing, but the family that he typified are the nearest to the pre-human ancestral type that we have.

In view of these facts, there is little justification for the attempted witticism that in making the "African ancestors typified by the Taungs infant" the "foundation stone of the human family tree"—whatever that may be—I am making "a mistake identical with that of claiming a Sussex peasant as the ancestor of William the Conqueror." This is merely a case of mistaken identity on the part of Sir Arthur. I have but translated into everyday English the genealogical table suggested by Dr. Robert Broom (NATURE, April 18, 1925), with which I agree almost entirely. I take it, however, as a mark of his personal favour that Sir Arthur should have attacked my utterance and spared Dr. Broom's.

Sir Arthur need have no qualms lest his remarks detract from the importance of the Taungs discovery—criticism generally enhances rather than detracts. Three decades ago Huxley refused to accept Pithecanthropus as a link. To-day Sir Arthur Keith regards Pithecanthropus as the only known link. There is no record that Huxley first accepted it, then retracted it, but history sometimes repeats itself.

RAYMOND A. DART.

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Johannesburg.

PROF. DART is under a misapprehension in supposing that I have in any way or at any time altered my opinion regarding the fossil ape discovered at Taungs. From the description and illustrations given by him (NATURE, Feb. 7, 1925, p. 195) the conclusion was forced on me that Australopithecus was a member of "the same group or sub-family as the chimpanzee and gorilla" (NATURE, Feb. 14, 1925, p. 234). In the same issue of NATURE, Prof. G. Elliot Smith expressed a similar opinion, describing Australopithecus as "an unmistakable anthropoid ape that seems to be much on the same grade of development as the gorilla and chimpanzee without being identical with either."

All the information which has come home since Prof. Dart made his original announcement in NATURE has gone to support the close affinity of the Taungs ape to the gorilla and to the chimpanzee—it is a member of that group. Prof. Bolk, of Amsterdam, and Prof. Wingate Todd, of Cleveland, Ohio, have directed attention to the fact that the skulls of occasional gorillas show the same kind of narrowing and lengthening as has been observed in that of the Taungs ape. Prof. Arthur Robinson has shown that there is a wide variation in the size of jaws of young chimpanzees of approximately the same age, the smaller of the jaws approaching in size and shape to the development seen in the Taungs ape. The dimensions of the erupting first permanent molar of the Taungs ape and the form of its cusps point to the same conclusion—that Australopithecus must be classified with the chimpanzee and gorilla. It is, therefore, "preposterous" that Prof. Dart should propose to create "a new family of Homo-simiadæ for the reception of the group of individuals which it (Australopithecus) represents." It is preposterous because the group to which this fossil ape belongs has been known and named since the time of Sir Richard Owen.

The position which Prof. Dart assigns to the Taungs ape in the genealogical tree of man and ape has no foundation in fact. A large diagram in the exhibition in Wembley, prepared by Prof. Dart, informs visitors that the Taungs ape represents the ancestor of all forms of mankind, ancient and modern. Before making such a claim one would have expected that due inquiry would first be made as to whether or not the geological evidence can justify such a claim. From his letter one infers that Prof. Dart does not set much store by geological evidence. Yet it has been customary, and I think necessary, to take the time element into account in constructing pedigrees of every kind. Dr. Robert Broom and, later, Prof. Dart's colleague, Prof. R. B. Young, have reviewed the evidence relating to the geological antiquity of the Taungs fossil skull, and on data supplied by them one can be certain that early and true forms of men were already in existence before the ape's skull described by Prof. Dart was entombed in a cave at Taungs. To make a claim for the Taungs ape as a human ancestor is therefore "preposterous."

Finally, Prof. Dart reminds me that whales and elephants have massive brains and that many large-headed men and women show no outstanding mental ability. Still the fact remains that every human being whose brain fails to reach 850 grams in weight has been found to be an idiot. Size as well as convolutionary pattern of brain have to be taken into account in fixing the position of every fossil type of being that has any claim to be in the line of human evolution—the Taungs brain cast at Wembley possesses no feature which lifts it above an anthropoid status.

ARTHUR KEITH.

Royal College of Surgeons of England,
Lincoln's Inn Fields,
London, W.C., September 5.

The Rate of Man's Evolution.

ALL those interested in the important question of man's evolution will have read with pleasure Sir Arthur Keith's recent contribution to this problem in NATURE (August 29, 1925). It is with some diffidence, therefore, I record the fact that I am unable to agree with certain of his conclusions. He states in the article above mentioned (p. 317), that the Ice Age terminated "some 12,000 years ago," and again (p. 319), that the well-known palæolithic epoch—the Mousterian—"closed some 20,000 years B.C." It is, however, known that the close of palæolithic times coincided with that of the Ice Age, and thus, according to Sir Arthur Keith's dating, the distinct and widespread civilisations of the Aurignacian, Solutrean, and the Magdalenian, together with the change of climate and of fauna that accompanied them, can have occupied no more than 10,000 years.

Again (p. 319) your readers are informed that "the Chellean phase of culture was moving towards its zenith 100,000 years ago." But, in view of the fact that there is good reason to believe the Chellean phase is referable to the Cromer Forest Bed, and that two major glaciations, with their inter-glacial periods, have occurred since the Forest Bed was laid down, it is, I think, perhaps unwise to assign any implements of Chellean age to an epoch so comparatively recent as 100,000 years from the present.

To suppose these things is surely to exceed the archæological and the geological speed limits?

The recent discovery, in a cave in Galilee, of portions of a human skull of Neanderthal type has a direct bearing upon the matter under discussion in this note. In Mr. Turville Petre's account of this find (*Times*, August 14, 1925) he states that the specimens were found in an undisturbed deposit containing flint implements, which "seem to indicate a transition culture from Early Palæolithic, or Acheulean, to Middle Palæolithic, or Mousterian." If this determination is correct, then it is clear that the skull fragments must be referred to the *beginning* of the Mousterian period. Yet Sir Arthur Keith claims, for some unreported reason, that the Galilee individual lived about 20,000 years B.C., which, according to his own dating, is when the Mousterian period *ended.*

As for the antiquity of the modern type of man, I am compelled to conclude, after a review of all the evidence, that the discovery of human bones of this type in ancient deposits at Galley Hill and elsewhere support definitely the reality of this antiquity.

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The Cause of Surface Tension.

IN an article in NATURE for April 4 (vol. 115, p. 512) Mr. N. K. Adam revives the old question as to the reality of a state of tension in the surface film of a liquid, and expresses grave doubts as to its existence. I myself fell into this same heresy in my first flush of enthusiasm over Laplace's theory of capillarity; what eventually led me back into the fold was the contemplation of simple cases like the following.

Consider a drop of water hanging in equilibrium below a hole in the bottom of a vessel of water; and for definiteness let us mean by the "drop" the water below some horizontal plane P drawn very close to the bottom of the vessel. The drop is acted on by two downward forces, its weight, and a net downward push exerted by the water above, for there can be no doubt whatever that over the plane P the hydrostatic pressure exceeds atmospheric.

Now the crucial question is, what upward force balances these two downward forces? It is no good arguing about resultant inward forces on the surface particles of the bottom part of the drop, for not even a water-drop can lift itself by its own boot-straps. Some portion of matter outside the drop must be pulling or pushing upward upon it. The only matter that can be doing this is the contiguous water above the drop. But cohesion by the central part of this water cannot be the cause, for the *net* force exerted by the central part, due to kinetic or contact pressure minus cohesion, constitutes the force of hydrostatic pressure referred to above, and certainly acts downward. We are inevitably driven to the conclusion that the surface skin of the adjacent water above P is, on the whole, pulling upward upon the surface skin of the drop.

This is all that we mean when we say that the surface skin is in a state of tension; any selected portion of the skin pulls harder than it pushes upon each adjacent portion. Note that the maintenance of the equilibrium of a surface molecule is quite a different matter; that depends upon the sum of all pulls and pushes taken together, and has no bearing on the question of the relation between pull and push in a given direction.

This argument is very elementary and old, of course. But I cannot find where any one has pointed out how simply the tension can be deduced also from those same Laplacian conceptions which have proved so misleading to many.

Let us in thought divide the surface skin by a perpendicular plane R, and let us consider a horizontal slab of the liquid of unit width, of thickness dx, and extending perpendicularly from R to a point on the right beyond the molecular range of action, h. The liquid to the left of R will attract this slab with a component of force normal to R equal, say, to tdx; and it will also press upon the slab with a force pdx where p = intrinsic pressure, which we assume to be equal in all directions at a given point in consequence of the fluidity. (We omit the superposed action of the hydrostatic pressure.) Then in the interior

$p=t$, whereas at the surface $p=0$, while t has here just half of its value in the interior, representing the attraction of half of a hemisphere upon the slab. We may therefore conclude that in the surface skin on the average $t>p$, and the skin to the left of R will exert a net pull upon the skin to the right equal per unit length to

$$T=\int_0^h (t-p)dx.$$

T is the "surface tension."

This argument involves no assumption of any special mechanism or arrangement of molecules on the surface; such an arrangement, different from the state of the interior, may exist, as a separate phenomenon, or it may not. The argument does, however, lose most of its meaning if one adopts the modern idea that h is really very short, perhaps less than a molecular diameter. The difficulty is not to conceive how the state of tension can exist, but to show from molecular behaviour that it *must* exist. The surface must be a kinetic affair, with large momentary fluctuations of form and of molecular concentration, so that tension and pressure become mere statistical averages. Perhaps nothing more is possible for the theorist than to fall back on physical instead of molecular considerations, and to conclude from these that the dance of the surface molecules is so ordered as to make the mean horizontal tension exceed the mean pressure.

E. H. KENNARD.

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THE water drop hanging below an orifice takes up such a shape that the relation between the pressure difference p inside and outside the surface, the potential energy per unit area of the surface γ, and the radii of curvature of the surface R_1 and R_2, is

$$p=\gamma\left(\frac{1}{R_1}+\frac{1}{R_2}\right).$$

This relation is deduced simply from the fact of potential energy in the surface proportional to its area, and holds good whatever the law of force or mechanism by which this potential energy is produced. (See, for example, Besant and Ramsey, "Hydrostatics," 6th ed., p. 192; Gibbs, "Equilibrium of Heterogeneous Substances," Works, vol. 1, p. 228.) It is sufficient to account for the equilibrium of the drop. The fluidity of the water allows it to attain the configuration of least potential energy very rapidly, and this will be such that the curvature at each horizontal section is exactly that necessary to give an internal pressure at the level of that section, equal to atmospheric pressure plus the pressure due to the column of water above that section. Greater curvature will be necessary at the bottom of the drop than at the top. In my article in NATURE of April 4, I suggested that the greater internal pressure under a convex surface of liquid might be pictured as due to the convergence of the normals to the surface, drawn inwards; the attractive forces on molecules in the surface act along these normals. These inward forces are the cause of potential energy in the surface, since work must be done to form a new surface by dragging molecules from the interior. Since the relation between curvature and internal pressure can be deduced independently of the mechanism causing the surface potential energy, it is evident that the inward attractive forces on the surface molecules can set up the pressure distribution within the drop which is consistent with minimum potential energy. No more is required to account for the equilibrium of the drop.

I think Dr. Kennard is mistaken in his treatment of the statics of the problem. The molecules of water are moving across the plane P continually, so that any attempt to regard the drop merely as a piece of inert heavy baggage, which leads to the conclusion that it cannot be held up by cohesion in the centre, is not clear enough to give a solution. It does not help, when meeting the difficulties arising from this point of view, to ascribe the support of the drop to a hypothetical surface skin, about the properties of which nothing is stated. The consideration of the pressures at different levels in the drop at once gives the solution, as it so often does in hydrostatical problems. The motion of the particles of the drop, including exchange between surface and interior, is so rapid that it is not possible to ascribe the supporting of the weight of the drop to any particular region, and the method of pressures appears the only one available.

Dr. Kennard's expression for the "tension" deduced from Laplace's theory seems quite sound as an expression for the average deficiency in internal pressure in the surface layer. But I can see no reason for calling this a tension. It might be properly termed a state of rarefaction. A rather similar argument was, I think, employed by Worthington (*Phil. Mag.*, 1884—I am without means of verifying the reference), who considered that there was probably a deficiency in density near the surface, and therefore there must be a tension in the surface to separate the molecules. Such arguments as these seem to be inspired more by the desire to employ the word "tension," with as many as possible of its associations, in connexion with the surface, than by any clear picture of what really is the structure in the surface.

There are other reasons than Laplace's theory for not regarding the surface as containing any material structure like a contractile skin. I have found three of these particularly convincing. Following Langmuir, in the attempt to unravel the structure of thin surface films, I found that it led nowhere to speculate how the fatty acid molecules acted on the surface skin so as to diminish its "strength." But regarding the molecules of the fatty acid film simply as hard floating objects, attracted by the water perpendicularly to the surface, attracting each other laterally, and small enough to show Brownian movement, very complete analogies have been drawn between these films and matter in three dimensions; and the shapes of the molecules have been shown to be exactly what would be expected from their structural formulæ, obtained by the methods of organic chemistry. It would be scarcely possible to find a stronger *a posteriori* argument against the existence of a contractile skin than this success obtained by its total abandonment.

Osborne Reynolds found that the motion of oil spreading on a dust-covered surface of water suggests strongly that the oil is spreading by reason of an inherent expansive force, and does not resemble at all that to be expected if the oil were being pulled out by the tension of a skin on the water. He was considerably puzzled by this, as he felt bound to consider the expansion of the oil as due to the tension of the water surface (Works, vol. 1, p. 410; Brit. Assoc. Rep., 1881).

Maxwell (Works, vol. 2, p. 553; "Ency. Brit." art. on Capillarity) considered what would occur if the surface tension between two liquids became negative, concluding that in this case we should expect the interface to extend itself spontaneously, by folding and puckering. He pointed out that liquids do actually mix by diffusion, which is molecular motion. Some such puckering of the interface seems to be a necessary consequence of a "contractile skin" becoming negative in tension and becoming an expanding skin. No genuine case of mixing of liquids in this manner seems to be known; with Mr. Jessop I have recently examined what was reported as a case, but found it due to a peculiar combination of gravity and diffusion, only possible in very special circumstances, and not connected with capillary phenomena (Proc. Roy. Soc., A, 108, 324).

Regarded solely as a convenient mathematical equivalent for the potential energy associated with unit area of the surface, the term surface tension avoids constant reference to the principle of virtual work, and shortens calculations; but as a means of gaining insight into the molecular structure of surfaces, there is evidence that it has proved very misleading.

N. K. ADAM.

The University, Sheffield,
September 2.

The Miller Effect and Relativity.

IT is reasonable that the unexpected results of the recent repetition of the Michelson experiment by Prof. D. C. Miller should have made Dr. Silberstein say that they "knock out the relativity theory radically" (NATURE, May 23, p. 798). But though Einstein has built the special Theory of Relativity on the negative result of the experiment, I am of opinion that the Miller effect does not prove anything against the *general* theory. It should be stated emphatically that *the special Theory of Relativity can only be built up rigorously if based upon the general theory*, not inversely. The special theory does not consider any but linear transformations. But avoiding every acceleration implies the impossibility of comparing measures and clocks moving relatively to each other. On the other hand, the usual supposition that the effect of a passage from rest to uniform motion, etc., tends to zero with the time in which it takes place, can only be based upon the assumption that the ratio of the time to the proper time (interval) between two points on any (curved) world line remains finite and different from zero. But this assumption requires the consideration of non-linear transformations, and thus of the general Theory of Relativity.

In order to put the so-called "Principle of Equivalence" into a slightly different form, we make the following statements:

1. The world can be considered as a set of points which represent "event-particles."
2. The points can be ordered along "world lines" by means of a "relation of identity," which is given by the psychical phenomenon of recognition.
3. A bundle of world lines can be considered as a single world line. This is based upon the psychical judgement that they "belong together." This "relation of whole and parts" ("relation of class") permits us to consider the set of world points as four-dimensional.
4. There are considered binary relations between different points, namely, "relations of cause and effect," which can be represented by the "lines of causality."
5. *It is possible to describe every physical phenomenon by using only the relations of coincidence, identity, class and causality.*

These assumptions imply that we can construct a four-dimensional "graph" of universal history, graphs topologically equivalent not being distinguished by this definition. The very meaning of the ether-question is: Do the phenomena require a particular *metrical* system to which the universe must be referred? The reduction of the question to this form enables us to answer it at once, and obviously in the negative. For a topological transformation never can translate a "true" description of an observation into a "false" one. Relativistic physics has acquainted us with the new notion of the "metrical field" which is *apt to replace the old ether* as a carrier of electro-magnetic waves, so that it appears to be quite appropriate to reconcile "etherists" and "non-etherists."

Following a remark of Hermann Weyl ("Was ist Materie?", Berlin, Jul. Springer, 1924, p. 63) it is possible to reduce to rest simultaneously all bodies in the world (however they are moving relatively to each other) by means of a topological transformation. Consequently there is no meaning in speaking even about relative motion of separate bodies, *e.g.* of the stars and the earth. All we can say is that the earth moves relatively to the surrounding field, to the "star-compass." Here I would remark that even a relative motion of the earth to the surrounding field only has a meaning if the world is anisotropic around the earth: for *a spacial isotropic field can always be considered as being statical.*

The Miller effect shows us that rigid rotation does not leave the light-paths invariant; in other words, *that isotropy of the field and isotropy of the light-paths are not equivalent.* If rigid motion, *that is to say, the metric field,* is isotropic, then light-motion is not, and vice versa. Consequently the light-paths do not coincide with the minimal lines of the field. Although the Theory of Relativity in its present form holds for this coincidence, relativism in general leaves open the possibility of light-motion differing from quickest motion (as has been stated by Prof. Whitehead). Light only loses its exceptional qualities and quickest motion becomes an unreachable or at least unreached limit, not only for material, but also for electromagnetic motion, and in general for each form of motion which transports energy. But instead of being contradictory to the idea of relativism, this difference on the contrary agrees much better than the special Theory of Relativity with the modern view that matter and light are only gradually differing forms of energy.

Until now it has been impossible to say whether the Miller effect is due to translational or to rotational motion. In the first case the effect should vary periodically in time with the two periods of one day and one year; in the second case it should remain constant. From the point of view of the field-theory of matter the second case would mean a statical anisotropy of the field, whereas the first case would lead to an anisotropy varying in time, namely, a turning around the world lines of terrestrial matter, the latter being supposed to be reduced to rest.

In any case the Miller effect has shown us (according to a remark of Prof. G. Mannoury) that *the field, or the ether, or empty space, whichever you call it, plays an integrant part among the causal relations of physical phenomena and thus is not so very "empty" as it is supposed to be.*

D. VAN DANTZIG.

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August 28.

Non-reversible Transmission.

ATTENTION has been directed to the possibility of non-reciprocal relations in the transmission of radio waves between two wireless stations (NATURE, by Prof. E. V. Appleton and M. A. F. Barnett, March 7, p. 333, 1925). Such a possibility appears at first sight to be contradicted by the general reciprocal theorem which states that the E.M.F. induced in A by unit current in B is equal to the E.M.F. induced in B by unit current in A. But this theorem rests on the assumption that all solutions are linear, and if this condition is waived, non-reciprocal relations are possible.

In confirmation of this the following examples may be cited which may have some bearing on the observed fact that transmission from west to east (on long waves at night), for example, England to Australia, appears to be considerably better than in the opposite direction. It should be noted that each of these are examples of "non-linear" effects. In the first case, consider a slab of ionised gas, the ionisation being assumed to be maintained by some external agency, for example, ultra-violet or X-rays. It can be shown that associated with this medium there is a critical frequency given by

$$n_0 = \left(\frac{e^2N}{\pi m}\right)^{\frac{1}{2}}$$

where N = number of ions per c.c. (assumed for simplicity of one sign), e the charge, and m the mass of such ion. Neglecting the effect of collisions, then for frequencies n_0 the medium is transparent, but for frequencies less than n_0 the slab acts as a perfect reflector even for normal incidence. The physical reason for this is closely associated with the radiation pressure exerted by the electromagnetic waves on the medium. Thus in the neighbourhood of n_0 the rate of increase of momentum of the ions (due to the E.M. forces in the wave) is equal to the rate of change of momentum in the waves, where these are supposed to be completely reflected, so that the wave is totally reflected by mechanical reaction against the moving ions.

Consider now two radio stations A and B, one on each side of the slab. If the frequency of the emitted waves is n_0 or less than n_0, neither station will be able to communicate with the other.

Now suppose the slab of ionised gas to be moving from left to right with a velocity v. So far as the slab is concerned, the frequency of the waves emitted by B will appear to be increased and those by A decreased. The slab will be transparent to waves from B but not to those from A, that is, B will be able to communicate with A, but A will not be able to communicate with B. Alternatively, we may treat the problem as an exercise in relativity with the same ultimate result.

The other example is more complex and depends upon the existence of a steady magnetic field.

A slab of ionised gas is again the mechanism by which the irreversible effects are produced. But in this case we assume that the ions have a velocity of drift, say vertically downwards (in the direction of the Z axis), that the normal to the electric wave is in the direction of the X axis, say right and left, and that the steady magnetic field, Hy, is at right angles to both, that is, in the y direction.

Under these conditions the electrons in the downward stream will be subject to two average forces, (*a*) a force at right angles to their velocity, and at right angles to the steady magnetic field Hy (this force will be in the X direction), and (*b*) a force due to the radiation pressure of the wave in the positive or negative direction according as the wave is moving from left to right or vice versa. In the former case the two forces conspire in producing a motion in the ions, and in the latter, if Hy, V, and E are suitably arranged, they cancel. The reaction of the ions on the incoming wave will then be different according as the wave moves from left to right or vice versa. In the latter case there should be no work done by the radiation pressure on the ions, and therefore no loss of energy in the waves; in the former case work is done and a consequent loss of energy ensues.

The amount of reflection will be different according as the wave approaches from the left or from the right, and an irreversible effect is produced.

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The Future of the British Patent Office.

DR. MARTIN's courteous letter in NATURE of September 12 calls for some reply, for although on questions of history we are in the main in agreement, yet when, as he says, we come to close quarters, he fails to reproduce my argument quite accurately.

Dr. Martin says, for example, that my two basic principles are not necessarily antagonistic. This I asserted, but said that for administrative purposes they could not be treated as co-equal; for the two types of administration would differ fundamentally. If the institution of new industries is the proposed object of our patent law, as I think is clearly the case from the provisions in the 1919 Act, the application form would have to be altered. The applicant would be required to affirm, as he used to do, that he was in possession of an invention which was not in use in the kingdom, and which it was his intention to introduce at the earliest opportunity. The official search certificate would state to what extent, if at all, the applicant's claims appeared to conflict with descriptions or claims in British specification of patents in force or with pending applications of concurrent or prior date. The case of applications under the International Convention would have to be reconsidered. The preferential treatment of the foreigner has always seemed to me contrary to the policy of our patent law. The validity of patents when granted would depend—(*a*) in cases where commercial working was shown, upon the state of the art in the kingdom at the date of the letters patent, and (*b*) where the patentee relied upon his specification, upon the state of public knowledge in the kingdom. In the latter case the patentee would be bound to show good reason why his patent had not been put into practice.

It is not, therefore, correct to say that since perfection in practice cannot be attained I recommend no search at all. My view is that, where one inventor fails, others should be encouraged to try again. For this purpose the official search must be brought into harmony with the revised statutory definition of novelty.

The anonymous letter which I quoted was intended to show that the world-wide search was breaking down and that, in the opinion of one well informed in American practice, a radical change in the statutory definition of novelty was the only solution of the difficulty. All bibliographical evidence tends to support his opinion.

Again, Dr. Martin does not agree with the thesis "that when security is at its highest, restraining power is necessarily at its lowest"—but my statement was "that as a general rule when security is at its highest the other factor will be little or none at all." The percentage, however, of really great inventions which pass scathless through the fire of the examining staff is very small, and their commercial value depends, not upon an examiner's report, but upon the homage paid by all men of science to the path-breaker who opens a new road of research for the benefit of mankind.

E. WYNDHAM HULME.

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THE present Patent Office search, extending back for fifty years for novelty, is, as Mr. Hulme says (NATURE, September 5, p. 356), really useless, and a fuller search ridiculous. To the inventor it is irritating; and it is of little value to the manufacturer, for before he gives a high price for the monopoly or spends much in adapting his plant and designs for using it, he, as a prudent man, will want something more.

Of course the granting of letters patent for overlapping existing protected inventions should be avoided, but that is all that is required. It should be open to any one to use the invention, or part of it, if he can show that it, or the part of it he is using, is old in the sense that it has actually been used; and a patent should not be invalidated because it, or part of it, has been described or figured a long time ago and forgotten until rediscovered by much "fever of the brow" and expenditure of time of the searchers.

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Analysis of the Arc Spectrum of Copper.

STARTING from the constant frequency differences in the copper arc-spectrum, suggested by Rydberg, I have recently been able to deduce the values of a large number of new terms of that spectrum. My paper in the *Philosophical Magazine* (vol. 69, p. 951) has shown that copper gives a spectrum which is far from simple, and the further data now obtained show even greater complexity.

The new terms can be divided into two sets, those of the first set all being positive and combining with one or both of the known abnormally high d-terms. This set contains several terms already used in my paper. The inner quantum numbers are of course definite except in those cases where combinations with both d_2 and d_3 occur. The second set of terms consists altogether of negative terms which each combine with three or more of the first positive set, giving lines the wave-numbers of which differ from the calculated by not more than two-tenths of a wave-number. Altogether, about 125 lines are accounted for by these new terms. The inner quantum numbers of the negative terms can be deduced, though with some uncertainty, from their combinations with the positive terms. The values of the terms are as follows, the probable nature and inner quantum numbers being given with each:

5026·2 ($j=4$)	−95·2 (3)
5656·7 (2 or 3)	−640·2 (p'_3)
6278·2 (4)	−1276·4 (p'_1)
15709·8 (2 or 3)	−8690·0 (3)
17345·2 (4)	−8819·7 (3)
17763·9 (p_2)	−8870·1 (3)
17901·8 (d'_3)	−8960·1 (3)
18581·9 (d'_2)	−9619·1 (p'_2)
18794·1 (4)	−9708·6 (3)
20005·5 (s'_1)	−9758·9 (p'_3)
20745·2 (2)	−9785·0 (3)
21154·7 (4)	−10890·7 (p'_2)
21364·3 (p_1)	−10996·5 (p'_2)
22194·0 (p_2)	−14722·0 (5)
23289·4 (4)	−14760·1 (5)

As yet I have been unable definitely to arrange many of these terms together either as doublets or quartets. It is evident, however, that quartets are involved. The difficulty arises partly from the large separations which are common in the copper spectrum and make estimations of relative intensities of lines of a multiplet uncertain. The complete analysis should afford tests of the theory of negative terms suggested by Russell and Saunders in their recent paper on the calcium spectrum.

Dr. L. A. Turner, of Harvard University, has recently suggested to me a possible explanation of the abnormally large inverted d-terms in the copper spectrum 51105·5 (d_3) and 49062·6 (d_2), based on considerations brought out in a paper by Pauli (*Zeit. für Phys.* 31, 10). If we consider these terms as being due to the displacement of an electron from a 3_{32} or a 3_{33} group to the 4_{11} group, which is then closed, the atom might be considered as in a d-state. The inversion would be accounted for since the 3_{33} position is of higher energy than the 3_{32} position. Moreover, the formula $\Delta\nu/R = (z-s)^4/2\,\alpha^2/3^4$ (Sommerfeld, p. 449) should yield a screening constant s approximately equal to 13·0, which is the value given by the separation of M_{32} and M_{33} for atoms of high atomic number. The value found is $s=13{\cdot}6$, which is suggestively close, considering the large extrapolation, and the approximation involved in considering the two electrons in the 4_{11} ring as having the same effect in the two cases.

A. G. SHENSTONE.

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August 3.

Dispersal of Butterflies and other Insects.

IN the issue of NATURE for September 5, Mr. E. P. Felt in his interesting article on the "Dispersal of Butterflies and other Insects" says, "It is quite possible that some insect movements are direct responses to a migration impulse." As bearing on this point, the following incident, which occurred some years ago, may not be without interest.

I was walking through a field of standing wheat that was growing on the Downs near Walmer, Kent; the sun was just below the horizon, the air warm and still, when I noticed that moths were rising from the wheat and flying vertically upwards until they were lost to sight. On closer inspection, I found that vast numbers of the silver Y moth (*Plusia gamma*) were buzzing about among the wheat stems and that individuals were continually leaving their fellows and taking the upward flight. Although the larva of *P. gamma* will feed upon a great variety of low-growing plants, such as nettles, docks, and so forth, it is most unlikely that such numbers could have found sustenance on the weeds that might be growing in a fairly well kept wheat field, and the inference is that the moths had assembled among the wheat stems with the purpose of migration, and by their upward flight were seeking a favourable wind current to assist them in their journeyings in the upper air.

The incident, moreover, is not an isolated one, for Richard South describes a similar happening (*Entomologist*, 1880, p. 42) which he had witnessed in the Isle of Wight: the insects were, he believes, the same species, but in his case they were rising from furze bushes.

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Fifty Years' Evolution in Naval Architecture and Marine Engineering.[1]

By Sir ARCHIBALD DENNY, Bart.

AFTER Watt's invention of the separate condenser, many years elapsed before the next considerable step in marine engineering—the introduction of the compound steam-engine. This was natural, as steam pressures were too low to make compounding profitable. The first record I can find of compounding was John Elder's *Brandon* in 1854, and progress thereafter was not very rapid; but when I began my apprenticeship, in 1876, the old box boiler had been replaced by the now highly appreciated Scotch circular return-tube boiler, supplying steam to two-cylinder compound engines at about 60-lb. pressure. It was not then found profitable to carry more than about 25 in. of vacuum. Auxiliary machinery was almost non-existent.

As to types of marine engines—in the Navy, for protection reasons, horizontal machinery was not uncommon, while in the mercantile marine, for screw ships, the vertical type was practically universal. In paddle-steamers for river and coast service, of which there were many, the beautiful oscillating engine, which had the advantage of taking up little room lengthwise, was still built; but the diagonal engine was more common, either with single cylinder and haystack boiler or compound two-cylinder.

Returning to sea-going vessels, the *Propontis*, a vessel built in 1864, was re-engined at Fairfield with triple-expansion three-crank engines designed by the late Dr. Kirk in 1874, with boilers working at 150-lb. pressure; but the boilers, Rowan's water-tube, proved unsatisfactory, and in 1876 new Scotch boilers of 90-lb. pressure were fitted. The first really successful triple-expansion three-crank job, the *Aberdeen*,[2] was built in 1880 by Robert Napier and Sons, and fitted with engines and 125-lb. pressure boilers designed by Dr. Kirk. The re-engining of the *Propontis*, however, marked the opening of a new era, which only developed slowly at first, due in some measure to the then rules for the thickness of the boiler shells and furnaces.

The next great step was the introduction of the Parsons turbine. None can forget the tremendous interest created by the appearance of the 34½-knot 100-ft. *Turbinia*, at Spithead Review in 1897. I felt that here was the engine we had been looking for to use in fast cross-Channel work, and it was a great gratification when Sir Charles Parsons and Captain John Williamson arranged with my firm that we should join in a venture to build and run a Clyde river-steamer fitted with turbines; the *King Edward*, put on service in the spring of 1901, was the result—the first commercial turbine. Before that, however, in 1898, the Parsons Marine Steam Turbine Company received an order from the Admiralty to build the *Viper*, and Messrs. Armstrong, Whitworth, on their own account, built the *Cobra*, engined by Parsons. Both of these were torpedo-boat destroyers, and the *Cobra* was purchased by the Admiralty.

Following the *King Edward* and *Queen Alexandra*, the *Queen* for the Dover-Calais service and the *Brighton* for the Newhaven-Dieppe service were the first cross-Channel turbine steamers put in service in 1903. They also were most successful, and the turbine as a commercial engine was fairly launched, a great tribute to the genius of Sir Charles Parsons and his courage in overcoming the many initial difficulties. The decision, taken early in 1905, to fit turbines in the large Cunarders *Lusitania* and *Mauretania*, built by Messrs. John Brown and Messrs. Swan and Hunter respectively, was a very bold and momentous one fully justified by the success of these vessels; it was a tremendous step to take from the smaller vessels already built and tried, to these leviathans crossing the stormy Atlantic. In 1905 the Admiralty also decided on the general introduction of turbines in all classes of warships.

The earlier turbines were all fitted as direct drives and hence to vessels of fairly high speed, when the revolutions were not too low to spoil the efficiency of the turbine or so high as to spoil the efficiency of the propeller. But from the first it was felt that some means of gearing down the propellers was absolutely necessary; Sir Charles Parsons' conversion of the *Vespasian* in 1909 from reciprocating to geared turbine gave the answer required and marked another new era.

In 1897 Dr. Diesel began developing his internal-combustion engine, depending for the ignition of the charge of heavy oil not on electric sparks, hot tubes, or bulbs, but on the heat generated by compressing the air charge. Immense developments have taken place in this direction. Initially the greatest progress was made with this type of engine on the Continent. My information is that the first successful ocean-going motor-ship was the *Vulcanus*, built in 1911 by Werkspoor of Amsterdam for the Anglo-Saxon Petroleum Oil Co., while the first completed in Great Britain was the *Jutlandia*, built in 1912 by Barclay, Curle and Co.

While Great Britain may have been slow at first in taking up the Diesel, certain types—such, for example, as the Doxford and the Cammell Laird-Fullagar—are purely English. Another purely English one (which, being a combination of steam and oil, is exceptionally interesting) is the Still engine, of which that on the *Dolius*, built by Messrs. Scott of Greenock for Messrs. Alfred Holt and Co. of Liverpool, has been successful. The first double-acting four-stroke cycle marine engine in Great Britain was developed at the North-Eastern Marine.

While the turbine developed from the fast passenger-vessels direct driven, to the slow cargo-boat with gearing, the Diesel started in the slow cargo-vessel and is developing towards the faster liner, of which the *Aorangi* of the Union Steamship Co. of New Zealand, built this year by the Fairfield Co., is, at the time I am writing, the most notable example.

The foregoing is the briefest of brief outlines of the changes in the main engines of ships, but the development in auxiliary machinery has been of tremendous importance and extent. In no direction has advance been greater than in the use of electricity on board

[1] From the presidential address delivered at Southampton on August 27 before Section G (Engineering) of the British Association.

[2] Messrs. Augustine Normand, Havre, have now proved to me that Benjamin Normand fitted a Seine passenger steamer with triple-expansion engines in 1871, and fitted at least two more successfully before 1874.

ship. In 1884 the *Arawa* and *Tainui* were fitted with incandescent electric lighting with stand-by oil lamps. The total power used was about 30 horse.

What developments there have been since then! Instead of the feeble 20 kilowatts, hundreds of kilowatts are now in use on a vessel of the same size, and the current is used not only for lighting, but also for ventilating, local heating, cooking, and for driving small machinery of all kinds, including frequently many of the important engine-room auxiliaries; in fact, in some vessels practically all the auxiliaries are driven by electric motors.

The fuel consumed in developing the power of these auxiliaries is now such an important proportion of the total fuel consumed that their design and installation is becoming, to a certain extent, a separate branch of engineering. To show the importance of a thorough study of this auxiliary-power question on board ship, I have been informed that in a large intermediate passenger-ship the consumption of fuel for auxiliaries is reported as exceeding 10 per cent. of the total consumption, and that 15 per cent. or more is not uncommon in some other vessels.

In types of boilers the development has gone from the old box form with safety valve opening inwards to prevent them collapsing when cooling, to the well-known and most extensively used Scotch marine circular boiler with return tubes. But always there were inventors working at the water-tube boiler, and several were constructed which proved successful. The Haystack was an early example, and those of Yarrow, of Thornycroft, and of Babcock and Wilcox may be named as types. In my own experience Yarrow and Babcock have each been used in fast cross-Channel steamers with absolute success, and, apart from the great user of water-tube boilers, the Royal Navy, water-tube boilers are being used increasingly in oversea merchant-ships. For land stations they are in great demand, fitted with mechanical coal-stokers or with pulverised coal or oil firing, in units of such enormous size and with steam pressure so high that steam drums have been built and used 34 ft. long, 4 ft. internal diameter, and 4 in. thick. Shall we see such boilers on board merchant-ships? I have no doubt we shall, though I would not care to express any opinion as to the ultimate highest steam-pressure which will be used, but 500 lb. is in sight.

Superheating of steam was early recognised as a very desirable thing, but it took many years to produce a reliable superheater, and then there were lubrication and other difficulties in reciprocating engines which had to be surmounted. In the case of turbines certain of these difficulties were non-existent, and turbines are peculiarly suited to the use of superheated steam. Another economical advance is pre-heating of air, which is now being pushed much further than ever, but with which the name of Howden will always be associated. Stage feed-water heating is also being very fully carried out.

Fuel-oil firing of boilers has been very largely adopted in steamships, with a marked gain in speed and, when oil is marketed at certain figures, with economy of cost as compared with coal, not only on account of its relatively smaller weight consumption, but also on account of the reduced crew required and the more regular speed obtained, hence shorter time at sea. But in considering the relative advantages of steam- and motor-driven ships one must remember that an oil-fired steamship, in the event of oil soaring in price, may be converted to coal-burning, while in a motor-ship the owner has not that option.

As to powers developed by the main engines in any one steamship, from the 2000-3000 I.H.P. in good class passenger-ships of 1875 to the 75,000 I.H.P. we now find in the most powerful merchant-ships, or more than 140,000 in naval vessels, is a stupendous step.

Turning now to the ship herself and to naval architecture. I crossed to the United States to see ships' behaviour in heavy weather in December of 1882 in the *Parisian*, of the Allan Line, and returned in the same month by the *Alaska*. The latter was the "crack ship" at that time, and was 500 ft. long, the former was 440 ft. long, and they were considered enormous ships. The *City of Rome* was 560 ft., but was not so fast as the *Alaska*. They were all single-screw ships.

Mr. Foster King read a paper at Philadelphia, U.S.A., in 1912, in which he divided ships into three groups:

(*a*) Atlantic passenger-ships (the longest ships).
(*b*) Passenger-ships on all other routes.
(*d*) Cargo-ships.

He obtained from the owners and registry books particulars of thousands of ships, and plotted them on diagrams on a base of years and with lengths of ships as ordinates. From these diagrams he concluded that the growth of "the largest ships in the world" might be fairly represented by straight lines in each group; that group (*a*) ships grew at the rate of 66 ft. in ten years, and group (*b*) 50 ft. in ten years. He observed, however, that after 1897 special vessels in (*a*)—namely, the fast Atlantic ferry—grew much more rapidly, at the rate of 150 ft. in ten years. For cargo-vessels (*d*) the rate of growth was about 30 ft. in ten years.

Taking Mr. King's (*a*) line, in 1875 the longest ship was about 475 ft., while, owing to the above-mentioned offshoot of the Atlantic ferry-boats, in 1912 it was round 900 ft. The *Majestic*, the present longest ship, is 915·5 ft. Reading from the (*b*) line, in 1875 the longest ship was round about 425 ft. In 1912 it should have been 610 ft., but was actually 570, and he remarks in explanation that "one of the usual pauses was occurring." The *Oronsay*, on the Australian trade, is the present longest (*b*) line boat at 633·6 ft. The *Empress of Canada*, on the Pacific, is 627 ft. long. As to cargo-ships—general traders—in 1875 a 3000 dead-weight carrier was a large ship; the more usual size was 2000-2500 tons. Now, 7000 to 8000 is the ordinary size, 10,000 is not uncommon, and many exceed that latter dead-weight.

In dealing with the growth in breadth of ships, Mr. King remarks that about 1875 the fashion in passenger-ships was about ten beams to length, but that after 1880 proportionate breadth became rapidly greater. An analysis of data available to me confirms this view, and that it is not now uncommon to find a proportion of eight beams to length, or even seven and a half.

The draught increased along with the increase in length, and the ports were constantly improved in depth, while new dry docks and floating docks kept pace. Perhaps no better example can be given than the port of Southampton with its "longest in the world" floating dock.

Increase in draught is usually the most economical way of increasing carrying capacity or speed, hence the desire of naval architects for ample depth in ports and canals. When a curve of draught for the same proportion of depth to length is drawn with length as a base, it is seen at once that draught is proportionately less for the longer ship, and, as Lloyd's original tables were based on the current practice of the day, it is to be presumed that practical sea experience is responsible for this. Mr. Foster King's 1912 analysis of practice, as might be expected, shows the same thing. In the early 'eighties, however, experience was limited to about 400 ft. in length, and subsequent experience has shown that these and the longer steamers might safely be loaded deeper than the original rules contemplated.

Let us now turn to consider the change in the provisions for the comfort and convenience of the passenger. In the earlier days of steamships the first-class were in a poop, and the accommodation was very much in the style of the old sailing-ship—a row of cabins at each side with the dining-tables in the centre. There was an open-ended bridge and a forecastle, where the officers and men were accommodated. Gradually, in later vessels the poop joined the bridge, and then the bridge joined the forecastle, and the vessels became awning-deckers or spar-deckers. Then in later ships forecastles again appeared, and midship houses developed into bridge-houses; then poops were fitted, to go once more through the same programme. Thus, as size increased, deck after deck has been added, until in the largest vessels the old names of bridge, upper, main, lower, and orlop no longer suffice, nor are they truly descriptive, and the decks are lettered A, B, C, D, etc.

The navigating bridge of a modern high-class steamer is an inspiring sight, with gyro compass probably fitted with an automatic quartermaster, "tell-tales" from the engine-room giving the revolutions of the engine and the direction of turning, similar "tell-tales" to the rudder head showing the angle of the tiller; the steering gear, now fitted aft, is controlled by a "telemotor," first invented by A. B. Brown of Edinburgh; wireless rooms, wireless direction-finder, and it may be underwater microphones for finding the position from underwater land bells; probably an outfit of telephones communicating from the bridge to the various chiefs of departments; automatic indicators showing the water in all holds and ballast tanks, and means for closing all watertight doors below deck in event of fog or collision.

Returning for a moment to the cargo-steamer—I have already dealt with the growth in size, but there are many other changes in these ships. Sails having practically disappeared, we find the place of masts taken by Samson posts and gantries; indeed, very many modern vessels, built for special trades, look more like a building berth in a shipyard than a sea-going steamer. The equipment has much improved both in the engine-room and on deck, and cargo appliances are quite different. But an important change is in the question of fullness of block. For a considerable time the shipowner seemed to think in terms of £'s per ton dead-weight. This inevitably led to fuller and fuller blocks, until 0·83 was not uncommon; result—a low speed and a great uncertainty as to date of arrival at a port if any bad weather was encountered. Of course, block must be coupled with length, for the longer ship may have a fuller block, but round 400 ft. a block of 0·76 is now much more fashionable, with the result that, while the dead-weight lifted at one time on the same length of vessel is less, yet the higher speed and the greater regularity of time on the voyage, due to the ability to keep up a reasonable speed in bad weather, make the finer vessel a more economic proposition.

A most interesting and important type of special trader is the bulk-oil carrier or oil-tanker, which has developed quite a special technique in design, construction, and fastenings. Originally oil was carried in cases, but, starting with quite small bulk-oil carriers, we now find oil-tankers among the mammoth dead-weight carriers of to-day. Bulk grain, coal, and especially ore carriers, involve also quite special considerations in stability, and strength to resist concentrated loads in the last mentioned, of which type the highest development is to be seen on the Great Lakes of North America.

I have not referred at all to the tremendous changes which have taken place in the Royal Navy; that in itself would take more time than I have at my disposal. In main engines, however, the lines of development have been much the same as in the mercantile marine, while in the vessels themselves their purpose is so different that no comparisons can be drawn. But their design has not been without its influence on the merchant-ship in many details, and there are several directions in which the work at the Admiralty has had a commanding influence on naval architecture in Great Britain.

We may now turn to the technical training of the marine engineer and naval architect. Until the founding of the John Elder chair of naval architecture and marine engineering at the University of Glasgow, the technical education available to apprentices in private works was provided practically entirely by evening classes under the South Kensington Science and Art Department. Many of those men who, for at least a generation, were responsible for the great strides made in the technical efficiency of the twin industries received their professional education at these classes. These classes are still doing good work. Of course even before special chairs were established, B.Sc. courses in engineering were open to students, but only a few bursary or moneyed students could take advantage of them. For generations the Royal dockyards have taken care of the technical instruction of their apprentices, and schools for their instruction were, and are, at work in every dockyard. I can only stop to note the foundation of the Royal School of Naval Architecture and Marine Engineering at South Kensington. The best students from each dockyard were sent there for the first time in 1864, to receive a training in higher science and mathematics of a severity unmatched in any college.

Without proper technical education an efficient corps of designers and of research workers could not be maintained, and considerable and important has been the research work guided by the Admiralty, by our technical institutions, by Lloyd's Registry, and by many private firms and individuals.

In research, to no two men are we more indebted than to Dr. Wm. Froude and his son, Mr. R. E. Froude, for the experimental work done by them on ships' resistance and screw propellers. The British Association in 1868 appointed a committee to consider stability, propulsion, and sea-going qualities of ships, and of that committee Dr. Froude was a member, the others being Merrifield, Galton, and Rankine. The committee recommended experiments on actual ships, but Dr. Froude dissented and gave it as his opinion that model experiments were of value and were much cheaper to carry out, describing some he had made in 1867. In 1868–69, on the suggestion of Sir Edward Reed, then Chief Constructor, the Admiralty agreed to bear the cost of the construction and the working costs of the tank at Chelston Cross, Torquay. This tank started work in 1871, Dr. Froude acting as chief, and he gave his services gratuitously as long as he lived. On his death Mr. R. E. Froude took over charge, continuing and expanding his father's work. The results were freely communicated by him, with the full consent and encouragement of the Admiralty, to the Institution of Naval Architects in a series of valuable papers. The Torquay tank was ultimately dismantled and transferred to Haslar, where the good work is continuing.

There are now, besides the Government tank at Haslar, the following Froude tanks in Great Britain, in the order of age—Denny (Dumbarton), Brown (Clydebank), William Froude (Teddington), Vickers (St. Albans), and Parsons' have also a smaller open-air tank at Newcastle: that is six; and there are in Italy, Germany, France, Sweden, Russia, Austria, Japan, and the United States other eleven, a total of seventeen, and it may be claimed that tanks have had more far-reaching effect on design than any other means of research.

Yet, when one considers the research carried out on ferrous and non-ferrous metals, that claim may be disputed. Time fails me to do more than indicate to you the history of mild steel. While steel had been used in shipbuilding at an earlier date, our present material came into daily use in merchant-ship building in the late 'seventies of last century, and I can remember the interest taken in the *Buenos Ayrean*, the first steel Atlantic ship, built in 1879. With the considerable reduction in scantlings allowed by the Classification Societies, mild steel rapidly displaced iron in ship construction. But still we were warned that it was unreliable if worked at a blue heat, and some failures were recorded. Further improvement in manufacturing methods, however, finally gave us a material of great reliability and easily worked. The limits of 28-32 tensile strength and 20 per cent. extension in an 8-inch specimen have been standard now for many years, though steels of greater carbon content and higher tensile strength have been used: and as Young's modulus is practically the same for all ordinary carbon steels, these higher tensile steels could be used in conjunction with milder steels without disadvantage. But there is now another mild carbon steel on the market which has a higher elastic limit, the use of which is just beginning; it is claimed that it will ensure further advantageous developments in reduction of weight of hull.

Sir Robert Hadfield's invention of high-manganese steel gave a fresh impetus to research in ferrous alloys; and now we have alloys of nickel, chromium, vanadium, tungsten, and other metals, each with its own special use either in construction of ships and their machinery or in the machine-shop for tool-steel, thus still further advancing the science and art of shipbuilding and marine engineering.

Other powerful factors in the development of the merchant marine were the Board of Trade, the Classification Societies, and the technical institutions and societies.

The Board of Trade is charged by statute with the duty of seeing that ships are safe and sufficient for navigation. The individual surveyor is legally responsible, and it is he who must certify safety and sufficiency; but, for co-ordination purposes, there is a Consultative Branch at Whitehall which issues "Suggestions and Instructions" to the surveyors as to how they should carry out their duties. These "buff books" have in practice largely the same effect as the rules and regulations of the Classification Societies.

Practically every maritime nation has a Registry or Classification body or bodies of its own, but in Great Britain that type of organisation has been earlier and more fully developed than in other countries. Lloyd's Registry has a world-wide name and has had a profound influence on design not only in this country but also all over the world. This leads me to speak of standardisation in shipbuilding and engineering. The first work of the B.E.S.A., when it was established in 1901, was the standardising of ships' sectional material. Order was thus brought out of chaos, the number of standards, sections of all kinds and sizes, was fixed at 175, and the steelmakers reported that a saving of at least 5*s*. per ton was the result. A revision in 1918 reduced the standard sections to 115. A recent piece of work of the B.E.S.A. is the standardising of the tail-shafts of ordinary cargo-vessels, which standards may also be applicable to many passenger-ships. The taper of the shaft to take the propeller boss is also fixed. It can easily be seen what a saving this would mean in the case of damage at a distant out-port, where, were these standards adopted, only a few spares need be kept, or even the spare of one steamer could be used for another with the same diameter shaft, and thus in the case of damage the present long delays in an out-port waiting for replace parts would be avoided.

The influence of the Institution of Naval Architects on the progress of design cannot be exaggerated. Founded in 1860, there has been a constant stream of valuable papers read and discussed at the annual meetings; naval architects and marine engineers were glad of the opportunity of presenting the results of their experience to their fellows and of profiting by the discussion of their ideas. Now there are all over Great Britain—at Liverpool, Newcastle, Southampton, Glasgow, and other centres—similar institutions, contributing to the advance of the science by their meetings and published transactions.

Radiometric Determination of the Temperature of Mars in 1924.

By Dr. W. W. COBLENTZ, Bureau of Standards, Washington, D.C.

THE main problem in the radiometric programme of 1924 at the Lowell Observatory, as stated in the article in NATURE of September 19, p. 439, was the measurement of the radiation from Mars. For this purpose most of the measurements were made at the 640-inch focus of the 40-inch Lowell reflector, which gave an image of the disc of Mars about 2 mm. in diameter. The receiver of the vacuum thermocouple was 0·23 mm. in diameter, or about $\frac{1}{8}$ of the diameter of the disc of Mars at opposition. This permitted the isolation of small areas on the disk of the planet and revealed hitherto unobserved and perhaps unexpected temperature conditions.

By means of a series of screens of water, quartz, glass, and fluorite, the radiation emanating from a planet, *e.g.* Mars, was separated into spectral components and the radiation intensities determined in the spectral regions of 0·03 to 1·4μ, 1·4 to 4·1μ, 4·1 to 8μ, 8 to 12·5μ, and 12·5 to 15μ. In this paper the ratios of the spectral components of the planetary radiation at 8 to 12·5μ and at 12·5 to 15μ (A : B) are of special interest. The radiometric work was carried out in collaboration with Mr. C. O. Lampland, and the complete results are given in the June and July issues of the Journal of the Franklin Institute.

In view of the conflicting opinions regarding temperature conditions on Mars, it was desirable to reduce the radiometric data by various methods and also to have someone not connected with the work to make some of the calculations. The writer therefore submitted to Dr. D. H. Menzel a considerable portion of the observations obtained in 1924 for calculation, thus supplementing the work of 1922, as mentioned in NATURE of September 19.

Martian temperatures were derived by the following methods: (1) by the fourth power law of black body radiation (Menzel), using Russell's formula and the observed Martian water-cell transmissions (W.C.T.'s in Table 1); (2) by the law of spectral radiation and the ratio of the Martian spectral radiation components, A : B; (3) by plotting Very's observed lunar temperatures against the observed lunar spectral radiation components, A : B, and extrapolating to the observed ratios of the Martian components; (4) by calculating the lunar temperatures (Menzel) from the lunar water-cell transmissions, using the fourth power law, plotting these temperatures against the observed lunar spectral radiation components, A : B, and extrapolating to the observed ratios of the Martian spectral radiation components; and (5) by plotting the lunar temperatures (which were obtained by calculation from the lunar water-cell transmissions, using the fourth power law) against the observed lunar water-cell transmissions and extrapolating to the observed Martian water-cell transmissions. (A more complete discussion is given in the *Astronomische Nachrichten*, June 1925.)

TABLE 1.—MARS: COMPARISON OF TEMPERATURES ON THE APPARENT CENTRE OF THE DISK AS OBTAINED BY VARIOUS METHODS.

Date 1924.	Water-cell Trans-mission (W.C.T.).	Spectral Com-ponents (A:B).	Temperatures, °C. Method. Black Body. 1 Menzel (W.C.T.).	Black Body. 2 (A:B).	Moon. 3 Very (A:B).	Moon. 4 Menzel (A:B).	Moon. 5 (W.C.T.).	Mean.	Region on Mars.
Aug.									
6	33·5	41·7	−1	12	14	12	2	8	Syrtis Major.
14	30·5	41·3	9	10	13	11	16	12	Mare Sirenum.
15	32·4	43·1	5	21	18	14	8	13	,,
18	31·1	38·6	4	−5	8	7	13	6	,,
21	32·5	40·7	3	6	12	10	6	7	,,
21	34·9	39·1	−5	−3	6	8	−7	0	Bright region north of Mare Sirenum.
23	32·8	36·6	2	−20	3	4	4	−1	,, ,, ,,
25	33·7	38·3	−7	−8	7	6	2	−1	Bright region north of Beak of Sirens.
28	31·2	50·0 ?	4	55 ?	32	24	12	18	Solis Lacus. Poor seeing.
Sept.									
11	30·8	47·8	1	45	26	20	15	22	Syrtis Major.
13	29·6	39·3	6	−2	10	8	22	9	,,
13	25·1	55·8 ?	22	..	42	32	..	32	,, 18·4 foot focus.
14	29·3	46·4	6	40	22	18	25	22	Mare Cimmerium.

In addition to these calculations, planetary temperatures were inferred from comparisons with the earth, in which it is shown that the temperature of the solid surface of Mars would be expected to rise almost as high as that of the earth. In fact, with much clearer skies and with less air convection in some of the darker places on Mars, especially in the temperate and in the frigid zones, where the insolation is so prolonged, the temperature should be considerably higher than observed on similar regions of the earth.

The temperatures derived by these various methods of reducing the data are in good agreement and indicate conclusively that the equatorial temperature of Mars, at perihelion, was considerably above 0° C. When one considers the difficulty in establishing the temperature of a terrestrial object within 10° C., it seems truly remarkable that these various methods appear to be so close in agreement in indicating that the temperature of Mars rises above 0° C. This is an extremely important deduction, for the possibility of vegetable life on Mars depends partly upon the question of temperature conditions.

A weakness in the method of using the spectral components is owing to the fact that the spectral range of the planetary radiation is narrow, and the spectral transmissions of the atmosphere and of the fluorite screen at 10 to 11μ are not known with sufficient accuracy to determine the temperatures to better than 10° C. However, it is a new and an independent method for obtaining temperature levels.

Ordinarily it would be considered sufficiently close to have determined the temperature level to within 10° C. However, in the present problem the temperature estimates range about 0° C., and the question at issue is whether the average estimates place the value somewhat above 0° C., for the question of the possibility of vegetation on Mars depends partly upon this temperature estimate. While the results obtained by this method give a wider range of temperatures than the other methods, its usefulness in supplementing the other methods seems evident.

The dark regions were found to be hotter than the bright regions; also the east limb or sunrise side was observed to be cooler than the west limb or afternoon side of the planet. The temperatures of the bright areas range from – 10° to 5° C., while the temperatures of the dark areas range from 10° to 20° C., or perhaps even higher. The average temperature of the apparent centre of the disk, including the bright and the dark areas, was found to be about 15° C., verifying the estimate of 10° to 20° C. based upon the radiometric measurements of 1922. There was but little seasonal change in temperature (average 14° C.) on the centre of the disk during the six weeks from August 1 to September 14. While the measurements were in progress it was winter in the north polar regions. Under these conditions the temperature of the irradiated north polar region was down to – 70° C., or perhaps even lower, and continued at this temperature during the course of our measurements. Similar temperatures occur in our arctic regions during the winter. On the southern hemisphere it was early summer, and the temperature of the south polar region, as observed through the overhanging atmospheric mantle of mist or perhaps ice spicules, was – 60° C. However, in view of the fact that it was the summer season, with melting snow and a receding polar cap, it is reasonable to assume that the temperature of the solid surface at the south pole was up to 0° C. The complete paper by Coblentz and Lampland in the Jour. Franklin Institute (June and July 1925) gives data on climatic conditions on various parts of the surface of Mars: (1) the bright and dark regions on the centre of the disk; (2) the east and west limbs; and (3) the north and south polar regions.

To the writer the apparent temperature of – 60° C., as measured through the water cell during the early Martian summer in the south polar region, is not inconsistent with the commonsense interpretation of the visual observations (receding polar cap, melting ice) indicating a temperature up to 0° C., but is a remarkable verification of the presence of an atmosphere containing a mantle of ice spicules or perhaps water vapour ("mist"), which prevents the escape of planetary radiation from the solid surface. It is to be noted that our interpretation of planetary temperatures is based upon the radiation of wave-lengths 8 to 15μ which emanates from the planet. Evidently this overhanging mantle is of considerable extent and is perhaps in the form of a thick mist or fog which is opaque to these wave-lengths. For it is well known that the highly attenuated water vapour in our atmosphere is quite transparent to radiation of wave-lengths 8 to 15μ, whereas mist and fog prevent the transmission of infra-red rays of long wave-length.

The temperature of the south polar cap changed but slowly during July and August. However, in September the temperature began to rise rapidly, and by October the water-cell transmissions decreased to 30 per cent. or even lower, indicating a temperature of 6° C. (true temperature about 15° C.). This is extremely interesting in view of Rev. T. E. R. Phillips' recent paper on this subject (Mon. Notices R.A.S., 85, p. 179, 1924), in which micrometric measurements are given showing that the melting of the snow proceeded slowly during July, but that the cap diminished rapidly in size during August and September, and became very small in November.

This rapid rise in temperature of the south polar region from – 60° (the temperature of the isothermal layer of the polar canopy; 0° C. if interpreted from the visual observations of the receding cap of melting ice) in July to 10° C. or even higher at the Martian summer solstice (on October 5) is perhaps one of the most important results of this investigation. From a consideration of the prolonged insolation on the south polar region, such a temperature rise is to be expected.

On the west limb the observed temperature was – 2° to – 8° C. at the beginning of August, when there was a small dark phase. When there was no dark phase on the west limb the temperatures ranged from 0° to 6° C.

Perhaps the most interesting series of measurements relate to the east limb or sunrise side of the planet. During the first part of August, the east limb was irradiated for an hour or more before turning into view. Under these conditions the observed temperatures of the eastern limb range from – 10° to – 20° C. At opposition, August 22, when there was no dark phase, the temperature was down to – 45° C. At the conclusion of the series at the 53·3 foot focus, on September 12, when the dark phase was barely perceptible on the east limb (illuminated surface 0·976), the temperature was – 60° C. How much lower the temperature falls, and whether this very low temperature is owing to setting the receiver on the atmospheric envelope, remains to be determined.

From the low temperatures recorded at the poles, and the small atmospheric envelope, it appears that the temperature of the night side of Mars may fall below – 70° C.

This study of the seasonal changes in temperature, especially of the southern hemisphere of Mars, was continued late into November by Mr. Lampland, using the same radiometric equipment and galvanometer employed by us during the preceding months. He reports that the water-cell transmissions of the radiation from the north polar region continued unchanged at

70 to 80 per cent., indicating a temperature of about −70° C., as was to be expected with winter on this hemisphere.

On the other hand, the water-cell transmissions of the radiation from the south polar region decreased from the high value observed in the early part of September to 30 per cent., or even lower, in November and December, indicating a temperature of 10° to 15° C., or even higher. Granting that some ice still remained at the pole, there would be a temperature gradient for which a correction should be made. On this basis, the water-cell transmissions would be still lower and the temperature of the south polar region would be higher than indicated by these measurements.

The observed high surface temperatures on Mars may be accounted for on the assumption that these dark areas contain vegetation having the properties of the tuft-forming grasses of our high prairies, and the tussock mosses and lichens of our dry tundras, which have a high absorptivity for solar radiation and a low thermal conductivity. The assumption of the presence of such a type of vegetation is in harmony with the visual observations, which show changes in the colouring of the dark areas with changes in the seasons, and it is in agreement with the lower intensity of insolation on Mars. The radiometric observations indicate that during the summer season on Mars, temperature conditions at noonday are not unlike the bright cool days on this earth, with temperatures ranging from 5° to 15° C. or 40° to 60° F.

Sir William Thiselton-Dyer and the "Flora Capensis."

THE publication in the *Kew Bulletin* (No. 7, 1925, pp. 289-293) of an account, by Sir W. T. Thiselton-Dyer, of the commencement, progress, and completion of the "Flora Capensis," affords a fitting opportunity of recalling Sir William Thiselton-Dyer's work at the Royal Botanic Gardens, Kew, and more especially the work he has done for the British Empire in advancing the knowledge of its botanical riches in the domain both of economic and systematic botany. With regard to the systematic study of the Colonial floras, the two works which are especially associated with his many years of office at Kew are the "Flora Capensis" and the "Flora of Tropical Africa." Proposals for both these works were made by Sir William Hooker, so long ago as 1863, when *inter alia* he put forward a proposal for a flora of the "South African Colonies" in ten volumes and a flora of the "West African Colonies" in two volumes. Out of the former proposal has come the now completed "Flora Capensis" and from the latter the "Flora of Tropical Africa," which, when finished, will occupy eleven or twelve volumes.

The "Flora Capensis," as Sir William Thiselton-Dyer states, had, however, actually been commenced at the suggestion of Sir William Hooker. It was undertaken by Dr. Harvey, "sometime Treasurer of Cape Colony," the professor of botany in the University of Dublin. He "undertook to print and publish the Flora at his own risk and cost, trusting chiefly to colonial subscriptions for a repayment of the outlay." Dr. Sonder, of Hamburg, "gladly accepted Dr. Harvey's offer to share the authorship." Volume 1, dedicated to Sir George Grey, K.C.B., "Governor and Commander-in-Chief of the Colony of the Cape of Good Hope," bears the publication date 1859–60. Volume 2 was published in 1862, and Volume 3 in 1865. The following year Prof. Harvey died, and Dr. Sonder, who took no further part in the work, died in 1881.

Sir Henry Barkly, Governor of the Cape of Good Hope from 1870–77, himself an ardent naturalist and fellow of the Royal Society, urged upon Sir Joseph Hooker, who had succeeded his father as director of Kew, the completion of the work of Harvey and Sonder, and Sir Joseph Hooker suggested to Mr. Dyer, as he then was, that he should undertake the completion of the work of the Cape Flora. As, however, he was at that time assisting Sir Joseph in sub-editing the "Flora of British India," he was unable to entertain the proposal; and later, being appointed to the post of assistant director of Kew in 1875, he was again precluded from taking up any particular part of the Flora himself. Sir William, however, was able to enlist the aid of numerous contributors in carrying on the work; but the general task of supervising and editing a work which was part of a project initiated by Kew, appeared to him to fall naturally within the scope of his official duty, and so after a long interval the "Flora Capensis" was again started.

Sir William points out as a striking fact, that in the volumes published by Harvey a very large number of the species are only represented by a single collection. It was highly desirable to have more copious material to work upon, if only to supply more ample data for geographical distribution, and thanks to Sir William Thiselton-Dyer a numerous body of contributors was marshalled, and they rendered valuable service in sending home material for the adequate working out of the Flora. Among these Peter MacOwan and Dr. Harry Bolus deserve particular mention.

Sir William, in his article, refers to the fact that upwards of ten thousand specimens have been named and catalogued for South African botanists and collectors in connexion with the work of the Flora, and that during twenty years, from 1877, the time of one member of the Kew staff, Mr. N. E. Brown, was almost exclusively occupied with the determination of these fresh accessions of South African plants. Sir William bears eloquent testimony to Mr. Brown's work, pointing out that from his complete mastery of the features of the flora and of South African topography "he has been the invaluable mainstay of my own share in the undertaking."

It was in 1877 that Sir William was able to start the work on the Flora on an effective basis, and he was fortunate in being able to secure the co-operation of South African contributors, including Dr. Harry Bolus, who undertook the Ericaceæ; Dr. E. P. Phillips, who worked out the Proteaceæ; and Miss E. L. Stephens, who worked out the Penæaceæ. The Orchids, which should have been worked out by Dr. Harry Bolus, could not be carried out by him and were undertaken by the late Mr. R. A. Rolfe of the Kew Herbarium staff. Other contributors of whom Sir William makes special mention were Mr. J. G. Baker, who elaborated the "Cape Bulbs," and Mr. C. H. Wright, assistant in the Herbarium, Royal Botanic Gardens, Kew, who sub-edited the whole of the contributors' manuscript.

It is interesting to note that Sir William Hooker estimated both the number of volumes and the financial support that would be needed to carry out the work with remarkable accuracy. He fixed the number of volumes at ten, which is the number now published, and he also estimated that ten thousand would be the number of species to be dealt with. The actual number, however, is 11,705, and of these 2016 are described for the first time.

The "Flora of Tropical Africa," like the "Flora Capensis," though it owes so much to the energy and sagacity of Sir William Thiselton-Dyer, was commenced before he was able to assume any control over its preparation. Originally it was intended to be the joint work of Sir William Hooker and Prof. Daniel Oliver, Keeper of the Kew Herbarium; but the work was handed over to Prof. Oliver, and the first three volumes appeared in 1886, 1871, and 1877 respectively. Then, as with the "Flora Capensis," came a long break, and it was not until Sir William Thiselton-Dyer was able to take the matter in hand that the preparation of this flora could be resumed. As an outcome of his activities a new volume of the Flora appeared in 1898 devoted to the petaloid monocotyledons, Volume 7 of the entire work, this being the first volume to be produced under Sir William's editorship. This was followed in due course by Volume 4, published in two sections, Volume 5, Volume 8 and Volume 6, Section 1, the latter, which was published in 1913, being the last to appear under his editorship. The Flora has been continued under the editorship of Sir David Prain, and only some two parts, dealing with the grasses, now remain to be published.

The work entailed in arranging for the collection and naming of the material for these two great works would, it might well be thought, be sufficient to have occupied the full attention of the director of Kew, upon whose time there are so many calls with regard to botanical problems both at home and abroad; nevertheless, Sir William found time to initiate yet another work, *The Kew Bulletin of Miscellaneous Information*, for the purpose, more especially, of disseminating knowledge about the economic botanical products of the Empire. The *Bulletin* was started in 1887 and is still in a flourishing condition, despite one or two times of difficulty—one of which was during the War, when an attempt was made to suppress it on the mistaken idea of economy.

Sir William's preface, which we quote, fully explains the scope and purpose of the work:

"It is proposed to issue from time to time, as an occasional publication, notes too detailed for the Annual Report on economic products and plants, to which the attention of the Staff of the Royal Gardens has been drawn in the course of ordinary correspondence, or which have been made the subject of particular study at Kew. It is hoped that while these notes will serve the purpose of an expeditious mode of communication to the numerous correspondents of Kew in distant parts of the Empire, they may also be of service to members of the general public interested in planting or agricultural business in India and the Colonies. "W. T. THISELTON-DYER,
"Director.

"1st January 1887."

The present condition of the Kew Museums is also largely due to Sir William Thiselton-Dyer. Originally started by Sir William Hooker, the collections grew apace and fortunately they came under Dyer's purging hand, with the result that much encumbering dross was removed and the economic products were displayed to the best possible advantage. At the same time the Museum guides were produced and put on sale, in order that the public might be provided with accurate information on the wealth of the vegetable kingdom and the economic products derived therefrom.

These, with the two African floras and the *Kew Bulletin*, are a record of service which is of the highest importance, not only in the development of our knowledge of the botanical resources of the Empire but also because of the impetus this gives to scientific research in botany.

Such services as these, and many other activities displayed by Sir William Thiselton-Dyer in various botanical enterprises, have rarely been surpassed in value and importance by the labours of any other public servants to whom the British Empire owes so much.

Obituary.

PROF. FELIX KLEIN, FOR. MEM. R.S.

FELIX KLEIN, who was born at Düsseldorf on April 25, 1849, died on June 22, 1925. He had been professor at Göttingen since Easter 1886, having previously been at Erlangen (1872–1875), Munich (1875–1880), and Leipzig (1880–1886). With a trenchant expository style, revealing a forceful genial character, he wrote on almost every branch of mathematics; he was editor of the *Mathem. Annal.* from the time of the death of Clebsch (1872), originator of the "Enzyklopädie" for mathematics and mathematical physics (from 1895), and, in his own country, worked incessantly for a living co-operation of physics, engineering, and mathematics, and (since 1908) to bring the teaching in the schools into touch with current scientific problems. He was also a constant traveller and lecturer; was twice in America and many times in England, since 1873. His exceptional personality appeared at once after his student days at Bonn; he took his doctor's degree at the age of nineteen; issued the second part of Plücker's book on line-geometry at the age of twenty; by the end of 1871, when he was twenty-two, had published eighteen original papers (some of these with Lie); by the end of 1875 he had published forty. Many of these are still mines of suggestiveness; his Erlanger Programm (1872) has been translated into English, French, Italian, Polish, Russian, and Hungarian.

Klein's mathematical papers were published, under his own supervision, in three volumes, in 1921–1923, containing more than two thousand beautifully printed pages; in these is inserted a running personal commentary; in effect, a detailed account of his scientific thoughts and aims from the age of eighteen, with many references to colleagues and pupils. These volumes, intensely interesting from so many points of view, are the sufficient and authentic basis for a review of his life.

It appears, what will be new to many, that Klein's life was lived under a resolve, never relinquished, made when serving Plücker as assistant for his lecture on experimental physics, to devote himself to physics. He desired only, first, as a preparation for this, to make himself acquainted with all branches of mathematics, in order to trace the connexions of their leading ideas, and to be in a position to raise physics to a higher plane. The notes enable us to trace how this resolve was modified by circumstances, and only realised in the work of others whom he inspired: two leading causes are brought out—his pre-eminently sympathetic temperament, and a serious breakdown of health at the age of thirty-three. It seems clear that he worked mainly by discussion with friends and pupils, and by lecturing. His vivid account of the time spent with Lie in Paris in the early part of 1870; his evident interest in meeting Sylvester, Cayley, Clifford, and Ball at the British Association at Bradford, in 1873; and the reference to the happiest time of his productive activity (1876–1880), when he, from Munich, and Gordan, from Erlangen, each travelled a long way to enjoy on Sundays a *Mathesis quercupolitana* at the half-way Eichstädt, are examples of what appears throughout.

Now such discussions were conditioned by the interests of his colleagues, as his early work had been influenced by his teachers (Plücker, Clebsch, Weierstrass, Kummer); and thus Klein was led into giving his publications a form quite other than physical. We see, however, how he fought to maintain his early resolve, particularly in the manner of approach to Riemann's theory of functions, and, later, in his volume (with Sommerfeld) on the motion of the top. This begins in a mathematical way; but, in the course of the thirteen years occupied in its publication, reaches a very technical plane. But besides this concession to his surroundings, it appears that, first at Munich, and then more seriously at Leipzig (in 1882), he was warned that he could not continue to work with the same intensity, and must needs live on a different level. Thus he began to limit himself to the supervision of the long series of books and lectures, on almost every subject of mathematics and mathematical physics, of which the detailed work was carried out by others.

Meanwhile Klein's unceasing anxiety for the organic working union of physics and mathematics expressed itself in administrative ways. He secured, one can imagine with what trouble, a co-operation of German Academies, to bear the responsibility for the "Enzyklopädie"; he travelled hither and thither to secure competent contributors, especially to England (there being, as he explains, no sufficient sympathy in Germany between mathematicians and physicists); himself undertook the part dealing with mechanics, in connexion with which he obtained the translation into German of Routh's "Dynamics," Lamb's "Hydrodynamics," and Love's "Elasticity." In his own Göttingen, later on, were founded a Physical Institute, with the help of German manufacturers, and a society for the encouragement of mathematical physics; to him it appeared "Mechanik, überhaupt angewandte Mathematik, kann nur durch *intensive Beschäftigung mit den Dingen selbst gelernt werden*; die Literatur gibt nur eine Beihilfe." He took every opportunity, by visits to conferences and lectures, to keep in touch with engineers and physicists; he organised vacation courses for teachers to give their teaching the proper modern orientation; and finally, from 1908, he gave his attention to the schools, and lamented the ruin the War had wrought in the extensive preparations made for an international campaign.

Little need be said in this place of the brilliance of the mathematical papers, especially of Klein's earlier years. If the reader agrees with Poincaré, in a letter quoted here, "Je ne crois pas qu'une démonstration puisse être résumée; on ne peut en retrancher sans lui enlever sa rigueur et une démonstration sans rigueur n'est pas une démonstration," he will find here, also, Klein's reasoned reply. Nor need we think that his international aims were not genuine because of his evident patriotism, and his desire to see Göttingen "über Alles." These are desires which he would have commended in others. For we are bound to feel that his life was devoted to a very real and practical problem of our time, and that he worked at it loyally and unremittingly—namely, how to bring under as few points of view as can be grasped by one man the astonishing output of physical and mathematical thought in the last hundred years. The difficulty is not that the ideas involved are so wide apart; on the contrary, they are very cognate—Bohr uses the ideas of the theory of Abelian functions, and would use the approximation theory elaborated by Lagrange, combined with Planck's physical results, to construct an explanation of spectrum lines; Einstein uses an absolute differential calculus, tracing its origin to Lie's work for continuous groups as well as to Riemann's thoughts on geometry, with a realistic outlook such as was discussed by Mach, to found a new calculus for the motion of material bodies. It is probably the case that the grooves in which the mind of the physicist can move, to elaborate his theories, have generally been worn by the imagination and systematising efforts of the mathematician, who, in rare cases, may be the same person; and it is certain that only by the development of all aspects of thought can progress be continued. But how shall one man secure an adequate understanding of all that may concern him in the work of so many others? Must we say that the answer is that only if the civilised world can continue in patience and amity to co-operate to this end, can the end be reached?

At least we owe honour to the commanding personality and penetrating intellect of Felix Klein, for his life's devotion to the solution of the problem.

COUNT GOBLET D'ALVIELLA.

THE death of Count Goblet d'Alviella on September 8 as the result of a motor-car accident is announced from Brussels. Count Goblet d'Alviella was born in 1846, and for some time was professor of the history of religion at the University of Brussels. He had a distinguished career in public life successively as a member of the Chamber of Deputies, member of the Senate, of which he became vice-president in 1912, and Minister of State and member of the cabinet during the War.

He held the degree of doctor of philosophy, and the Universities of Edinburgh and Glasgow had conferred upon him honorary degrees. In 1891 he delivered the Hibbert Lecture, his discourse being published afterwards under the title, "A Lecture on the Origin and Growth of the Conception of God as illustrated by Anthropology and History." He was the author of a number of books, including "Sahara and Lapland: Travels in the African Desert and the Polar World," which was published in an English translation in 1874, and "The Contemporary Evolution of Religious Thought in England, America, and India," published in England in translation in 1885.

Goblet d'Alviella's most important work, however, was "La Migration des symboles," published in Paris in 1892, and in an English version with a preface by Sir George Birdwood in 1894. This book embodied material originally appearing in the *Bulletin de l'Académie Royale de Belgique* and elsewhere, but in much extended form. The study of forms of symbolism had at that time fallen somewhat into disrepute owing to the unscientific and highly speculative methods of earlier writers such as Depuis and Creuzer, but Goblet d'Alviella placed it on a secure footing by the application of inductive methods and comparative study. As Sir George Birdwood said in his foreword, he "raised the inquiry to its proper position as a department of archæological research, producing a work destined to exert an abiding influence on the whole future of the study of symbolism"—a prediction which time has not belied. This book still remains the best study of the principal symbols employed in early decorative art, such as the swastika, the triskele, the tree of knowledge, and the winged disc. It is interesting to note that while Goblet d'Alviella derived each of such symbols in the main from a single origin in some one centre, he was prepared to admit that in certain areas and in favouring circumstances they probably had arisen independently.

WE regret to announce the following deaths:

Prof. C. Chandler, formerly professor of chemistry at Columbia University, New York, a former president of the American Chemical Society, and an original and an honorary member of the Society of Chemical Industry, aged eighty-eight years.

Prof. Albert T. Clay, professor of Assyriology and Babylonian literature in the Graduate School of Yale University, and president of the American Society for Oriental Research, on September 14.

Sir Francis Darwin, formerly reader in botany in the University of Cambridge, on September 19, at seventy-seven years of age.

Dr. William C. Farabee, curator of the American section of the University of Pennsylvania Museum, distinguished for his archæological and ethnological work in South America, on June 24, aged sixty years.

Prof. W. S. Hendrixson, professor of chemistry since 1890 at Grinnel College, Iowa, known for his contributions to the study of electrometric methods in chemistry, on July 1, aged sixty-six years.

Senator E. F. Ladd, formerly professor of chemistry at North Dakota College and president of the Agricultural Experiment Station, on June 22, aged sixty-five years.

Dr. Georg von Mayr, professor of political economy and statistics in the University of Munich and an honorary member of the Royal Statistical Society, aged eighty-four years.

M. Auguste Pavie, an honorary corresponding member of the Royal Geographical Society, who carried out important explorations in Indo-China, Siam and Upper Annam, adding considerably to our knowledge of French possessions in Asia, aged seventy-eight years.

Prof. F. Ranwez, professor of pharmaceutical chemistry in the University of Louvain and president of the International Congress of Pharmacy held at Brussels in 1897, aged fifty-nine years.

Dr. Georg A. Schweinfurth, distinguished by his geographical, botanical, and ethnographical work in Africa, on September 19, at eighty-eight years of age.

Dr. A. Tuckerman, known especially for his bibliographic work in the United States on the literature of the spectroscope and of thermodynamics, on May 25, aged seventy-seven years.

Prof. Charles Vélain, the first occupant of the chair of physical geography in the Faculty of Sciences of the University of Paris and founder of the "Revue annuelle de Géographie," on June 6, aged eighty years.

Prof. J. B. Woodworth, of the Department of Geology and Geography at Harvard University since 1890, a pioneer in the scientific study of earthquakes, who was also known for his work in the glacial geology of Brazil and other areas, on August 4, aged sixty years.

Current Topics and Events.

AT the recent meeting at Southampton of the British Association, it was a subject of general remark that modern scientific thought shows a striking drift away from the facile generalisations of the Victorian age. The progress of research in the sciences bearing on agriculture illustrate this change to a very marked degree, and the report of the Rothamsted Experimental Station for the years 1923–1924, which has just been issued, bears witness to the number and variety of the investigations in progress at the premier institution for agricultural research in Great Britain. The list of scientific papers published from the Station during the period reached the remarkable total of fifty-eight. The Physics Department alone was responsible for thirteen papers, of which three appeared in the Proceedings of the Royal Society. Under the various sections of this report dealing with the many physical and biological factors which enter into plant growth, we are constantly met with references to the interplay of contending forces. In the soil, in place of absolute values assigned to specific plant nutrients (*teste* Page), colloidal calcium- and other complexes now figure as the battle-ground of warring ions, and in the biological field, as the work of Cutler and Thornton has shown, much depends on the ebb and flow in the bacteria-protozoa conflict. Superimposed on all these come the vagaries of the weather, an extraordinarily difficult factor to measure. The work of evaluating all these factors falls to the Statistical Department, the activities of which (perilously esoteric!) are ably directed by Mr. Fisher.

THE outlook of Rothamsted is, in the main (and rightly) academic, but if there is any department the concern of which more intimately touches upon existing economic conditions, it is that dealing with the physics of the soil, in charge of the Assistant-Director, Dr. Keen. Costs of "cultivations"—man and horse labour—may approach three-fourths of the total cost of home-grown crops, and, at the present rates of wages, the homeland is almost hopelessly handicapped—a topic, by the way, prominently brought to notice at the Southampton meeting by Sir Daniel Hall and Sir Henry Rew. It may be hoped that the new Research Institute in Engineering recently founded at Oxford will find it possible to enter into intimate co-operation with the fundamental work on cultivations now going on at Rothamsted. We notice a reference in the report to a matter of considerable public interest, and that is, the problem of exploiting, on a commercial scale, discoveries made in laboratories supported by large grants from the State. The Rothamsted authorities are happy in finding, in Lord Elveden, a patron who is willing to undertake the commercial development of the discovery made by Hutchinson some years ago of a method of making "artificial" farm-yard manure. The report also contains the details of the various field experiments which are in progress at Rothamsted, as well as full particulars of the interesting investigations conducted by Dr. Voelcker at the farm at Woburn, the maintenance of which the Royal Agricultural Society somewhat precipitately jettisoned some years ago.

AT the second Pan-Pacific Science Congress held in Australia in the summer of 1923, the invitation of the Japanese delegation to hold the third congress in Japan in 1926, under the auspices of the Japanese National Research, was accepted, and a preliminary announcement has recently been issued. The main objects of the Congress, like those of 1920 and 1923, will be the promotion both of co-operation in the study of scientific problems affecting the Pacific region and of the sense of brotherhood among the scientific workers of the countries concerned as a means of strengthening the bonds of peace among the Pacific nations. To these ends, the programme will consist largely of symposia upon selected subjects. Three discussions suggested provisionally for general sessions of the whole Congress deal with the physical and biological oceanography of the Pacific, radio-transmission in the Pacific region, and the geotectonics of the Pacific area, respectively. The provisional programme for the Division of Physical Sciences includes discussions, with special reference to the Pacific region, on solar activity, terrestrial magnetism, meteorology, the strand-line during Pleistocene and post-Pleistocene time, the correlation of Mesozoic formations, metallogenic epochs, volcanoes, and earthquake-proof constructions. The Division of Biological Sciences will probably discuss the floras and faunas of the various countries and islands of the Pacific and their relationships, plant successions and quarantines, the protection of aquatic animals, the genetics of live-stock and crops, particularly rice, the antiquity of man, and the diseases of native races. Other suggested discussions deal with astronomical observations, earthquake observations, geodesy, oil-bearing formations, thermal springs, storage of cereals, green manuring, diseases of animals, anthropometry, tropical diseases and food, drugs, clothing, and housing in the Pacific region. It is stated that the committee authorised at the Congress in 1923 to effect a permanent organisation of scientific institutions of the countries of the Pacific has been set up. It contains representatives of the countries of the region and of the European powers interested in the Pacific.

THE International Commission of Eugenics is a body originally nominated by the International Eugenic Congress with power to co-opt additional members. The International Congress of Eugenics meets every five years, and the Commission was intended to afford eugenists opportunities for the exchange of views and mutual consultation at more frequent intervals. The fourth meeting of the Commission was held in London in July: the third meeting having taken place last year at Milan. The London meeting was attended by representatives from the United States, France, Holland, Belgium, Italy, Denmark, and Norway. Two important resolutions were agreed to, the first moved by Dr. Davenport, the American representative, to the effect that, as every nation has a right to determine who shall be included in its body politic, so it is expedient that every immigrant-receiving country should inquire into the family and personal history of each would-be immigrant, and the second, also moved by Dr. Davenport, that the standard pedigree chart devised by Miss Van Herwerden should be printed and published by the Commission as the best and most practicable form of recording such histories. Dr. Collin, one of the Norwegian representatives, agreed to summarise the most recent theories as to the causes of the rise and fall of civilisations, and report on the subject to the next meeting of the Commission. Dr. Mjoen, the other Norwegian representative, delivered an interesting lecture on the inheritance of musical ability. He showed clearly that it was impossible to explain this inheritance as the results of the passing on and segregation of a Mendelian factor. He adopted the device of postulating the existence of numerous factors inherited separately; these factors were, however, arbitrarily chosen and ill-defined.

IN a report circulated by Science Service of Washington, D.C., which appears in *Science* for August 2, it is stated that a joint expedition of the Smithsonian Institution and Amherst College has discovered a crushed human skull associated with stone arrow-heads and the remains of mammoth and mastodon near the towns of Melbourne and Vero, Florida. Above the elephant stratum pottery was found among an accumulation of recent shells, and in the sands below, teeth of horse, camel, and sabre-toothed tiger, indicating a characteristic Pleistocene fauna. Dr. J. W. Gidley, leader of the expedition, is confident that the human remains were not buried in the mammoth strata. The inference drawn is that the mammoth and mastodon survived in this area of Florida for some 10,000 years after those of which the remains have been recently discovered in Indiana and are assigned to the late Pleistocene. The result of further investigation of the evidence will be awaited with interest, and should it confirm the conclusion here stated, the late survival of the mastodon may serve as a possible explanation of the association of human remains with bones of the mastodon at Natchez, which those who deny high antiquity to man in America have hitherto been constrained to explain as due to burial or fortuitous causes and as affording no evidence for contemporaneity.

As agreed at the conclusion of the World Power Conference held at the British Empire Exhibition, Wembley, last year, the International Executive Committee met in July last for the purpose of discussing the future activities of the movement. An invitation to hold the second World Power Conference at Basel in 1926, on the occasion of the Internal Exhibition for Inland Navigation and Utilisation of Hydraulic Power, was refused on the ground that a longer period than one or two years was desirable between plenary sessions of the Conference. Meanwhile, however, it was decided to hold sectional meetings in various areas, under the auspices of the International Committee, to discuss programmes on specific subjects within the general conference programme. An invitation was accordingly sent to the Swiss National Committee to hold a sectional meeting at Basel in 1926 for the discussion of the development of hydro-electric power combined with inland navigation, the interchange of electric power between countries, the economic relation between hydro- and thermal power, railway electrification and electricity in agriculture, stress being laid particularly on financial and economic aspects. The International Executive Committee further recommended, as a means of securing the continuity of the Conference movement, that a *Journal of the World Power Conference* should be published at regular intervals. It was decided, subject to reconsideration at a later meeting, that the second World Power Conference should be held at Rome in 1930.

In the *Lancet* of September 12 there is an important paper on the experimental treatment of implanted malignant tumours of the rat, by Dr. Thomas Lumsden, of the Lister Institute. A short time ago, Dr. Lumsden published the results of the action of an anti-serum which had been prepared by injecting rats or rabbits with emulsions of ground-up cancerous tumours of mice. When such a serum was brought into contact with cultures of cancer cells, the latter were injured or destroyed. Normal serum had no such effect, and the cancer serum had no effect on cultures of cells other than cancerous. Thus a fragment of heart culture could flourish and beat in anti-cancerous serum. Dr. Lumsden, in his new paper, has extended these results to the possible therapeutic action of such anti-sera. When rats were inoculated on the foot with a fragment of Jensen rat sarcoma—a highly malignant tumour—the resulting new growth could be made to disappear when the anti-serum was injected locally and prevented from diffusing itself through the body too quickly. Remarkable to say, the animal, after the cure of its tumour by serum, was found to be immune and could not be reinfected. When rats were inoculated on two of their feet, the resulting tumours both disappeared when the serum was injected locally into only one of the tumours. Further developments of this work will be awaited with interest.

The probable rainfall in India during August and September, based on the weather in India in June and July, associated with the weather conditions in other parts of the world which are most likely to influence the coming rains in India, was issued on August 7 to the Government of India by the Director-General of Observatories. In both June and July the monsoon was normal in activity; the rainfall for the two months over the plains as a whole was about 5 per cent. in excess of the normal. There was an excess of more than 50 per cent. in Orissa, the United Provinces west, and the Punjab east and north; of 20 to 50 per cent. in the United Provinces east, Baluchistan, Rajputana east, Central India east and the Central Provinces east; and a defect of 20 to 50 per cent. in Kashmir, Sind, Berar, Hyderabad north and Mysore. In the remaining subdivisions the total rainfall of the period was within 20 per cent. of the normal. It is summarised that there is no strong reason to expect any large excess or defect in the total rainfall of August and September, either in north-west India or in the Peninsula. The Bombay correspondent of the *Times* reports, however, under date September 19, that the monsoon, which until a fortnight ago was favourable everywhere, shows signs of failing, and that rain is badly needed in many districts in the south of India.

An adequate supply of pure distilled water is an indispensable requisite in all chemical and in most physical laboratories. If the consumption be very small and the degree of purity required be only "reasonable," the commodity can usually be purchased with impunity from the local druggist; but in all other cases it must be prepared in the laboratory. Common defects of the ordinary still are painfully slow rate of production, and "accidents" with the gas or water-supply. The patent automatic tin-lined stills supplied by Messrs. Brown and Son (Alembic Works), Ltd., of 9 Wedmore Street, London, N.19, as has been found from many years' experience, are free from these faults. The rate of distillation secured with this still is many times greater than that obtainable with any of the old-fashioned types, and the mechanical device, ensuring that the water-supply is turned on simultaneously with the gas-supply, makes the apparatus as fool-proof as possible; it does not, however, prevent minor mishaps due to fluctuating pressure in the gas and water mains. Such fluctuations are a source of great annoyance in many chemical and physical operations, and simple, cheap devices for counteracting them are badly needed. The new catalogue issued by Messrs.

Brown and Son contains illustrations and particulars of stills heated by gas, steam, or oil, together with information concerning their output per hour.

IN Bulletins 746 and 747, the United States Geological Survey has published a Bibliography and Index to the "Geologic Literature on North America, 1785–1918," compiled by John M. Nickles. These two volumes will be extraordinarily useful to geologists all over the world. The flood of geological literature is so great that it is always difficult to keep pace with it, and an important work of reference such as this is what the late Prof. Cole would have called a very real aid to practical geology. It should be noticed that the publications indexed refer to the whole of North America from the West Indies to the Arctic and to the Hawaiian Islands. In Part I. the names of authors are arranged in alphabetical order, papers being listed in chronological order in each case. About 45,000 titles are indexed in this way. Part II. is a subject index and contains about 70,000 headings.

THE officers of the Röntgen Society for the session 1925–26 are as follows :—*President*, Dr. F. W. Aston ; *Vice-Presidents*, Dr. Robert Knox, Mr. N. S. Finzi, Prof. A. W. Porter ; *Hon. Treasurer*, Mr. Geoffrey Pearce ; *Hon. Editor*, Dr. G. W. C. Kaye ; *Hon. Secretaries*, Dr. E. A. Owen, Mr. Russell J. Reynolds.

DR. WILLIAM C. REYNOLDS, referring to his letter in NATURE of September 12, p. 394, states that data regarding the troposphere and stratosphere provided in Dr. G. C. Simpson's presidential address to Section A (Mathematics and Physics) suggest that the optical, electrical, and thermal zones probably coincide—a simple and important geophysical condition. An aeroplane observer at sunrise and sunset should, therefore, have three separate methods of determining the limits of the lower zone. Such data regarding the thermal zones as Dr. Reynolds had when writing his earlier letter appeared to place the stratosphere higher up.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned : An assistant lecturer and demonstrator in engineering and an assistant lecturer and demonstrator in mining and mine-surveying at the University College of South Wales and Monmouthshire, Cardiff—The Registrar (October 3). A senior lecturer in pure mathematics in the University of Cape Town—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, London, W.C.2 (October 20). Junior technical assistants in the wireless experimental department of the Royal Aircraft Establishment—The Superintendent, R.A.E., South Farnborough, Hants (quoting A. 79).

Our Astronomical Column.

BROOKS' PERIODIC COMET.—A telegram from the International Astronomical Union Bureau, Copenhagen, announces the detection of this comet by Prof. Tcherny at Kief Observatory ; its position on Sept. 19 at $19^h\ 9{\cdot}5^m$ Universal Time being R.A. $23^h\ 17^m\ 36{\cdot}9^s$, S. Decl. $5°\ 12'\ 11''$. The magnitude was 9·5, considerably brighter than the predicted value, which was about 12 ; there is therefore a possibility that the comet is not identical with that of Brooks. The R.A. is $18^m\ 49^s$ in excess of Prof. Dubiago's prediction : the Decl. 15·3′ south of it. The predicted elements were :

$$\begin{aligned} T &= 1925 \text{ Nov. } 8{,}\ 5838 \text{ U.T.} \\ \omega &= 195°\ 48'\ 59{\cdot}4'' \\ \Omega &= 177\ \ 25\ \ 36{\cdot}5 \quad 1925{\cdot}0 \\ i &= 5\ \ 42\ \ 44{\cdot}6 \\ \phi &= 29\ \ 0\ \ 41{\cdot}0 \\ n &= 510{\cdot}9845'' \end{aligned}$$

The correction to T from the R.A. is $-5{\cdot}354$ days : that from the Decl. $+0{\cdot}942$ days. These are considerably discordant, and strengthen the suspicion of non-identity. If it is Brooks', the appropriate weights are 3 to R.A., 1 to Decl. ; weighted mean $-3{\cdot}78$ days.

The perturbations at the last aphelion passage were very large, the distance from Jupiter being less than 8 million miles. Curiously, Wolf's Comet made a similar approach at about the same time.

The following ephemeris for 0^h is found from that of Dubiago by applying $+18^m\ 49^s$ and $-15{\cdot}3'$:

	R.A.	S. Decl.
Sept. 26	$23^h\ 15^m\ 47^s$	6° 1′
,, 30	23 14 58	6 31
Oct. 4	23 14 34	6 57
,, 8	23 14 33	7 20
,, 12	23 15 0	7 40
,, 16	23 15 56	7 56

On Sept. 26 the comet is due south about 23^h. Its distance from the earth is 0·9 unit.

MARS.—Prof. W. H. Pickering observed Mars last year from Mandeville, Jamaica, and gives in *Popular Astronomy* for August-September an interesting summary of his own and other observations. He reproduces some early photographs of Mars taken on ordinary plates in 1888 and 1890. Some of these show the prominent markings obliterated by a whitish veil, like Mr. Wright's recent photographs on ordinary plates ; this corresponds (as both observers noted) to the fact that terrestrial photographs on ordinary plates fail to show distant objects plainly visible to the eye, while red-sensitive plates show them. Others of the old photographs show the dark markings plainly, indicating that the clearness of the Martian atmosphere is subject to large variations. Prof. Pickering agrees with Mr. Wright in concluding that the atmosphere is denser and more extensive than was recently thought probable. He argues in the same direction from the recent thermopile measurements, which indicated a temperature well above the freezing point. As the desert regions showed a lower temperature than the maria, he conjectures that they are more elevated. Assuming a temperature gradient similar to that on earth, he gives the mean elevation as 8000 feet.

There are detailed descriptions of some of the large clouds that appeared in the equatorial regions at the last apparition. One of these was 1200 miles by 500 miles, its rate of motion being 24 miles per hour.

In common with several other observers, Prof. Pickering looks on the presence of vegetation on Mars as practically assured, and presumes that this implies the presence of at least some forms of animal life. There has been a pendulum-like swing in views on Mars ; in the middle of the last century it was generally looked on as a miniature of the earth. Towards the end of the century the view of its non-habitability was widely held ; now we notice a tendency to revert to the earlier view.

Research Items.

A CHIBCHA TEMPLE IN COLOMBIA.—In 1924 an official Commission identified and investigated the site of the Chibcha Temple of Suamox, which was burnt in 1537 by the troops of Quesada, who had been attracted thither by reports of its riches. The Commission consisted of Gerardo Arrubla and General Carlos Cuerva Márques, the former of whom describes the results of these investigations in the English edition of *Inter-America* for August. By a careful examination of the chronicles and traditions and of trustworthy witnesses, and by exploration on the ground, the Commissioners were able to fix the site of this Temple of the Sun with certainty in the city of Sagamoso itself. Excavation confirmed the traditional account that it had been built of wood and had been destroyed by fire. Tradition also has it that the wood used had been carried from a great distance on the backs of the Indians. It was found that the wood of the temple columns does not grow in the valley or nearer than the plains. Each pillar was said to have been erected on the body of a sacrificed slave, and human remains with small objects of gold, stone, clay, and shell were actually discovered at the base. The temple was circular in form and had a diameter of 36 metres, a remarkable size considering the rudimentary architecture of the Chibcha.

THE ORIGIN AND DISTRIBUTION OF TREPANNING.—Dr. Wölfel of Vienna has made an exhaustive study of the practice of trepanning among primitive peoples, of which Part I. appears in Hefte 1-2, Bd. xx., of *Anthropos*. The operation was practised in prehistoric Europe and in North Africa; it persisted in Albania and Serbia and among the Berbers. It occurs in Melanesia and New Guinea, and a number of skulls have been found in America which show that it was employed by the inhabitants of the Mississippi Basin, in Mexico, and in the Andean region. In the present section of his work, Dr. Wölfel deals with Melanesia and New Guinea and America, and, after a comparative study, concludes that in these two areas it is an element in a common culture complex. In Melanesia and New Guinea its use is mainly surgical, especially for healing wounds caused by stone clubs or sling stones by removing fractured bone. It is also practised for epilepsy and headache, as a matter of fashion, and to secure longevity. It has also a magical implication. Essentially, however, it is to be connected with the use of the stone club and sling in war. Turning to America, the skulls which have been found, occurring even so far north as Lake Huron, show that trepanning was adopted as a method of dealing with a crushing blow, such as might be caused by a stone club or sling. Here also there is evidence of disease, and MacCurdy directs attention to traces of cauterisation. Although the existence of the sling in pre-Columbian America has been denied, there is sufficient evidence to call for the revision of this conclusion, *e.g.* in the Winland slingers of the Saga of Eric the Red, the Algonkin devil-head slings, among the Beothuk of Newfoundland, and so on. The existence and distribution of stone-headed clubs is also well attested. It is therefore to be concluded that trepanning is an element in a culture complex which was associated with the stone-headed club and coheres with the "two-class" system common to both the South Seas and America.

TEMPERATURES IN EUROPE DURING THE TERTIARY PERIOD.—A paper with the title "Der Einfluss der variabeln Erdbahnelemente auf das morphogene Wärmebild Europas im Tertiär" is published in the 1924 year-book of the Academy of Sciences, Vienna. The author, M. F. Kerner-Marilaun, read the paper before the mathematical-physics class, and he deals with the influence of variable elements in the earth's orbit on the temperature distribution in Europe in tertiary times. Von Spitaler's calculations of temperature in pure land and sea climates were used to establish regions with extreme temperatures in tertiary Europe. For winter temperatures, values calculated earlier by the author were employed, while special formulæ were developed to obtain the summer temperatures, and from these results the temperatures for the places of thermal extremes were found. By the variations of flora in horizontal and vertical directions, the regional and zonal fluctuations of temperature caused by astronomical variations can be traced. It is not always possible to trace the influence of each heat wave in an oceanic climate, because other influences may mask the changes to be examined.

THE ORIGIN OF CONTINENTS.—In *Die Naturwissenschaften* for July 31, Dr. Otto Ampferer of Vienna discusses in detail the various possibilities arising out of the distribution of the continents. He accepts Wegener's conception of the sial and sima layers, but believes that there are probably more than two layers of different density, and that in particular a third layer, intermediate between sial and sima, may underlie the continents. If vertical movements alone are postulated, then the oceans may be due to simple sinking, either by bending without fissures, or by in-breaking with bordering faults. This corresponds with the requirements of the contraction theory, but it is pointed out that expansion would lead to a similar result, the continents being then due to relative uplift. The existing evidence of both compression and tension in the earth's crust implies that both processes have contributed to some extent at least. However, the tectonic study of mountain ranges has proved beyond doubt that very large horizontal displacements have actually taken place, implying that extensive regions of the continents have been bodily moved. Vertical movements alone cannot explain these extraordinary thrusts, and Ampferer believes that, in addition, horizontal movements, independent of those arising from compression, must be postulated. He shows that Wegener's displacement theory involves the difficulty that it provides no possibility of explaining two absolutely opposed processes: the first, the compression of the original uniform shell of the earth into a primeval continent collected around Africa; and the second, the subsequent break-up and dispersal of the land area into the continents of to-day. Wegener suggests for the cause of the dispersal only relatively feeble external forces. Ampferer insists that some entirely different kind of phenomenon is necessary. He does not discuss the recent views of Joly, Holmes, or Evans, all of whom have contributed to a possible solution; but he favours the idea that under-streaming currents within the earth may be responsible. Ascending currents beneath the continents would raise and split them, and carry the fragments in all directions; whereas Wegener's forces would lead to a definite direction of drift.

RAINFALL IN AUSTRALIA.—The rain map of Australia for 1924, which is published by the Commonwealth, shows the distribution of precipitation for each month, and contains also a detailed map of the annual fall indicating excess and deficiency compared with the normal. The year was similar to 1923 in its marked rainfall contrasts. In the north-western part of the continent there were severe drought conditions, while on the other hand, in eastern Australia, including Tasmania, there was abundant rain, making the year one of the most favourable on record for pastoral and agricultural interests. Winter was comparatively dry, but in August widespread rainfall set in and continued for three or four months. In December the rains decreased, and harvesting conditions were ideal in most parts. Over the continent as a whole, 27 per cent. of the area had a rainfall above the annual average. This compares with 22 per cent. in 1923, 21 per cent. in 1922, and 63 per cent. in 1921. In 1924, however, the excess above the normal was almost entirely confined to the eastern part of the continent.

TERRESTRIAL MAGNETISM.—Several new propositions with regard to terrestrial magnetism are announced in the June issue of *Terrestrial Magnetism and Atmospheric Electricity*. The fact that magnetic storms increase in frequency with the sun-spot numbers has been known for some time, but Dr. A. Pödder, of the Irkutsk Observatory, shows from an examination of the records of that observatory for the past thirty years that storms are more frequent in March and in September than in any other months, and traces this to the passage of the earth in those months through the plane in which the centres of maximum activity of the sun are situated. He finds there is also a daily variation in the frequency of storms, which is independent in character of sun-spot number and of season. During each storm the deviation of the compass is reduced, the dip increased and the horizontal component of the magnetic field decreased. With regard to "sudden commencements," Dr. L. A. Bauer finds from an examination of the records of 30 disturbances that while there may be cases in which they occur simultaneously at all points, the speed of propagation may be so low as 1000 kilometres per second along parallels of latitude and only 100 kilometres per second from the magnetic equator towards each magnetic pole.

THE PHYSICAL NATURE OF THE CORONA.—The various theories as to the nature of the solar corona are discussed by Dr. W. Anderson in the *Zeitschrift für Physik* for Aug. 1. Taking into account the amount of light emitted by the corona, and the amount passing through it from the photosphere, he estimates that, if more than fifty per cent. of the gravitational force acting upon the material of the corona is to be balanced by the radiation pressure, the total mass within one solar radius of the sun's surface must be less than 10^{15} grams. The theory of C. Fabry, which ascribes the continuous spectrum of the corona to diffusion of solar light by gases as in Raleigh's theory of the spectrum of light from the sky, does not explain the absence of Fraunhofer lines in the coronal spectrum, and is in other ways unsatisfactory. The hypothesis that gaseous particles fluoresce under the influence of the light of the photosphere is rejected, since the spectrum appears to be truly continuous, with a few bright lines, and not to be due to the superposition of a number of banded spectra due to fluorescence of different gases. It is very improbable that the coronal light is due to bombardment with corpuscular radiation of radioactive origin. The difficulty with the electron gas theory of the corona is that it requires a positive charge on the sun equal to the negative charge of the corona, and that under these conditions the extension of the corona could only be small. This difficulty may possibly be got over by assuming that Coulomb's law of electrostatic force ceases to hold for large distances. It is possible to test the universe square law of gravitational force for large distances, but this is not possible in the case of electrostatic force, and it may perhaps fall off in such a way as to account for the structure of the corona.

SHEET GLASS PRODUCTION.—Prof. W. E. S. Turner describes the modern production of sheet glass in a paper published in the Journal of the Royal Society of Arts for July 24. For many years, until quite recently, glass used for sheet had the composition SiO_2 72-74 per cent., CaO 12-14 per cent., Na_2O 12-14 per cent., the latter being mainly derived from soda ash. In two of the automatic processes recently introduced, a softer glass has been employed containing a higher percentage of sodium oxide. The presence of magnesia retards devitrification and tends to make more uniform the rate of change of viscosity. In Lubbers' process, the glass is melted in a large tank and is removed in 560-570 lb. lots in an iron ladle. This is poured into a hot "drawing pot," really a shallow fireclay dish, and a "drawing head" is lowered in. On elevating the latter the glass is drawn up into a cylinder, which may attain a length of 36 ft. and is usually 30 in. in diameter. The cylinder is then split and flattened in the usual manner. Methods are now in use in which sheet glass is drawn directly without necessitating the formation of a cylinder. Two such processes are described. The Libbey-Owens process was inspired by the inventor watching a paper-making machine; molten glass is drawn from a trough over rollers on to a "flattening table," where it is annealed. In the Fourcault process, molten glass is drawn vertically upwards through a slot. The manufacture of plate glass dates from 1665 and the process has remained practically unchanged; the modified process used by Ford for manufacturing wind-screens for motor cars is described.

EXPLOSIVE GAS MIXTURES.—Papers 8, 9 and 10 of the Safety in Mines Research Board deal with the very important matter of the ignition of firedamp (H.M. Stationery Office, Nos. 8 and 9, 6*d*. each, No. 10, 4*d*.). The work embodied in the reports has been carried out by Dr. R. V. Wheeler and co-workers. Papers 8 and 9 are intimately connected. It is shown that the mixtures of methane and air most readily ignited by a sustained source of heat are those containing an excess of oxygen. Such mixtures require a source of heat at a lower temperature and, moreover, a shorter period of contact (provided, of course, the temperature is above the ignition point). With other paraffin hydrocarbons (*e.g.* ethane, propane, butane, pentane) the mixtures most readily ignited by a similar source of heat contain an excess of combustible gas. The ease of ignition of paraffin hydrocarbon-air mixtures increases as the hydrocarbon series is ascended; the lag on ignition decreases under similar circumstances. Report No. 10 deals with firedamp explosions within closed vessels and the effects of turbulence, the latter being studied in relation to the maximum pressures produced and the time taken to attain the maximum pressure. Whereas considerably enhanced pressures can be obtained from weak mixtures of methane and air when they are turbulent, the most explosive mixtures (9-10 per cent. methane) are not much affected even by extreme turbulence. The maximum pressure obtainable from any quiescent mixture of methane and air, initially at atmospheric pressure, when exploded in a closed vessel is about 105 to 110 lb. per square inch. The effect of turbulence is to increase this maximum pressure by about 4 per cent. On the other hand, with both weak and strong mixtures the effect of turbulence is greatly to increase the rapidity with which the maximum pressure is attained.

The Heating of Rooms.[1]

THE Fuel Research Board has published a useful paper on the heating of rooms by Mrs. Margaret Fishenden and Mr. R. E. Willgress. A room of about 4000 cub. ft. capacity, shaded from direct sunlight, and possessing a hearth and flue, was used. Air-heating was obtained by hot-water radiators or by luminous batswing gas flames placed about 6 inches above the floor. The air movement was then about ¼ to ½ ft. per second. After entering the test-room, the two observers engaged in sedentary employment for at least an hour before the comfort feelings were noted.

With no source of radiation, a comfortable feeling of warmth corresponded with a temperature of air and surrounding surfaces of 65° F. One of 62° F. was too chilly, and 68° F. slightly too warm. This is the range for minimal evaporation of a resting clothed man in still air. Increased evaporation begins at about 73° F., and 72° F. was the temperature at which distinct discomfort was felt.

When the walls and floor were slightly cooler than the air, the air to give comfortable warmth had to be warmer, *e.g.* 66° F. for walls, etc., at 63° F., and 67° F. for 61° F. On the other hand, with walls, etc., at 66° F., 67° F., air temperatures of 63° F., 61° F. sufficed. When the walls, etc., were more than a degree or two colder than the air, chilliness combined with stuffiness was felt, but with the walls a few degrees in excess of air temperature, very comfortable conditions were felt. With the flue blocked, a feeling ensued of heaviness, airlessness, and blunted mental energy. Even with the flue open, air-heating was found to be far from ideal for mental work. The authors concluded that a sunless room cannot be rendered entirely pleasant by air-heating alone. They found that variation of wet bulb temperatures from 51° F. to 57° F. for a dry bulb of 65° F. had no effect on the comfort feeling.

With air-heating and air-flows of 2, 4, 6, and 8 ft. per second over the entire position of the observer, dry bulb temperatures of 69°, 72°, 75°, and 76·5° F. were needed to sustain comfort. The corresponding mean wet bulb temperatures were 60°, 62°, 64·5°, and 66·5°. As was pointed out by the inventor, the ratio between the rate of cooling of the kata-thermometer and the rate of cooling of a clothed man increases as the air velocity increases, because clothing exercises an increasingly important shielding effect as the air velocity rises. Draught exceeding 4 ft. per second became annoying, and distracted the attention from mental work.

Ideal conditions conducive to mental work were got in a room with south-west aspect by an air temperature of 64° F. to 68° F. with October-November sunshine and open windows, and a draught of ½ to 1½ ft. per second.

Radiation was studied by means of a modern gas-fire, and by an open wire electric heater placed under the chimney flue. Additional draught could be produced by a gas-ring in the flue; thus 2½ to 4½ changes of air per hour could be had. The air temperature was brought to the desired level, and the subject sat at various distances from the fire. While warm enough at an air temperature of 65° F. without radiation, at 60° F. a mean horizontal component of 30 B.Th.U. per sq. ft. per hour was required to produce warmth, at 55° F., 75 units, at 50° F. 120 units, at 45° F. 170 units. Radiation figures well below or above these gave chilliness or warmth.

The most comfortable conditions were with 55° F. and adequate radiation; above this a slight feeling of mental lassitude was produced, and below it a feeling of too warm on one side, too chilly on the other. Below 45° F. it was impracticable by a fire to avoid this feeling. The alpine sun may, however, give one in a reclining position 500 B.Th.U. per sq. ft. per second—enough for an air temperature far below freezing point. It is the equable climate of Britain which makes open fires practicable. In countries where the outside temperature remains for months below freezing point, air must be heated, and a closed stove or central heating is used. A low temperature radiator heated by bunsen burners below red heat and 6 ft. square in size was found very pleasant. This is equivalent to wall panel heating, which has been found successful in the Bush building at Aldwych, London.

Two cylinders of water 8 inches in diameter and one-third the height of an average man were used, one of bright polished copper, the other coated with lamp black, and the effect of clothing on the loss of heat from these cylinders was studied. The water was kept stirred. In still air, a single woollen vest reduced the heat loss to 66 per cent. of the unclothed black body, with an additional white serge garment to 45·5 per cent., with further black serge coat to 38·5 per cent. In a draught of 2 ft. per second the reductions were to 60, 42, and 36 per cent., and in one of 6 ft. per second to 48·5, 32, and 25·5 per cent. respectively. The three garments together cut down the absorption of radiation to 20 per cent. of that which was absorbed by the unclothed black calorimeter.

The last part of the paper deals with the cost of heating. The hot-water radiator with coke boiler is most economical for continuous heating of a small room (1000 cu. ft.), or for a larger room (4000 cu. ft.) where people cannot gather round a fire. An open fire is cheapest for the larger room when occupied by a few people who can gather near it, because air-heating is not then necessary. For intermittent heating, the hot-water radiator is cheapest for a small room, and open coal, coke, or gas fire for a larger room. "Whatever the method adopted, the cost will be closely allied with the completeness of insulation of the rooms." An air space between two thicknesses of brick and double windows are two suggestions made.

Here we come up against that conflict between stagnant artificial heat and good health which is not considered by the authors, but is established both by physiological research and the experience of open-air life. We should aim at the least degree of heating with which we can do sedentary brain-work or skilled hand-work in comfort, and the maximal amount of window ventilation. If clothes were adjusted to individual need in offices and factories, and the feet kept warm by small local units of heat, far less air-heating would be necessary, and far more window ventilation made possible, and in this way, and by abolishing smoke pollution and securing more sunlight, catarrhal infections would be reduced. It is the open-air life, and not sheltering indoors in heated rooms, that keeps catarrhal diseases off and the general health up.

L. H.

[1] Department of Scientific and Industrial Research: Fuel Research Board. Technical Paper No. 12: The Heating of Rooms; a Comparison of the Costs of different Methods on the Basis of Warmth Comfort. By Dr. Margaret Fishenden, assisted by R. E. Willgress. Pp. iv+48+6 plates. (London: H.M. Stationery Office, 1925.) 1s. net.

Thunderstorms and Other Features of the Weather.

Mr. Brooks has compiled a very valuable monograph on the thunderstorms of the world.[1] A "day with thunder" is the unit employed, and records are used from 3265 stations, 2680 being in Europe. Maps show the percentage of days with thunder for the whole year, and for each half-year. It is assumed that thunder can only be heard up to ten or twelve miles, and that on the average it will only be recorded when occurring within six miles of any station. Mr. Brooks shares the general opinion that thunder is not heard farther than about twelve miles, but this distance may frequently be doubled at night, and sometimes tripled.

The maps show six areas of maximum frequency of thunder, Madagascar, Central Brazil, Panama, Southern Mexico, Central Africa, and Java, in which island thunder occurs on 61 per cent. of all days. Areas with thunder on less than 1 per cent. of all days are Greenland, north Iceland, north Norway, the north coast of North America, the Arctic Ocean, and the Antarctic Continent. There are areas of low frequency on the west coasts of North and of South America, and on the west coasts of South and North Africa; the latter area extends across the Sahara into Arabia, the other three do not extend far inland, but all of them go a long way out into the ocean. All these regions are on the east side of anticyclonic areas in positions where winds from a polar direction keep the surface temperature cool; they are also in regions of cool ocean currents, and, though Mr. Brooks does not actually point it out, these may have something to do with the low thunderstorm frequency; the Peru, the Benguela, the California, the Canaries, and the Labrador currents are all reflected in the isobronts; even the small cool current down the Korean coast shows its effect.

A very interesting map is given showing what percentage of thunder occurs in winter in western Europe; the 30 per cent. line extends down the Norwegian coast, embraces practically the whole of the British Isles, and crosses Brittany and the north-west coast of Spain; eastward the percentage decreases, but north-westward it increases to 75 per cent. for the region of Iceland and the Faröes. Another map illustrates the distribution of thunder over central Europe in July, and shows that the "chief maximum of thunderstorm frequency in Europe extends in a long narrow belt at the base of the northern slopes of the Alps."

It is estimated that over the whole globe 16,000,000 thunderstorms occur per annum; if the average duration is one hour, there are 1800 storms occurring at any one time; if there are approximately 200 flashes per hour in a severe temperate, or an average tropical storm, there will be 100 flashes per second over the globe. The number thus estimated by Mr. Brooks is of the same order as the frequency of atmospherics, which may all, therefore, be possibly due to lightning. In further sections are discussed the variation of thunder with season and with latitude over both land and sea, the diurnal variation and the effect of height on thunder frequency.

Mr. Brooks's work is a most important addition to the literature of the subject, and is one that no meteorologist can afford to be without; it will also be of value to those who take an interest in thunderstorms without being themselves meteorologists.

Dr. Sen[2] has collected the records on wind components that have been published in the *Geophysical Journal*, and his paper is illustrated by tables and diagrams. The south-north and west-east components of the wind are discussed in relation to the annual and diurnal variation; maps show the averages of the gradient, the gradient wind, and the resultant wind for each month; and the growth of convection winds in summer—land and sea breezes—is investigated.

The scope of Mr. E. V. Newnham's work[3] is best explained by the opening paragraph: "The object of this classification is to provide a ready means for discovering whether the conditions prevailing over the North Atlantic and Europe at any time bear any resemblance to situations that have arisen in the past at about the same time of the year, and, further, to bring into evidence any distributions of pressure which tend to recur and may be regarded as genuine types, and to determine the seasonal variations of such types." The position of anticyclones is the basis of the classification; the region between latitudes 30° N. and 80° N., and longitudes 30° E. and 70° W., has been divided into ten areas to each of which a letter has been assigned; the position of anticyclones is shown by the capital letters of the areas over which they occur, while the position of depressions is shown by small letters.

The work must have involved an immense amount of labour; Table III. gives each of the 5478 days of the period concerned with the pressure distribution found on each, while Table IV. gives an index of the pressure distributions with the dates on which each occurred. It will prove of great assistance to those who are interested in investigating types of weather and changes in types; the summaries are in an extremely convenient form for reference.

C. J. P. C.

[1] Air Ministry: Meteorological Office. Geophysical Memoirs, No. 24: The Distribution of Thunderstorms over the Globe. By C. E. P. Brooks. (M.O. 254d.) Pp. 145-164+4 plates. (London: H.M. Stationery Office, 1925.) 2s. net.

[2] Air Ministry: Meteorological Office. Geophysical Memoirs, No. 25: Surface and Geostrophic Wind Components at Deerness, Holyhead, Great Yarmouth and Scilly. By Dr. Sachindra Nath Sen. (M.O. 254e.) Pp. 165-178+6 plates. (London: H.M. Stationery Office, 1925.) 2s. net.

[3] Air Ministry: Meteorological Office. Geophysical Memoirs, No. 26: Classification of Synoptic Charts for the North Atlantic for 1896–1910. By E. V. Newnham. (M.O. 254f.) Pp. 179-200+1 plate. (London: H.M. Stationery Office, 1925.) 6s. net.

The International Psycho-Analytical Congress.

(From a Correspondent.)

The ninth international Psycho-Analytical Congress which assembled on September 3-5 at Bad Homburg, Germany, was marked by some interesting features. Unlike its predecessor which met at Salzburg at Easter 1924, under the shadow of Prof. Freud's serious illness, the ninth congress was very happily able to begin its business by sending Prof. Freud a congratulatory telegram on his restoration to health.

As at the last three congresses, dating from 1920, the year which saw the first re-assembly since the pre-War period, many nations were represented, and by many distinguished names. In his presidential address, Dr. Karl Abraham, Director of the Berlin Psycho-Analytical Clinic, welcomed representatives, who with relatives and visitors numbered about two hundred, from Austria, France, Germany, Great Britain, Holland, Hungary, India, Poland, Switzerland, Russia, and the United States. Dr. Abraham expressed particular satisfaction at the presence of his American colleagues, who included such well-known workers as Dr. Jelliffe and Dr. Pierce Clark of New York, Dr. Trigant Burrow of Baltimore, and Dr. Isidor Coriat of Boston. The attendance of representatives from France was another sign of the acceptance of Freud's views in countries which have hitherto stood aside.

The most important features to be noted in the movement are the developments of psycho-analytical theory and practice; the increase in the number of constituent societies, and in the membership of these societies; the continuous research work and the increased publication of results; the large amount of clinical work carried on, and the greater general attention given, even if at times in the form of opposition, to Freud's discoveries. The work of the Berlin and Vienna Polyclinics clearly evidences the need for, and appreciation of, psycho-analytic treatment, and it is much to be hoped that before long every country will establish similar clinics, especially so great and important a country as England, which is still, strange to say, without a solitary clinic for this treatment. The valuable help which can be obtained by those sufferers who have found no solution for their difficulties through existing methods of treatment will then be more widely appreciated.

The contributions to the Congress were divided into four sections: theoretical questions, therapeutical questions, clinical matters, and applied psycho-analysis—an arrangement which made for clearness and simplification. Perhaps the sections of the greatest interest, at least to the Congress as a whole, were the two dealing respectively with therapeutical questions and applied psycho-analysis. In the first section, Prof. Freud's paper, a very technical one, on "The Bearing of the Anatomical Differences in Male and Female on the Oedipus Situation," was read by his daughter, Fräulein Anna Freud, who is herself a brilliant children's analyst, practising in Vienna.

Great interest was shown in the paper given by Dr. Ferenczi (Budapest Psycho-Analytical Society), one of the most widely known Continental analysts, on "Counter-indications to Active Psycho-Analytic Technique," in which he dealt with the theme of "active therapy" once more. This subject, which was put forward by him at the Salzburg Congress and created a somewhat sensational effect as a seeming sharp departure from the Freudian technique in treatment, was now dealt with by Dr. Ferenczi for the purpose of pointing out certain misconceptions which had arisen. It was important, he said, to realise that he did not suggest the employment of this "active" technique for all cases under treatment or as the sole method in any individual case, or with rigorous application, but only as *one* method at given times and at an appropriate stage. In respect to his "terminal limit" for the patient's treatment and the complete severance between patient and analyst when such a limit had been reached, a view also put before the Salzburg Congress, Dr. Ferenczi explained that he no longer wished to adhere strictly to such practices, but rather to make use of them only in exceptional situations. It may be said that the general tenor of the paper was in the direction of more elasticity, more modification of previous stringent views, although without any abandonment of basic Freudian principles.

Much the same attitude was expressed in the paper given, in the same section, by Dr. Otto Rank (Vienna Psycho-Analytical Society) on the birth theory formulated by him at the Salzburg Congress, and embodied in his book, "The Trauma of Birth." He made something of an apologia for his too definite pronouncement of a year ago, making it plain that he no longer regarded the birth-situation (the first great trauma) as the only significant one in the shaping of the individual's destiny, but as playing a vitally important rôle in the whole psychic drama. In this same section, two more papers of interest were Dr. Alexander's (Berlin Psycho-Analytical Society) on "Neurose und Gesämtpersonlichkeit," and Dr. Pierce Clark's (New York Psycho-Analytical Society) on "The Phantasy Method of analysing Narcissistic Neuroses."

In the fourth section, dealing with applied psycho-analysis, a brilliant paper evidencing deep research, was read by Dr. Géza Róheim (Budapest Psycho-Analytical Society), the well-known Hungarian anthropologist, who, it is interesting to recall, will read a paper before the Royal Anthropological Institute in London next month. Dr. Róheim took for his subject "The Scapegoat," and expounded the origin and significance of the idea of the sin-offering and expurgation among ancient and primitive peoples. Dr. Theodore Reik (Vienna Psycho-Analytical Society) gave a paper on "The Origin of Psychology," in which he dealt in a masterly manner with the problem of (to give a free translation of the German title) "How do Human Beings come to bother about Psychology?"

Dr. M. D. Eder (British Psycho-Analytical Society) gave a paper on a hitherto little-investigated subject, "A Contribution to the Psychology of Snobbishness," claiming it as appropriate that this theme should be dealt with by a speaker from England, since that country was the classic home of snobbery. He worked out in a very interesting manner the sources and significance of snobbishness, illustrated from actual analytical cases and from the rich material in English literature, especially the work of Thackeray ("The Book of Snobs," "Pendennis"), of Meredith ("Evan Harrington"), and of Thomas Hardy ("A Pair of Blue Eyes").

At the business meeting which concluded the Congress, after re-electing to another term of office the president, Dr. Karl Abraham, and the secretary, Dr. Max Eitingon, to both of whom the Congress expressed sincere gratitude for their past work, an important decision was taken. This was to form an International Commission, constituted from Committees formed in all the individual branch societies, to draw up regulations acceptable to all countries represented in the Association for the admission of practising analysts. For some time past it has been felt that the qualifications demanded from practising analysts differ too widely according to the country concerned and even the individual psycho-analytical society. In some cases the regulations are exceedingly strict, making for assured scientific equipment; in other cases, however, the qualifications demanded are too slight to ensure any genuine knowledge or experience on the part of the so-called analyst, or even that he has subjected himself to a real analysis. It is hoped that the new Commission will be able to frame regulations sufficiently acceptable to create uniformity of qualification, which shall be such as to ensure a high standard in respect of knowledge, training, and personal suitability for psycho-analytic practice.

The business proceedings ended with a debate on the meeting-place for the next Congress. The final choice lay between Italy and England, an invitation to the latter being extended by Dr. Ernest Jones, president of the British Psycho-Analytical Society, and predecessor of Dr. Abraham as president of the International Association. The question of distance was of importance to the Continental members, and ultimately, by a very small majority, Italy was selected.

In conclusion it is interesting to note that the characteristic feature of this Congress, one that sharply differentiated it from its predecessor, was the absence of dogmatic pronouncement and rigid conception; rather there was an apparent desire to discover how new, or partially new, theories could be adjusted to already established facts, and a spirit of modification and adaptation on the part of those who earlier had put forward ideas of a somewhat disruptive nature. This attitude, with the important decision already referred to in the direction of uniformity and increased efficiency in psycho-analytic practice, augurs hopefully for future developments in psycho-analysis, both in research and practical therapeutic work.

The Royal Photographic Society's Exhibition.

THE annual exhibition of the Royal Photographic Society at 35 Russell Square, London, W.C.1, remains open until October 24, and admission is free. The scientific and technical sections are numerous, and each contains exhibits of notable interest. The Astronomer-Royal shows "Prism-crossed Grating" spectra of Vega compared with spectra of the carbon arc and a ½-watt electric lamp. The comparison of these spectra gives data from which the temperature of the star may be calculated from the known temperatures of the artificial illuminants. Star spectra enlarged 7·6 times horizontally and broadened 19·5 times by means of a clepsydra apparatus invented by the exhibitor are contributed by Dr. W. J. S. Lockyer. Among the aerial photographs are several fine examples by the Royal Aircraft Establishment, and the application of this method of work to archæological research is well illustrated by Messrs. O. G. S. Crawford and A. Keiller, one of whose examples reveals an ancient village site seen through the crops, in Hampshire.

The natural history section is a very large one, and those of the ordinary kind are only mentioned as a group because there is such a great variety of good work. But Mr. Oliver G. Pike has endeavoured, with success, to show the action of the wings of birds during certain phases of flight. Presumably these photographs are enlargements from his slow motion cinematograph films shown elsewhere. Among the specimens of cinematograph films are some from the Eastman Kodak Research Laboratory which illustrate some possibilities in the use of colour and form in motion as a means of entertainment and to produce pleasurable sensations by an appeal to the visual sense similar to those produced by music. The kodachrome two-colour subtractive process is used in the production of these films.

The photomicrographs are many and chiefly low power work. Dr. G. H. Rodman illustrates the structure of the petiole of the water hyacinth, an aquatic floating plant of tropical America. In another series of 24 sections he shows the character of the idioblasts which occur in various water lilies. Mr. F. Martin Duncan contributes further studies on the cuticular scales of mammalian hairs, which confirm his theory of the importance of their specific characters in the phylogenetic study of mammals. Photomicrographs of several alloys, chiefly alloys of copper, and illustrating flaws and changes produced by various treatments, are contributed by Capt. J. W. Bampfylde. Micro-radiography as applied to geology and palæontology is illustrated by 24 examples by Pierre Goby, who also has four stereo-micro-radiographic pairs showing stereoscopic relief and pseudo-relief. Of natural size radiographs there are many examples.

Among the other examples of the application of photography to scientific investigations may be mentioned shutter test diagrams with full explanations from the optic division of the National Physical Laboratory, and Prof. Coker's natural colour transparencies which show the nature of stress under various conditions in models of buildings. The transmission of photographs over telephone wires for practically any distance and in a few minutes is illustrated by the International Western Electric Co., which shows transmitted photographic portraits, landscapes, views of buildings, letterpress, a finger-print, writing, charts, and a coloured photograph. The perfection of the reproductions is remarkable. Mr. Thorne Baker has an example of a picture transmitted by wireless telegraphy. The British Photographic Research Association shows the effect that fuming with ammonia has upon the character of the grain of silver bromide gelatine plates. The selenium density meter designed by members of this Association is shown by Watson and Sons, and in the rather large trade section Chance Brothers show optical glass from its manufacture to the finished lens, and specimens which illustrate the effects of tests for durability, of devitrification, and of the improvements in the quality of dense barium crowns in the years 1915, 1917, 1924, and this year. In the last the colour is practically eliminated and bubbles are scarcely visible.

Oyster Dredging in the Fal Estuary.[1]

DR. J. H. ORTON, of the Marine Biological Association, presents a useful report on the oyster fisheries of the Fal Estuary, which are managed by the Truro and Falmouth Corporations, being owned by the Duchy of Cornwall. Each dredgerman takes out a licence and is entitled to dredge oysters more than 2½ inches in diameter during the winter months. The proceeds formerly were largely used up in lawsuits, but we judge that they now mainly pay the wages of bailiffs, whose business it is to see that the size regulation is observed. There would seem to be no cultivation of the oysters, no cleaning of the grounds, no laying of suitable hard material on which the spat can settle (cultch), nothing indeed beyond the relaying of already marketable oysters in private or leased intertidal waters until there are suitable market conditions.

The spat falls in the three years 1922–24 were failures, and, as oysters are usually caught for market in their fourth and fifth years, the fishery is bound to be too lean for most of the 200-300 dredgermen to obtain a livelihood in 1926–29, even if the present year should see a good spat fall. Dr. Orton does not deal with the causes of the bad spat fall, and it is not clear whether there was an insufficiency of oyster larvæ, or whether the ground was so muddy that they could not survive when they settled on the bottom.

[1] Summary of a Report on a Survey of the Oyster Beds in the Fal Estuary in November 1924, with Notes on the Biology of the Oyster. By Dr. J. H. Orton. (Published for the Falmouth and Truro Corporations.)

We suspect the latter, as so much stress is laid on cultching as compared with the establishment of proper spawning stocks. Further, the small, mis-shapen, nut-like, rounded oysters, forming 45 per cent. of the stock, are characteristic of dirty ground.

The total stock on the grounds is estimated at about 8 millions, sufficient, if the "nuts" be deducted, to give a catch of upwards of a million a year, while in the last century the average catch was many times as much. Of course, the raising of the catchable size and all sorts of restrictions in the fishing are suggested, but it is questionable, if Dr. Orton's facts be accepted, whether these could do more than keep a limited number of dredgermen on the grounds while administrative authorities are seeing whether they will do anything.

Dr. Orton's summary does not tell us the exact condition of the Estuary to-day, but in 1915 the shores and main channel were filthy with mud, detritus, weed, etc., and the real question then seemed to us to be whether money could be found to harrow and cultch selected areas and afterwards to keep them in good order. A careful study of the alterations in land drainage, in mine workings, etc., of the watershed of the Estuary during the last century should show whether this is worth doing at all, and, if it be done, all regulations should be re-examined so that the fishermen should act as their own bailiffs for the new regulations, while their licence fees or royalties would be available for the upkeep of the whole grounds. We feel that it would be best for the two Corporations concerned either to return the fisheries to their owner, or to place themselves in the hands of Dr. Orton, or some other competent person, and carry out his behests.

J. S. G.

University and Educational Intelligence.

ST. ANDREWS.—Dr. David Rutherford Dow has been appointed to succeed Principal Mackay in the chair of anatomy in University College, Dundee. Since 1913 Prof. Dow has been lecturer in regional anatomy at the United College and assistant successively to Prof. Musgrove and Prof. Waterston, the Bute professors of anatomy there. His research work in anatomy has resulted in several papers published in the *British Medical Journal* and the *Journal of Anatomy*.

THE East Anglian Institute of Agriculture, Chelmsford, gives details in its Calendar for 1925–26 of some eighty courses which it offers in its departments of agriculture, agricultural biology, agricultural chemistry, dairy technology, horticulture, and poultry and small live stock. It undertakes to prepare students not only for its own certificates and diplomas and those of the Royal Agricultural and Royal Horticultural Societies and the British Dairy Farmers' Association, but also, in conjunction with University College, London, Bedford College for Women, East London College, and Chelsea Polytechnic, for the degrees in agriculture and horticulture of the University of London. The Institute specialises in animal husbandry, and farm economics, dominion agriculture, dairying, and commercial horticulture. It conducts a school gardening class on Saturdays for teachers. The North of Scotland College of Agriculture offers courses for the university degree in agriculture, the national diplomas in agriculture and dairying, a college diploma in poultry-keeping, and a special farmers' course in the winter. A joint committee of the College and the University of Aberdeen controls the Rowett Institute for Research in Animal Nutrition.

Societies and Academies.

WASHINGTON, D.C.

National Academy of Sciences (Proc. Vol. 11, No. 8, August).—Edwin B. **Wilson**: The logistic or autocatalytic grid. Arithmetic and logarithmic probability paper, on which the integrals of certain curves become straight lines, is of value in problems in chemistry, biology, economy and other subjects.—Nelson W. **Taylor** and Gilbert N. **Lewis**: The paramagnetism of "odd molecules." Evidence of paramagnetism was obtained for chlorine dioxide (in carbon tetrachloride), the free organic radicle α-naphthyl diphenylmethyl (in benzene) and in solutions of sodium in liquid ammonia and of thallium in mercury. In the latter solutions an electron is given up by the dissolved metal to the solvent, thus forming a molecule (the solvent) containing an unpaired electron.—Allan C. G. **Mitchell**: The activation of hydrogen by excited mercury atoms. The rate of reaction of mixtures of hydrogen and oxygen in the presence of mercury and exposed to light from a mercury lamp was measured and the effect of addition of argon determined. As the pressure of argon is increased, the reaction-rate decreases.—Selman A. **Waksman**: What is humus? 60-70 per cent. of the organic matter in the soil, including the "humic acids," is soluble in alkalies and precipitated by acids. This portion can be divided into α- and β-fractions which are insoluble and soluble respectively in dilute acids. The α-fraction (or "humic acid") gives the soil its black colour and is derived from lignins and the cells of soil micro-organisms. The β-fraction provides the buffering properties to soils. Peat soils contain largely the α-fraction, while mineral soils contain the β-fraction in addition and often predominating.—R. L. **Moore**: Concerning the separation of point sets by curves.—Selman A. **Waksman**: The soil population. Soil organisms form a biological complex and should be studied as such.—Ludvig **Hektoen** and Kamil **Schulhof**: The precipitin reaction of thyroglobulin.—J. B. **Collip**: The internal secretion of the parathyroid glands. The secretion can be obtained in a stable form and in a degree of purity and potency hitherto not available. The method used is the dissolution of gland by controlled acid hydrolysis and isoelectric fractionation. The hormone obtained is specific for parathyroid tetany in dogs; its effect is related in the main to calcium metabolism and it causes mobilisation of calcium in the blood.—Samuel K. **Allison** and William **Duane**. An experimental determination of the critical excitation frequency for the production of fluorescent X-radiation. It would appear that to produce a fluorescent line spectrum, the primary radiation must contain X-rays of frequency at least as great as that of the corresponding critical absorption.—William **Duane**: The calculation of the X-ray diffracting power at points in a crystal. To calculate the density of the diffracting power (or density of electron distribution) from the measured intensities of diffracted beams, certain fundamental assumptions relating to the symmetry of the crystal must be made.—Carl **Barus**: The effect of commutation of impedances on the acoustic pressure produced by paired telephonic systems.—R. T. **Cox** and J. C. **Hubbard**: A statistical quantum theory of regular reflection and refraction. Large aggregates of quanta are dealt with, and it is assumed that the media traversed by these quanta are continuous, that the quanta travel with the velocity of light and suffer a change of velocity but not of energy on passing from one medium to another.—R. J. **Havighurst**: (1) The distribution of diffracting power in sodium chloride. The density of electron distribution indicates that along the cube edge and body diagonal there is an alternation of two kinds of atoms; along the face diagonal, all are alike. (2) The distribution of diffracting power in certain crystals. Potassium and ammonium iodide have the sodium chloride structure; ammonium chloride has the body-centred cæsium chloride structure. The "electron density" of diamond cannot yet be determined.—A. Keith **Brewer**: Ionisation produced in gaseous reactions. Ethyl alcohol and oxygen are allowed to react, at temperatures below that of ignition, between gold, aluminium, copper, and glass electrodes. It is concluded that ions are formed in the gas layer in immediate contact with the electrode and that positive and negative ions are formed in equal numbers.—G. F. **Rouse** and G. W. **Giddings**: Ionisation of mercury vapour by ultra-violet light. When mercury vapour between two plane parallel electrodes is illuminated by light from a hot mercury arc, the ratio of the currents to the two electrodes is approximately that of the areas of the electrodes, indicating photo-electric action. With a water-cooled mercury arc and increased mercury vapour pressure, the currents observed are much greater and their ratio practically unity, indicating true ionisation. No single wave-length of sufficient energy to do this appears to be present, so a cumulative action must occur.—O. K. **De Foe** and G. E. M. **Jauncey**: Modified and unmodified scattering coefficients of X-rays in matter. Taking into consideration Compton's change of wave-length with scattering, the ratio of the scattering coefficient of the modified to the unmodified rays is calculated. Experimental results using copper are in fair accord with the calculation.—G. E. M. **Jauncey** and O. K. **De Foe**: The energy reappearing as characteristic X-rays when X-rays are absorbed in copper. The methods developed in the previous paper are used, and it is found that the greater part of the energy absorbed goes into the photo-electric ejection of K-electrons.

SYDNEY.

Royal Society of New South Wales, August 5.—G. **Taylor**, W. R. **Browne**, and F. **Jardine**: The Kosciusko Plateau, a topographic reconnaissance. The area investigated extends from "The Creel" at 3000 feet elevation in the east, to Kosciusko (7300 feet) in the west, a distance of 20 miles. As a result approximate contours (form-lines) of 100 feet interval were obtained, and these have been drafted on a map to the scale of half-mile to the inch. Aneroid and Abney-level observations were relied upon for heights. These were supplemented by sketches and photographs which were carefully orientated and annotated.—A. R. **Penfold** and J. L. **Simonsen**: The essential oils from the leaves of *Murraya Koenigii* (Spreng), *Murraya exotica* (Linn.), and *Murraya exotica*, var. *ovatifoliolata* (Englor).—J. H. **Maiden** and W. F. **Blakely**: Descriptions of sixteen new species of Eucalyptus. Six are eastern species (including one from South Australia) and ten from Western Australia. Two are suggested hybrids, while one has already been described as a variety. Of the eastern species, three are from Queensland, a pale-wooded bloodwood, a northern box and a glaucous ironbark, also from the north. Of the two suggested hybrids, the South Australian one comes nearest to *viminalis*, while one from the Federal Territory is a rough-barked species nearest to *maculosa*. The western species include five mallees, and two fairly large trees, the "Stocking tree" of Kondinin, so called because of its rough bark, sharply defined from a smooth trunk, and the Albany blackbutt, raised to specific rank.

Official Publications Received.

Department of the Interior: United States Geological Survey. Bulletin 757: Geology and Coal Resources of the Axial and Monument Butte Quadrangles, Moffat County, Colorado. By E. T. Hancock. Pp. vi+134+6 plates. 35 cents. Bulletin 772: A Reconnaissance of the Point Barrow Region, Alaska. By Sidney Paige, W. T. Foran and James Gilluly. Pp. v+32+9 plates. 20 cents. (Washington: Government Printing Office.)

The Royal Technical College, Glasgow. Calendar for the One Hundred and Thirtieth Session, 1925-1926. Pp. xxix+403. (Glasgow.)

The Stratigraphy of the Mississippian Formations of Iowa. By Francis M. Van Tuyl. (From Iowa Geological Survey, Vol. 30, Annual Reports 1921 and 1922.) Pp. 33-374+6 plates. (Des Moines: Iowa Geological Survey.)

Transactions of the Royal Society of Edinburgh. Vol. 53, Part 3, No. 33: Perthshire Tectonics; Loch Tummel, Blair Atholl and Glen Shee. By E. B. Bailey. Pp. 671-698+1 map. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.) 4s.

Proceedings of the Royal Society of Edinburgh, Session 1924-1925. Vol. 45, Part 3, No. 23: On the Cardinal Function of Interpolation-Theory. By W. L. Ferrar. Pp. 269-282. 1s. 6d. Vol. 45, Part 3, No. 24: The Electrosynthesis of *n*-Duotriacontane Dicarboxylic Acid. By Dr. David A. Fairweather. Pp. 283-285. 6d. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.)

Diary of Societies.

SUNDAY, SEPTEMBER 27.

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX (Conference at Balliol College, Oxford), at 9.30 A.M.—B. N. Langdon Davies: The Publisher and Research Libraries.—At 8.30 P.M.—H. E. Potts: Patents and Special Libraries.—H. J. Jeffery: The Imperial Institute: its Work and the Methods adopted in the Library to meet its Special Needs.—Miss A. L. Lawrence, A. J. Mundella, Percy Alden: A Sociological Library.—Miss Clayton, Brig.-Gen. Sir Magnus Mowat, Major W. E. Simnett: Transport Intelligence and Publicity.—Sinclair Wood: Research as the Basis of Advertising.

TUESDAY, SEPTEMBER 29.

ROYAL PHOTOGRAPHIC SOCIETY, at 7.—Sir Nevile Wilkinson: Decoration in Heraldry.

THURSDAY, OCTOBER 1.

FARADAY SOCIETY (at Oxford).—Discussion: Photochemical Reactions in Liquids and Gases.—At 3.30-5 and 5.30-7.30.—Part I. Einstein's Law of Photochemical Equivalence.—Prof. A. J. Allmand: Introductory Paper.—Prof. F. Weigert and Dr. L. Brodman: The Verification of the Einstein Photochemical Equivalent Law in a very Simple Photosensitive Liquid System.—Prof. Chr. Winther: The Relation between Quantum Sensitivity and Intensity of Radiation.—Prof. J. Rice: Note on the Radiation Theory of Chemical Reactions.—Prof. L. S. Ornstein: Note on the Influence of Radiation on Chemical Reactions.—Prof. D. Berthelot: The Law of Photochemical Equivalents and the Place of the Quantum Theory in Relation to Atomic Theory and Energetics.—Prof. P. Lasareff: Relations between the Velocity of Photochemical Reactions and Wave Length.—Prof. O. Stern: On the Transformation of Atoms in Radiation.—General Discussion.

CHILD-STUDY SOCIETY, at 6.—William Platt: The Child's Innate Feeling for Music.

FRIDAY, OCTOBER 2.

FARADAY SOCIETY (at Oxford).—Discussion: Photochemical Reactions in Liquids and Gases.—At 10-1 and 2.30-5.—Part II. On the Mechanism of Photochemical Reactions.—Prof. M. Bodenstein: Introductory Paper.—Prof. J. Franck: Elementary Processes of Photochemical Reactions in Gases.—D. L. Chapman: Some Conclusions from Recent Work on Photochemistry.—Prof. H. S. Taylor: Photosensitisation and the Mechanism of Chemical Reactions.—E. J. Bowen: The Dissociation Theory and Photochemical Thresholds.—Prof. Chr. Winther: Dielectric Constant and the Speed of Photochemical Reactions.—R. O. Griffith and A. McKeown: The Photochemical and Thermal Decomposition of Ozone.—Dr. E. B. Ludlam and W. West: The Electron Affinity of the Halogens.—W. Taylor: The Physical Antecedents of the Photo-activity of Chlorine.—Prof. W. Albert Noyes, Jr.: The Formation of Polar Compounds by Photochemical Reactions.—Prof. von Halban: Absorption of Light in Solutions of Electrolytes.—Dr. H. Kautsky: On Chemiluminescence.—Prof. C. Berthoud: Photochemical Sensitisation.—Miss C. E. Bluker: Flame Spectra and Chemical Reaction.—W. J. van Dijck: The Becquerel Effect on Copper Oxide Electrodes.—Prof. J. Perrin: The Photochemistry of Fluorescent Solutions.—Prof. E. Bauer: The Photolysis of Methylene Blue Sensitised by Zinc Oxide.—Prof. A. Coehn: The Influence of Moisture on Photochemical Reactions in Gases.—Prof. I. Plotnikow: (1) Concerning the Fundamental Laws of Photochemistry; (2) Photochemical Reactions and Methods of Measuring them.—Prof. N. R. Dhar and B. K. Mukerji: (1) Einstein's Law of Photochemical Equivalence; (2) The Mechanism of Photochemical Reactions.

ROYAL PHOTOGRAPHIC SOCIETY, at 7.

JUNIOR INSTITUTION OF ENGINEERS.—H. Bishop: Problems of Broadcasting.

SMOKE ABATEMENT LEAGUE OF GREAT BRITAIN (at Buxton).—Conference on Smoke Abatement.

SATURDAY, OCTOBER 3.

SMOKE ABATEMENT LEAGUE OF GREAT BRITAIN (at Buxton).—Conference on Smoke Abatement.

SUNDAY, OCTOBER 4.

SMOKE ABATEMENT LEAGUE OF GREAT BRITAIN (at Buxton).—Conference on Smoke Abatement.