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EVOLUTION: OLD AND NEW.

Darwin and Modern Science. Essays in Commemoration of the Centenary of the Birth of Charles Darwin and of the Fiftieth Anniversary of the Publication of the "Origin of Species." Edited for the Cambridge Philosophical Society and the Syndics of the University Press by Prof. A. C. Seward, F.R.S. Pp. xvii+595. (Cambridge: University Press, 1909.) Price 18*s.* net.

IN bringing together the series of essays composing this volume, the Cambridge Philosophical Society, the syndics of the University Press, and the editor of the work, Prof. Seward, have rendered a public service for which all those who cultivate science in any of its numerous branches must be deeply grateful. It is an appropriate international memorial raised at a most opportune time in memory of the centenary of the birth of our greatest naturalist, and in celebration of the jubilee of the publication of that epoch-making book which made the principle of organic evolution a living reality in the strictest scientific sense. We have now been provided with a symposium of twenty-eight essays by English and foreign experts—every name being that of a recognised authority in that subject with which he deals. It is no exaggeration to speak of this work as monumental; it is a monument of greater durability than bronze or marble, because it stereotypes the collective thought of our age. For the future historian of science it must for all time serve as a land-mark indicating the present stage of development of scientific doctrine in every department of human thought where science holds sway, and where the great principle of evolution has, under Darwin's influence, served as a guide in the interpretation both of organic and inorganic nature.

It detracts in no way from the value of this volume that it is in the best sense "popular" as distinguished from technical. As stated in the preface, "Authors were asked to address themselves primarily to the educated layman rather than the expert." From this point of view some writers, as might have been expected, have succeeded better than others, although, on the whole, the result is highly satisfactory. The book should thus be particularly valuable to those workers in other departments of science or in other fields whose occupations have precluded their keeping pace with the rapid development in knowledge and mode of thought to which Darwin gave the impetus half a century ago. But it is difficult, if not impossible, to impose any restriction with respect to the class of reader to which these essays will appeal. The names of the authors whose services have been invoked will suffice to show that every branch of scientific culture has been influenced by the teaching of the man who in his modesty wrote of his own work shortly before his death:—

"With such moderate abilities as I possess, it is truly surprising that I should have influenced to a considerable extent the belief of scientific men on some important points."

Biology naturally predominates, and for zoology and botany the names of Weismann, de Vries, Francis Darwin, Strasburger, Bateson, Sedgwick, Klebs, Loeb, Poulton, and Goebel stand as sponsors for their respective subjects. Schwalbe treats of the descent of man, and Ernst Haeckel of Darwin as an anthropologist. Geographical distribution is handled by Thiselton-Dyer and Hans Gadow; geology by Judd, and palæontology by W. B. Scott, of Princeton, and D. H. Scott. Lloyd Morgan writes on the "Mental Factors of Evolution," Höffding on evolution in relation to modern philosophy, Bouglé on sociology, the Rev. P. N. Waggett and Jane Ellen Harrison on the religious influence of Darwin's work. Philology is treated by P. Giles and history by J. B. Bury. For the essays on the application of the principle of evolution to inorganic nature we are indebted to Sir George Darwin, who treats of double stars, and to W. C. D. Whetham, who gives an account of the evolution of matter according to the modern hypothesis of atomic "disintegration." The history of evolution is written by J. A. Thomson, who treats of Darwin's predecessors, and by J. G. Frazer, who gives an account of early theories of the origin of man. An introductory letter from Sir Joseph Hooker appropriately prefaces this splendid contribution to the modern literature of evolution.

A work of the order and magnitude herein indicated does not come within the purview of the ordinary reviewer of scientific treatises. There is ample scope for discussion, for the views of some of the writers are at variance with those of others respecting the cardinal doctrine of the "Origin of Species by Means of Natural Selection," to quote the exact title of that classical work which the present volume commemorates. The one bond which unites all the contributors is the principle of evolution and the indebtedness of science, philosophy, and history to the man who made the nations "think in terms of evolution." Perhaps the best praise that can be bestowed upon the historical collection of essays forming the subject of this notice is to compare it in its candour with the writings of the master himself, for, as has so frequently been pointed out, the best and the severest critic of the theory of natural selection was Charles Darwin. It is only in harmony with the scientific spirit of our great leader that we should find between the same covers, and written with the same object of paying homage to the far-reaching influence of that leader's work, the strictly "selectionist" contributions of authors such as Weismann and Poulton, and the later divergent views of the schools represented by de Vries and Bateson. We quite agree with the latter that the greatness of Darwin's work is "that it may be admired from more aspects than one" (Essay v., p. 85). Perhaps not the least important of these aspects is that we must credit the "Origin" with having been the first work which successfully rescued the species question from the domain of ancient mysticism and ecclesiasticism, and handed it over to the scientific world for treatment by those same methods of investigation which had long been recognised as the only legitimate weapons of attack in other departments of natural knowledge—a true

scientific emancipation of the whole group of natural sciences to which we now attach the label biology.

But even if the claim to our admiration be not based upon his application of the principle of natural selection, it must never be forgotten that for Darwin the conviction of the reality of this principle was the motive power of his life-work. The history of the revolutionary little volume which convulsed the world of science and shocked the outer laity in 1859 shows that, as the result of his observations and reflections during and after the voyage of the *Beagle*, he had become convinced of the mutability of species. But the mechanism of the process by which species were produced in nature was suggested to him, as it was subsequently to his compeer, Alfred Russel Wallace, by the writings of Malthus. From the time of his perusal of that work "for amusement" in 1838, his views began to take definite form. This is an oft-told story and hardly requires recapitulation, but at this momentous period it may be pertinent to point out that without this light from Malthus there would have been no Darwin-Wallace theory of the origin of species unless the illustrious founders of that theory had independently discovered the Malthusian principle. Whether the recognition of natural selection as "the main but not the exclusive means of modification" ("Origin," sixth edition, p. 421) is Darwin's chief claim to our homage is, as appears from the present essays, a matter of individual opinion. But whatever view be held now with respect to the function of natural selection, it was the predominant factor from the first to the last edition of the "Origin." It is not going too far to say that all his later work was prompted by this theory, which was, and is, a theory of "adaptations," as shown by his adoption of Herbert Spencer's paraphrase "survival of the fittest" for "preservation of favoured races." Happily for us of the present generation, Darwin resolved at the outset of his work to refrain from polemical discussion. His champions were numerous, and, like Huxley, masters of that art, and to them he left it to give battle to his opponents. The nearest approach to controversy to be found in his writings is the well-known chapter (vii. of the sixth edition) in the "Origin" in which he discusses a number of "miscellaneous objections" which had been urged against his theory. A re-perusal of that chapter at the present time will serve to show that *utility*—the "adaptational" value of the characters of organisms—was still the basic idea underlying his replies to his critics.

A collection of essays such as those which make up the present volume would require, not a single reviewer, but a staff of reviewers to do justice to their contents. It would be impossible to give anything approaching an adequate account of the treatment of the various subjects by their respective authors within the limits of an ordinary press notice, even in the columns of a scientific journal. Some of the essays are quite easy to follow; others are necessarily more or less technical. In the way of absolute novelty there is not much to be found, nor, indeed, could novelty be expected from writers dealing with subjects which have in one form or another been before the scientific world for many years. The novelty is to be found rather in the way in which each contributor presents his case—in the consensus of homage paid to Darwin's influence in each particular field. If it is not invidious to make a selection, Judd's chapter on "Darwin and Geology" (xviii., p. 337) is the most fascinatingly interesting from the historical point of view. Weismann's, Poulton's, and D. H. Scott's contributions will be found delightful reading by those who (like the present writer) still believe that the Darwinian theory is a theory of adaptations. Poulton, by the way, gives us more novelty than any other writer by inserting some hitherto unpublished letters of Darwin, and by printing extracts from Burchell's note-books bearing on mimicry and protective resemblance. It is in no captious spirit that the essay of de Vries is referred to as lacking in lucidity; his statement of Darwin's position (p. 67) might have been made clearer, and the presentation of his own views—whether they are accepted or not—scarcely does justice to their distinguished author. Haeckel's contribution still rings with the battle-cry of the victor over his defeated German anthropological opponents. Those who look to the work as an authoritative expression of evolutionary opinion must perforce be struck by the omission of certain names which we should have liked to see on the list of contributors. The names of Alfred Russel Wallace and Francis Galton are conspicuous by their absence. Biologists would no doubt have been glad also to read essays by Henry F. Osborn, of Columbia University, by Sir Ray Lankester, and by Karl Pearson. "Biometricians" are not represented. Presumably there are valid reasons for these omissions, but the loss is ours nevertheless. The hypercritical reader also may want to know what influence can have been exerted by Darwin's work upon the genesis of double stars (Sir George Darwin, Essay xxviii., p. 543), or upon the evolution of matter as expounded by Mr. Whetham (Essay xxix., p. 565). Speculations on the "transmutation" of matter are older than any theories of the transmutation of species. But both these subjects now fall as naturally into the general scheme of evolution as do any of the cosmical theories admitted by Herbert Spencer in the "First Principles," and are, therefore, quite appropriate in the present volume. The only regret that can be expressed is that more space has not been given to inorganic evolution. We should have profited much by a popular exposition both of Sir Norman Lockyer's views on stellar evolution and of Sir George Darwin's suggestive application of the principle of survival among elementary atoms in his address to the British Association in 1905.

Now, bearing in mind the *raison d'être* of the work under consideration, the "resting stage," to use a biological expression, in the history of Darwinism provided by this galaxy of expert opinion enables us to formulate certain very definite questions. What has the "educated layman" to believe now with respect to Darwin's cardinal doctrine after the lapse of half a century? Has the theory that species *originate* mainly but not exclusively by natural selection stood the test of time; has it been modified in any

material particulars since Darwin's days, and, if so, in what direction and to what extent? Out of the conflicting views on this fundamental point it is safe to extract the general conclusion that for the great majority of living biologists natural selection is still a working power in organic evolution. Equally evident must it be to those who weigh the evidence brought together in these essays that the theory, as bequeathed to us by its illustrious founder, has, to borrow certain photographic terms, undergone in some directions intensification and in other directions reduction. By way of intensification we have the elimination of the effects of "use and disuse" and of "direct action" of the environment—the deletion by Weismann of all the Lamarckian factors. It is sufficiently notorious that Darwin attached a certain weight to these factors. When, in 1862, Hooker was inclined to throw over "direct effects of conditions," he wrote :—

"It is really curiously satisfactory to me to see so able a man as Bates (and yourself) believing more fully in natural selection than I think I even do myself" ("More Letters," vol. i., p. 199).

The same point is well brought out by Schwalbe in the present volume (p. 125), and by Haeckel (p. 141), although it may well be doubted whether Darwin was so much of a Lamarckian as Haeckel would make out. But in accepting the Lamarckian factors as subsidiary aids in the development of species, it must not be forgotten, as has so frequently been pointed out, that Darwin was only expressing the current belief of the time. The efficiency of these factors in producing individual modifications was an observed fact, but their inheritance was an assumption. The validity of this assumption was not challenged by Weismann until after Darwin's death, and the master, to our everlasting regret, never had an opportunity of weighing the evidence brought against these factors which he regarded as subsidiary. If it is permissible to speculate as to the probable effect of Weismann's contention upon Darwin's "immortal work" (Schwalbe, p. 125) and "epoch-making" volume (Haeckel, p. 143), it may, perhaps, be admitted that "the 'Origin' without 'use and disuse' would be a materially different book" (Bateson, p. 89). But in what way different? It may very well have transpired that the views of its great author would have become more rigidly "selectionist," as did those of Wallace after he had considered and admitted the cogency of the arguments against the Lamarckian tenets.

In view of the state of knowledge concerning heredity at the time of the publication of the "Origin," it may fairly be asked whether it is so absurdly unscientific, as many opponents of natural selection used to tell us, to extend the views of the founder of a great principle beyond the limits foreseen by their founder. The history of science furnishes numerous examples of such developments. We never heard it urged in scornful argument, for example, against the electro-magnetic theory of light that Clerk-Maxwell had made himself ridiculous by becoming more of an "undulationist" than Young and Fresnel. If, departing from Haeckel, who agrees with Herbert Spencer in rejecting Weismann's views (p. 140), we follow Francis Galton, Wallace, Poulton, Bateson (presumably, p. 89), and those who agree in believing that Lamarckism is discredited, we strike out a factor in species formation which "aided [natural selection] in an important manner" ("Origin," sixth edition, p. 421). The importance of natural selection *may*—it does not logically follow that it *must*—thereby be enhanced. It is perfectly scientific, and quite in harmony with the spirit of the great leader whose mind was ever open to fresh evidence, to believe that not only has natural selection stood the test of time, but that its author may have under-estimated rather than exaggerated its importance. This is the direction in which the theory has undergone intensification.

In the opposite direction and by way of reduction we have a number of opinions which practically amount to traversing Darwin's claim for natural selection as the "main" factor. Some attach less importance to it, some give it quite a subordinate *rôle* and a few almost appear to imply that it can be dispensed with altogether :—

"The discovery of de Vries that new species may arise by mutation and the wide if not universal applicability of Mendel's law to phenomena of heredity, as shown especially by Bateson and his pupils, must for the time being, if not permanently, serve as a basis for theories of evolution" (Loeb, p. 269).

Perhaps the author of the above passage will not admit that it bears this construction, but at any rate, as an example of the reducing action exerted by a certain class of modern workers, it seemed typical. Darwin thought that he had given a working theory which, if it did not completely solve, at least went a very long way towards solving the problem of the origin of species in nature. Bateson tells us (p. 99) :—

"The time is not ripe for the discussion of the origin of species. With faith in evolution unshaken—if indeed the word faith can be used in application to that which is certain—we look on the manner and causation of adapted differentiation as still wholly mysterious."

The "educated layman"—if his sense of humour has not been educated out of him—may possibly want to know why, if the species question is to be thus thrown into the melting-pot, the Cambridge authorities thought it advisable to issue a volume to commemorate "the fiftieth anniversary of the publication of the 'Origin of Species.'" It is, of course, perfectly legitimate for any biologist who has considered the question to declare that he is dissatisfied with the evidence on which Darwin based his claim for the prepotency of natural selection—to bring in a verdict of "not proven." That is a matter of individual judgment on the evidence submitted. But in giving this verdict, it must be clearly recognised that he is taking a position diametrically opposed to that of the author of the book which is being commemorated. It may be said, and is virtually said by some of the contributors, that the claim to the commemoration of the "Origin" is not based upon the

discovery of the principle of natural selection, but is due to the circumstance that that work brought conviction to naturalists as well as to the educated public of the truth of evolution as a principle. It unquestionably did so, but since the assertion has been made that without Lamarckism the "Origin" would have been a different work, it may be permissible to raise the question whether, without natural selection, the mere marshalling of the facts of evolution—even by the master mind of Darwin—would have done more towards establishing that principle than did the writings of the pre-Darwinian evolutionists or the powerful advocacy of Herbert Spencer before the publication of Darwin's work. At any rate, the discovery of natural selection was the cause of the publication of the "Origin," and the success of that book is attributable to the theory—the working mechanism of species formation which, rightly or wrongly, it proclaimed.

Not the least valuable feature of this volume of essays is that, by bringing together the views of the different and often antagonistic writers, it enables the ordinary reader to get a clear notion of the various lines of divergence from Darwin's original position. The representatives of the modern school of "genetics," for example, base their homage on the fact that he introduced scientific method into the study of variation and heredity:—

"Evolution is a process of variation and heredity. The older writers, though they had some vague idea that it must be so, did not study variation and heredity. Darwin did, and so begat not a theory, but a science" (Bateson, p. 88).

Perfectly true so far as it goes; but his study of variation and heredity was prompted from beginning to end by his desire to find out how the raw materials were supplied by nature for the action of natural selection (see the introduction to "Variation of Animals and Plants," *passim*). Also it is now a matter of history that Darwin's work in this very line of study did beget a theory—the "provisional hypothesis of Pangenesis," of which Strasburger says (p. 111):—

"We can however affirm that Charles Darwin's idea that invisible gemmules are the carriers of hereditary characters and that they multiply by division has been removed from the position of a provisional hypothesis to that of a well-founded theory. It is supported by histology, and the results of experimental work in heredity, which are now assuming extraordinary prominence, are in close agreement with it."

There can be no reasonable doubt in the minds of those who are familiar with Darwin's books that his study of variation and heredity centred round his main theory of natural selection, and the first question that the "educated layman" may well ask in this connection is, How far has our knowledge been extended since Darwin's time? It does not appear from the present body of evidence that we have got very much beyond Darwin with respect to the causes of variation in nature. Some ingenious hypotheses have been suggested, and varieties have been classified and put into named categories, but that is all. With respect to heredity it is generally conceded that *when certain varieties appear* the laws which determine their transmission are now, thanks to the experiments of Mendel and those who are continuing his work, being definitely established. This is undoubtedly a most important line of investigation, and evolutionists will anxiously await further developments. In the meantime, however, it would appear that at the halting period marked by this present volume, the experiments on cross-breeding have not yet contributed anything constructively to the main problem which Darwin set out to solve, since we have it on the authority of the leader in this class of work that "the time is not ripe for the discussion of the origin of species."

With respect to another divergence since Darwin's time, viz. the mutation theory of de Vries, readers must be referred to the author's own account (Essay iv., p. 66). Want of space forbids an analysis of this later departure in the way of "saltatory evolution," only it must be noted that this kind of variation was considered by Darwin over and over again, and always with the conclusion that it played no important part in the formation of species in nature. It will be noted also that de Vries still subordinates his "mutations" to the action of natural selection, and to this extent is a follower of Darwin. Although the bearing of this aspect of variation upon Darwin's theory has been discussed by many able writers, it may be useful at this period to direct attention to the fact that it is unhesitatingly rejected by Haeckel as giving no explanation of adaptations and as having "no causal value" (p. 141). Here is what Darwin wrote on this point in the last edition of the "Origin":—

"Mr. Mivart is further inclined to believe, and some naturalists agree with him, that new species manifest themselves 'with suddenness and by modifications appearing at once.' . . . This conclusion, which implies great breaks or discontinuity in the series, appears to me improbable in the highest degree" (p. 201).

"Although very many species have almost certainly been produced by steps not greater than those separating fine varieties; yet it may be maintained that some have been developed in a different and abrupt manner. Such an admission, however, ought not to be made without strong evidence being assigned" (p. 203).

Whether the evidence offered on behalf of this divergence from the "Origin" is sufficiently strong to warrant its adoption is still an open question (see Poulton's "Essays on Evolution," introduction, p. xiv). It is true that the author of modern "mutationism" is inclined to believe that Darwin recognised two kinds of variation, ordinary fluctuations and those which "happen to arise" ("Origin," sixth edition, p. 169), but those who have really mastered Darwin's meaning will agree with Prof. Seward's and Mr. Francis Darwin's contention (p. 71, footnote, of present work) that this interpretation of the passage in the "Origin" is incorrect. This, by the way, is the only "editorial" comment to be found in the volume under consideration.

Now, if we ask ourselves what has been the net result of the publication of the "Origin of Species"

on the main question with which it deals, or, in other words, How stands the species question after passing the ordeal of half a century? the answer must be that the only theory of species formation which still holds the field is that theory of natural selection which suggested itself to Darwin after reading Malthus in 1838, and independently to Wallace in 1858. Before 1838 it may be said that Darwin was a convinced evolutionist; subsequently he became a selectionist. Whether the reader of the present collection of essays takes the view that time has acted as an intensifying or a reducing agent upon the validity of the fundamental doctrine enshrined in that work which is now being commemorated, it is perfectly clear that the historian who in the distant future—say at the next Darwin jubilee—consults the present book in order to ascertain what platform had been reached in the year 1909 cannot but arrive at the conclusion that at the time of the publication of this memorial volume no alternative theory of the origin of species had survived the test of scientific criticism. No more effective mechanism of organic evolution than that offered to us by Darwin fifty years ago has up to the present time been suggested. We may degrade natural selection from the position assigned to it by Darwin, or the still higher position assigned to it by Wallace and Weismann as the result of post-Darwinian discovery; we may attach quite a small value to it as a factor, or we may eliminate it altogether. If so, the other factors remain to be discovered, and we must declare that we are still without a theory of the origin of species. The effects, direct or indirect, of the publication of the "Origin" upon lines of thought and of work other than those centring round the main question of species are sufficiently well known; the present volume bears living testimony to their far-reaching importance.

There is one other aspect of Darwin's work which at this juncture it may be opportune to insist upon. There is much talk in our time about "scientific method," "scientific habit of thought," and so forth; and yet it seems that there is a tendency among our present workers to neglect the example set by the great master, whose memory will ever be upheld with undiminished reverence by those who had the privilege of knowing him personally. It is he who, above any scientific worker of his time, taught us the value of *cumulative evidence* in establishing a new theory. Of his own doctrine he wrote:—

"Now this hypothesis may be tested—and this seems to me the only fair and legitimate manner of considering the whole question—by trying whether it explains several large and independent classes of facts" ("Variation of Animals and Plants," first edition, 1868, p. 9).

Is that canon faithfully followed now? We fear not. With many workers, one or a few observations, or the taking of a few measurements, combined with the complete exclusion of "independent classes of facts," suffice to provide a new theory of the universe. The lesson conveyed by the revolution in scientific thought effected in a comparatively short period by one book is in danger of being overlooked by the present generation. R. MELDOLA.

PROF. FISCHER'S INVESTIGATIONS ON THE CARBOHYDRATES AND ON FERMENTS.

Untersuchungen über Kohlenhydrate und Fermente (1884–1908). By Emil Fischer. Pp. viii+912. (Berlin: Julius Springer, 1909.) Price 22 marks.

PROF. EMIL FISCHER continues to put all chemists under an obligation to him by the re-publication, in collected form, of the series of remarkable investigations by which he has made the present Berlin school of chemistry famous for all time. These contributions to chemical literature are absolutely unique; in extent, in character, in originality and completeness, they are unparalleled. Not even Liebig, in his most forceful and prolific period, showed himself more able as a leader, more fruitful in directive ability, or more inspiring as a central controlling figure, than the present head of the most celebrated chemical laboratory of the world. The volume before us follows in quick succession that on the amino-acids, polypeptides, and proteins (1899–1906), and that on the investigations in the purin group (1882–1906). Collectively, these works constitute a monument more enduring than brass, and mark an epoch in the development of the science.

In a sense, Emil Fischer is the Paracelsus of his period—not, we hasten to add, in his mental habitudes or in his methods of inculcating his doctrines, but as the exponent and representative of a new phase in the evolution of chemical thought. What Paracelsus and van Helmont were to iatro-chemistry, Pasteur and Fischer are to bio-chemistry. But the analogy is only partial, and, indeed, soon breaks down. The truculent, turbulent Schweizer added ideas to science, but no new facts; the bland and suave Berliner, distinguished in manner and courteous in bearing, has enriched his science with innumerable facts and illumined it with ideas as the logical outcome of the facts. Other times, other manners. Nothing is more reassuring than to compare the "Opera Paracelsi," as turned out by Operinus, with the "Opera Fischeri" as published by the house of Julius Springer. Four hundred years have certainly done something for human civilisation. We may at least lay that unction to our souls.

The main significance of Fischer's work is in its relation to physiology. That physiology and chemistry are intimately connected and mutually related goes without saying; the fact has been recognised from the earliest times—certainly from the period of Galen and Avicenna. But it is Fischer's great merit that, after a comparatively arid and sterile period in physiological chemistry, due largely to the circumstance that the time and energy of the leaders of organic chemistry were directed to the exploration of other regions, he should have turned the force of his genius to the elucidation of the constitution of those substances which are dependent upon, or obviously connected with, vital processes. The sugars and the starches were among the earliest known of so-called organic compounds. They have long been recognised as among the most characteristic products of the physiological activities of plants, and from time immemorial they have been regarded as among the

most important alimentary substances used by man. The modes of their origin and transformation, first within the organism which produces them, and then within the organism which assimilates and consumes them, have been the subject of innumerable inquiries and of endless speculation. Comparatively simple in composition, their true nature and constitution long remained shrouded in apparently impenetrable mystery, and all the methods which chemists were in the habit of employing in the attempt to unravel the internal structure of bodies were in their case unavailing. This was no doubt due in large measure to their limited range of chemical activity, and the relatively small number of combinations and derivatives which could be obtained from them. Even when, by more or less drastic treatment, they were forced to yield other products, the few compounds so formed were products of small molecular weight and of simple constitution, evidently "degradation" products far removed in structure from the parent molecule, and incapable of affording any valid clues to its real nature.

In the work before us it will be seen how all this has been changed. Incidentally Prof. Fischer has gathered together all that has been accumulated respecting this large and important group, and, proceeding to attack in detail its individual members, he has succeeded, by a masterly series of researches extending over nearly a quarter of a century, in laying bare the internal structure of many of the more important constituents of the group and in exposing their genetic relations. The greater bulk of the volume consists of reprints of papers, contributed for the most part to the *Berichte* of the German Chemical Society either by Prof. Fischer, by him in collaboration with his pupils, or by certain of them alone working under his inspiration and direction. The memoirs on the sugars alone number ninety-three. In addition there are seven papers on the ferments. It is significant of Prof. Fischer's power and of the influence of the Berlin laboratory as an engine of research that a considerable number of his collaborators are English, Scotch, and American. This great wealth of experimental material admits, luckily, of very simple classification, viz. (1) as nitrogen-derivatives of the sugars; (2) the syntheses and configuration of the monosaccharides; (3) the disaccharides; and lastly (4) the glucosides. To the student and the investigator who may follow Prof. Fischer into the territory he has thus opened out, the compilation will be invaluable. He has provided us with a *vade-mecum* which will be indispensable to all who purpose to occupy themselves with what, as the direct result of his own assiduous cultivation, will long remain a fruitful field of inquiry.

Of more general interest, however, are the five introductory memoirs in which Prof. Fischer summarises the outcome of this prolonged experimental research. Two of them—"Syntheses in the Sugar-group"—have already been published as lectures delivered to the German Chemical Society and have appeared in the *Berichte*, and are everywhere regarded as among the classics of contemporary organic chemistry. The third paper has been put together for the purposes of this work. It deals with the material which has been accumulated since 1894, the year of the preceding lecture. The fourth and fifth papers are of special interest to the physiological chemist and medical man. The former is a reprint of a popular lecture given on the occasion of the celebration of the founding of the German Military Medical Academy (1894), and the latter is a contribution to the *Zeitschrift für physiologische Chemie* (1898), and is of particular importance as summarising the work then done on the action of enzymes, and more particularly the enzymes of yeast, upon the hydrolysis and fermentation of the polysaccharides.

The work before us is characteristic of much that we admire in Germany and of much that we deplore in our own country. With the possible exception of America, nowhere else in the world would such a monumental work have been possible. Prof. Emil Fischer, in the Prussian capital, worthily carries on the traditions founded by the Roses, by Mitscherlich, and by Hofmann, aided by all the material appliances which a wise liberality places at his disposal. Economically and financially Germany is even in a "tighter place" than we find ourselves to-day, but she is sufficiently wise to perceive that to starve her educational agencies and to cramp and hinder the development of her schools of research, and thereby interfere with the development of her material resources, is not a sane method of combating her difficulties. But every nation has a Government as good as it deserves. What is possible in Germany is possible only by the attitude of its people towards science and research, and what that attitude is is sufficiently indicated by the circumstance that a German publisher is willing to take the risk of issuing to the German public this memorable series of works, so strikingly characteristic of German capacity, energy, and thoroughness, and of which the volume under review forms a fitting crown and consummation. T.

THE "VALDIVIA" EXPEDITION.

Die Grundproben der "Deutschen Tiefsee-Expedition." By Sir John Murray and Prof. E. Philippi. Pp. 80–206; with 7 plates and 2 maps. (Jena: Gustav Fischer, 1908.)

THIS valuable monograph forms the fourth part of the tenth volume of the scientific results of the voyage of the German exploring ship *Valdivia* in the Atlantic and Indian Oceans, made during the years 1898–9. These admirable volumes are published under the editorship of Prof. Chun, the zoologist of Leipzig, who was leader of the expedition; and Prof. E. Philippi has secured the valuable cooperation of Sir John Murray, whose wide experience in researches of this class has proved of the greatest service. Prof. Philippi gratefully acknowledges the assistance he received at the *Challenger* office in Edinburgh from the members of the staff, as well as from Sir John Murray himself.

The route taken by the *Valdivia* was round the north of the British Islands, and thence southward, following, at some distance, the western coasts of Europe and Africa; from the Cape of Good Hope a

course southward was taken, until a latitude of 64° was reached; from that point the line taken was by Kerguelen Island to Sumatra, and thence by Ceylon and the East African coast to the Suez Canal. This route was sufficiently different from that of the *Challenger* and other exploring expeditions to supply much new and important evidence, in the 217 soundings and dredgings, concerning the contours of the floors of the Atlantic and Indian Oceans, and the deposits that cover them.

The nature of the materials brought up at various points during the voyage is well illustrated by a series of fine plates, similar to those accompanying the *Challenger* volumes. The globigerina ooze from different latitudes in the two oceans is represented by four very beautiful figures; the pteropod, radiolarian, and diatomaceous oozes, with the glauconite and coprolitic muds, have eight excellent figures devoted to them. Interesting points of difference from the deposits figured in the *Challenger* volume may be noticed on a careful comparison, though the general features are the same.

Of greater interest, however, than the organic deposits are the components of these oozes which are of mineral origin. No trace was found of any particles to which an extra-terrestrial origin could be assigned, neither particles of nickel-iron nor chondritic fragments occurring. A discussion is given of the mode of transport of the mineral fragments—by ice, wind, volcanic eruptions, and currents—and of the alternation of these deposits as proved by the soundings. In addition to the accounts of the glauconite, phillipsite, palagonite, and manganese nodules, of which some interesting particulars are given, we have in this monograph much valuable information concerning materials occurring at the bottom of the deep oceans, previously very imperfectly described or not known at all.

Besides the nodules containing up to 36 per cent. of calcium phosphate from the Agulhas Bank, a blue coprolitic mud is described from near the mouth of the Congo, at a depth of 214 metres, which contain numerous small, oval, phosphatic masses, believed by Sir John Murray to be the excrement of echinoderms. Among the concretions from the Agulhas Bank were found nodules containing 33 per cent. of calcium carbonate, 28 of calcium phosphate, 14.6 of calcium sulphate, and 4.8 of magnesium carbonate, with some ferric oxide, alumina, and silica. These nodules were dredged at a depth of 155 metres.

Perhaps the most interesting and suggestive, certainly the most novel, portion of this memoir is that which deals with the exploration of the "Seine Bank," a portion of the sea-bottom lying north-east of Madeira, which rises with steep slopes from depths of more than 4000 metres to within 146 metres of the surface of the ocean. This bank was first discovered in 1882 and 1883 by the cable steamers *Seine* and *Dacia*.

The calcareous sand dredged from the bank in question, at a depth of 150 metres, was found to be made up of fragments of Bryozoa, corals, and hydroid polyps, and shells and pteropods and other mollusca, spines, and plates of echinoderms, various Foraminifera, spicules of alcyonarians and sponges with fragments of crustaceans and otolites of fish. The inorganic constituents consisted of fragments of pumice and felspar.

The chemical analysis of different samples of this calcareous sand by Herr Pillow, of Berlin, revealed the interesting fact that the material had undergone a greater or less amount of dolomitisation. The several analyses gave percentages of 11·11, 14·36, 17·28, and 18·17 of magnesium carbonate, with a small amount, in some cases, of calcium phosphate. The study of thin sections of the material, stained by Lemberg's solution, showed that the dolomitisation was most marked in the calcareous mud, in which the fragments of organisms were embedded, but had also commenced in the latter themselves. Sometimes as much as nine-tenths of the cementing matrix of the deposit was found to be converted into the characteristic rhombohedra of dolomite.

The similarity of these results with those obtained by the study of the materials sent home by the Funafuti expeditions is very striking. The proportion of magnesium carbonate in the Seine-Bank material does not greatly exceed what is found in many organic deposits in which a gradual leaching out of the calcium carbonate appears to have taken place. It is interesting to notice that the depth of the deposits of the "Seine Bank" is only about 500 feet, and at this depth the chemical changes in question may be assumed to have taken place. The conditions under which the dolomitisation of limestones is brought about are still very obscure, but the facts described in the present memoir, with those contributed by Högbom, Natterer, Nichols, and other observers, are valuable contributions towards the solution of the problem.

Another interesting discovery was made in the South Atlantic Ocean in soundings, where the globigerina ooze was found to graduate into the red clay at a depth of 5040 metres. In the mixture of clay and calcareous ooze there were found numbers of minute, clear yellow crystals, which were shown by Prof. Linck to be the fundamental rhombohedra of calcite without any trace of magnesium carbonate. We seem to have evidence here that, at depths at which solution of calcareous organisms is going on, the dissolved matter may, under certain conditions, be re-deposited as calcite.

The whole of the memoir before us, indeed, abounds with facts and suggestions that cannot fail to be of great service in the solution of the problem of the chemical operations going on at various depths in the ocean—a problem which as deeply interests the geologist as it does the geo-physicist. J. W. J.

THE GEOLOGICAL SOCIETY OF GLASGOW.

History of the Geological Society of Glasgow, 1858–1908, with Biographical Notices of Prominent Members. Edited by P. Macnair and F. Mort. Pp. v+303. (Glasgow: Published by the Society, 1908.) Price 6*s*. net.

THE city of Glasgow, situated in the midst of a busy coal- and iron-mining district, within easy reach of the Highlands, the Western Isles, and the Southern Uplands, all replete with fascinating and

intricate geological problems, is exceedingly favourable ground for the development of an interest in geology, not only from a purely scientific, but also from a commercial standpoint. That such an interest was abundantly manifest in the earlier half of the last century is shown by records of numerous courses of lectures at the various public institutions, and by attempts to found a geological society both in 1840 and 1850. The latter venture lasted but a year, the earlier not so long.

The present society, with the history of which the handsome volume now under review is concerned, grew out of a "Young Men's Society" connected with Free St. Peter's Church. It was inaugurated on May 17, 1858, by eight young men, and by the end of its first summer and winter sessions had achieved a membership of ninety-eight. Since then the society has gone on and prospered. No provincial geological society can show a better record of work done or a more valuable series of Transactions than the Glasgow society. This is partly due to the exceptionally favourable surroundings, and partly to the fact that the society was able to secure contributions from men like Lord Kelvin, Sir Archibald Geikie, Prof. Lapworth, and others, some of which have become geological classics.

This jubilee commemoration volume begins with a brief account of the geology of the Clyde district. Then follows a notice of some of the earlier workers in the geology of this area, amongst whom may be mentioned the Rev. David Ure, author of the "History of Rutherglen and East Kilbride" (1793), containing the first descriptions and plates of western Scottish fossils; and John Craig, theologian, poet and geologist.

Chapter ii. contains a very full and interesting account of the origin and early history of the society, reprinted from a paper by Mr. T. M. Barr in the Transactions, vol. vii. The ensuing chapters contain reviews of the fifty years' work of the society in various branches of geological inquiry. Physical and dynamical geology is dealt with by Prof. J. W. Gregory, who gives a convenient summary of Lord Kelvin's early papers. The chapter on stratigraphical geology has been contributed by Mr. P. Macnair, that on mineralogy and petrology by Mr. Jos. Sommerville, and that on glacial geology by Mr. John Smith. Special praise must be given to the chapter on palæontological geology by Mr. James Neilson. This is really a most valuable summary of western Scottish palæontology, especially of the Carboniferous rocks.

Later chapters are devoted to biographical notices of some of the society's more prominent members. There is here quite a galaxy of famous names, amongst which we note those of Lord Kelvin (president for twenty-one years), Sir A. Geikie, Prof. C. Lapworth, Dr. B. N. Peach, James Smith of Jordanhill, R. H. Traquair, and Thos. Davidson, all, with the exception of the last-named, past-presidents of the society.

The book is well got up and illustrated by a fine series of photographs of prominent members. The editing seems to have been excellently done, the only errors discoverable being the substitution of "stations" for "sections" in the quoted title of a paper on p. 104, and the unaccountable omission of the names of T. G. Bonney, H. Woodward, and J. J. H. Teall from the list of honorary members at the end of the volume. G. W. T.

OUR BOOK SHELF.

Unités Électriques. By Le Comte de Baillehache. Pp. x+202. (Paris: Dunod et Pinat, 1909.) Price 6 francs.

SOME time before the Cambridge school of physicists (which we have heard irreverently termed the "ion-catchers") had made even the man in the street more or less familiar with molecular dimensions, a celebrated mathematician had been making some calculations as to atomic quantities. He was much surprised at the results he obtained. On looking over his work he was unable to find any mistake, but, nevertheless, felt sure something was amiss. At last a humble physicist was able to point out to him that he had forgotten to multiply by "v," his result being, therefore, only some thirty thousand million times too small, which put things more or less right. In this case the enormity of the error made excited grave suspicion, but it is not easy to say how many times in ordinary practice grave errors may not have arisen, for example, in the magnetic testing of iron, from failure to remember that the C.G.S. unit of current is not an ampere.

Count Baillehache's book is a useful and up-to-date summary of practically all that is required to be known by the physicist, engineer and technologist about electrical units of all kinds, dealing with matters even as recent as the Congress of Electricians held in London during October last.

Though nominally confined to electric units, the book deals in a preliminary chapter with units in general, and commences with definitions and a clear account of the evolution of the various systems in use.

A chapter on the metric system follows a fairly complete history of the work done in the establishment of the metre and the kilogram, and the determination of the volume of the kilogram of water.

The bulk of the book consists of a description of both the C.G.S. system and the various systems of practical electrical units and standards, the equations to their dimensions, their relations to one another, with a number of conveniently arranged tables.

Some account is also given of the legislation of the various countries on electrical matters, and of the labours of the various electrical congresses.

Full historical details of the evolution of the ohm, volt, &c., and the construction of the practical standards of the same, such as mercury-tube resistances, the various forms of Clark and Weston cells, &c., are also found.

The book appears to have been carefully compiled, and we have not detected any serious errors. We cordially recommend it to practical physicists and electricians. J. A. HARKER.

Traité de Mathématiques générales a l'usage des Chimistes, Physiciens, Ingénieurs, et des Elèves des Facultés des Science. By Prof. E. Fabry. Pp. x+440. (Paris: A. Hermann et Fils, 1909.) Price 9 francs.

IN 440 octavo pages of generously spaced printing, the author gives treatises on algebra, analytical geometry, the calculus, including differential equations, and even partial differential equations and mechanics. The book is very interesting, as it is intended for persons presumably not very mathematical, and there is hardly

one page of it which can be understood by a person who has not already made a study of higher mathematics. Every now and again it seems to strike the author that he is philosophising over the head of his reader, and for a moment he drops low enough to be understood by a chemist who has given more than the usual time to mathematics, but it is only for a moment. Naturally, he does not mention dy/dx until he has quite finished his treatment of curves by analytical geometry, and the time of vibration of his simple pendulum is given as an infinite series. He does not show anywhere that he knows the problems to which the chemist, physicist, or engineer would apply his mathematics. He does not seem to know that there are mathematical principles underlying thermodynamics and the flow of heat and problems in electricity which he might have referred to. The harm done by such a presentation of the subject is incalculable; it gives a student the notion that he cannot possibly learn to use mathematics, whereas we know that almost any person can be taught to use the highest kind of mathematical weapon with confidence and security. J. P.

Probleme der Protistenkunde. I. Die Trypanosomen ihre Bedeutung für Zoologie, Medizin und Kolonialwirtschaft. By Prof. F. Döflein. Pp. 57. (Jena: Gustav Fischer, 1909.) Price 1·20 marks.

IN this monograph Prof. Döflein deals in a simple and non-technical manner with an important group of protozoan parasites, the trypanosomes, in particular those which cause important diseases of man and animals, such as sleeping sickness of man, and nagana, surra, and dourine of horses, &c., so that the medical man without special zoological knowledge can readily understand the subject.

The author considers that there is little or no evidence that these trypanosome parasites leave the body of the host in an encysted or sporulating form, which may then re-enter the body and cause infection. Infection generally occurs through the agency of an intermediate host, or, in the case of dourine, by direct contact. He regards the reputed encysted forms as probably the result of degenerative changes in the parasite. The observations of Schaudinn on the supposed transformation of certain intracellular parasites of birds into trypanosome forms are discussed, and considered to be probably erroneous. After discussing the possible evolution of these parasites, the author concludes with some remarks on the economic importance of the diseases they produce in the colonies. The book is very readable, and is well illustrated. R. T. H.

American Philosophy: the Early Schools. By Prof. I. W. Riley. Pp. x+595. (New York: Dodd, Mead and Co., 1907.)

THIS rather bulky volume is the first of a series intended to give an historical summary of the progress of philosophical thought in America. The European reader must have an unusually determined interest in the history of speculation if, from the purely philosophical point of view, he is willing to follow Prof. Riley in his studies of minor thinkers, whose names, except in a few cases, will probably be entirely unknown to him. Regarded from a wider point of view as a study of the earlier development of the "soul of a people" that has come to fill so important a place in the modern world, the book will be found both valuable and interesting.

Prof. Riley has taken advantage of his three years' tenure of the Johnston scholarship in Johns Hopkins University to acquire an exhaustive knowledge of his subject, and he presents the results of his inquiries lucidly and attractively. After a brief historical survey and a still shorter essay on the relations between American philosophy and American politics, he develops in five successive "books" the history of the several movements—philosophical or religious—to which the thinkers of his period are related.

Of these movements the only one with which the philosophical student will, as such, feel much concern is early American idealism, which is decorated by the names of Samuel Johnson (of Connecticut) and Jonathan Edwards. Both these writers have relations with Bishop Berkeley, "the only European philosopher of the first rank who visited the colonies." Students of Berkeley already know that Johnson was his avowed admirer and follower, but they will be glad of the much fuller light which Prof. Riley has thrown upon the dealings of the two philosophers with one another. In the case of that remarkable man, Jonathan Edwards, Prof. Riley makes it manifest that his idealism was an independent development from Locke—a development the main positions of which Edwards reached at some time between his thirteenth and his sixteenth years!

The scientific reader will be tempted to give special attention to the pages on Benjamin Franklin, who, as "a kind of Socrates in small clothes," played an interesting if not imposing part in American deism, and will be reminded painfully of the bitterness of English intolerance in the eighteenth century when he comes upon the name of Joseph Priestley among the apostles of American materialism.

The Photography of Coloured Objects. By Dr. C. E. Kenneth Mees. Pp. vi+69. (Croydon: Wratten and Wainwright, Ltd., 1909.) Price 1*s.* net.

DR. MEES being a partner in the well-known photographic firm of Wratten and Wainwright, and writing on a subject most intimately connected with the manufactures of the firm, naturally refers almost entirely to the plates and colour filters that he is most interested in, but the volume is in no sense, or in any part of it, a trade advertisement. The author explains in a clear and straightforward way the details of the subject, and the chapters on "portraiture," "landscape photography," and "the photography of coloured objects for reproduction" have been produced by the aid of several authorities who devote themselves to these branches of work.

Many will be surprised to see the great advantage in photographing polished mahogany attainable by the use of a panchromatic plate and a red screen, as compared with the result obtained by an ordinary plate. The latter emphasises the scratches and other surface imperfections and hardly shows the grain, while the panchromatic plate gives what is obviously the natural appearance of the wood. For the correct representation of ordinary coloured objects, the general advice is to use a panchromatic plate and a rather deep yellow screen. M. Callier, in a note that he contributes, points out the practical shortcoming of the ordinary orthochromatic plate (erythrosin type) in the photography of open meadows and pine-trees. The green of the pines falls just into the gap of deficient sensitiveness in the spectrum, while the green of the meadows corresponds to the maximum of green sensitiveness; hence there is obtained an exaggerated contrast which no ordinary yellow screen will correct.

The author deals also with the suppression of certain colours, as in the photography of stained documents, the increase and decrease of contrast in coloured objects, as in photomicrography, and with three-colour photography, that is, so far as plates and colour screens are concerned. Although the volume is small it deserves an index.

The Nautic-Astronomical and Universal Calculator. The Mechanical Solving of all Arithmetical Problems, Plane and Spherical Trigonometry, including Terrestrial and Astronomical Navigation. By R. Nelting. Pp. 67. (Hamburg: R. Nelting, 1909.) Price 4 marks.

In many numerical processes there has been too great a tendency on the part of computers to employ more decimal places than are necessary, and to use logarithms where more direct methods would be effective. The introduction of mechanical contrivances for the performance of arithmetical operations has brought the problem of a possibly greater simplification of calculation more to the front, with the result that some neglected resources have been made available. One outcome has been the improvement in accuracy and ingenuity in construction of sliding scales for obtaining an approximate solution of many simple problems. With increased usefulness, however, comes a tendency to increase the number of moving parts and to give greater variety to the system of dividing, but this more complicated mechanism often destroys the simplicity of construction which is one great merit in the sliding scale. Certainly, the invention described by Mr. Nelting does not err on the side of simplicity. The inventor claims for his calculator that it will give the logs. of numbers, with their squares and square roots; the values of trigonometrical functions of sine, tangent, cosecant and cotangent of angles, whether expressed in time or in arc; tables of reciprocals with their squares and square roots. In addition to many other combinations, the scales can be used for facilitating or completely solving problems required in nautical astronomy connected with altitude, longitude, and latitude, with an accuracy sufficient for the purposes of navigation. Unfortunately, we have not had an opportunity of studying the mechanism, and the rules that are given for its use are not easily followed when the necessary constructions cannot be made. Moreover, the description is obscure in many parts.

The Theory of Electric Cables and Networks. By Dr. Alexander Russell. Pp. x+269. (London: A. Constable and Co., Ltd., 1908.) Price 8*s.* net.

We opened this book expecting to find it filled with the solutions of rather unpractical problems, the solutions, however, being of considerable importance in higher mathematics. We find that it is a very practical treatise which will prove useful to the increasingly numerous class of electrical engineers who deal with distributing networks, their insulation and faults. The last two chapters, on electrical safety valves and lightning conductors, are particularly good. J. P.

LETTERS TO THE EDITOR.

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

On the Relation of "Recoil" Phenomena to the Final Radio-active Product of Radium.

In the course of some experiments made by Miss Brooks (NATURE, July 21, 1904, vol. lxx., p. 270) on the active deposits from radium, it was found that the active product, radium B, escaped in some manner from a body which had been rendered active in the presence of radium emanation, and was carried at low pressures to the walls of the containing vessel. In his interpretation of this result, Rutherford ("Radio-activity," p. 392) suggests the possibility of the phenomenon being due to a recoil effect rather than to a volatility possessed by the product radium B.

Radium A atoms, in breaking up, are known to emit α particles with a velocity of $1{\cdot}7\times10^9$ cm. per sec., and as the mass of the α particle is 4 (H = 1) and that of the radium B atom approximately 200, it is clear from the explosive nature of the disintegration of the radium A atoms that the radium B atoms must be hurled away with a considerable velocity in directions opposite to those in which the α particles are projected.

Recent papers by Otto Hahn and Lise Meitner (*Verh. der deut. phys. Ges.*, xi., Jahr No. 3, and *Phys. Zeit.*, 10 Jahr, p. 81) and by Russ and Makower (Proc. Roy. Soc., No. 5, 553, p. 205, May 6) contain descriptions of experiments which confirm the truth of Rutherford's explanation, and also show that it is possible to isolate the radio-active products, radium A, B, and C, thorium D and actinium X and C, through the agency of this recoil action alone.

Other examples of this recoil phenomenon are also contained in the recent experiments of Debierne (*Le Radium*, April) and in those of Kennedy on the active deposit from actinium (*Physical Review*, May).

In considering these examples of the recoil effect, the question naturally arises of a possible connection between this phenomenon and the final transmutation product of radium. Radium G (polonium) is known to emit α rays, and when deposited on plates of copper, as Logeman and others have shown, to emit also a feeble δ radiation. From the illustrations which have been cited above it seems clear that here also the recoil phenomenon should manifest itself in the projecting from such radium G coated plates of atoms of the final radio-active product.

Evidence of such projection has recently been obtained in the physical laboratory at Toronto by Mr. V. E. Pound. In his experiments an insulated plate of copper, A, approximately 3 sq. cm. in area, which was coated with a deposit of radium G, was placed in a highly exhausted chamber facing a second insulated plate of copper, B. The plate B was joined to an electrometer, and the electrical charges which it acquired under various electric and magnetic fields were observed.

With moderate electric and magnetic fields results similar to those of Logeman, Ewers, Aschkinass, and others were obtained, and from the form of the charging curves which were obtained in such circumstances it was clear that at least three types of radiation were present and exerted an effect of greater or less degree on the charge acquired by the plate B, viz.:—(1) the α rays emitted by plate A; (2) easily absorbed δ rays emitted by plate A; and (3) an easily absorbed secondary radiation emitted by plate B, consisting of negatively charged particles.

With higher magnetic fields, however, an entirely new phenomenon appeared. With such fields, especially when the plate A was charged to an increasingly high positive potential, it was found possible gradually to increase the positive charge acquired by the plate B. As such higher magnetic fields were sufficient to prevent the secondary radiation from leaving the plate B, and the high positive potentials were sufficient to retain the δ radiation on the plate A without affecting the α radiation, it seems evident that the rise in the positive charge acquired by the plate B was due to the existence of a radiation of negatively charged particles from the plate A which had hitherto escaped detection, but which in these experiments were deflected by the magnetic field. When the plate A was neutral or negatively charged, the application of the magnetic field failed to give any indication of the presence of this radiation, but with the application of a potential of 160 or 240 volts (positive) to the plate A it could be readily brought into evidence. It is of interest to see, therefore, that in this case a positive electric field united with a magnetic field was the means by which the radiation was isolated.

The experiments are being continued, and it is too early at present to write more definitely regarding the new radiation. It seems, however, highly probable that this radiation can be attributed to the "rest-atoms" of the active product radium G. The expulsion of an α particle would leave this rest-atom negatively charged. Such rest-atoms would leave the plate in all directions as a stream of negatively charged particles. They would be less pene-

trating than the α particles, and so would escape detection in absorption experiments in gases at ordinary pressures.

If this new radiation consists of the "rest-atom" of radium G, we have in the property that it is projected with high velocity and in that that it carries an electrical charge the means of ascertaining its mass. Such a knowledge would give very definite information regarding the constitution of the final radio-active product of radium, and would also, in addition, furnish a means of checking the accuracy of the now highly authenticated theory by which the various known radio-active products of radium are connected and related.

The existence of this radiation, moreover, would afford a means of ascertaining whether the rest-atoms of radium G are the final products of radium or not, for it should be possible to obtain, through bombardment, a coating of these rest-atoms on a body such as the plate B in the experiments described above. This plate could then be placed in a high vacuum and investigated for the acquisition of an electrical charge. Any gain of charge which it might experience could be taken as proof of the formation of a new product, while the absence of such gain might be taken as evidence that radio-activity had ceased, and that in the rest-atoms of radium G stability is finally attained.

J. C. McLENNAN.

Physical Laboratory, University of Toronto, June 7.

Molecular Effusion and Transpiration.

ONE of Maxwell's most famous laws is his law on the distribution of velocities, to the effect that all the molecules of a gas do not possess the same velocity, but that the various velocities of the molecules group about a certain average velocity Ω in a definite way, which was further theoretically determined by Maxwell. This law has not, however, hitherto been directly proved by experiment, and I am therefore of opinion that the following may be of some interest to English readers.

The flow of the gases through very small apertures and narrow tubes at ordinary pressure has been investigated by Graham and several others, and definite laws (the effusion and transpiration laws) which apply to these flows have been found. My experiments now show that if the area of the aperture or the transverse section of the tube are small compared with the mean free path of the gas molecules, then other and still simpler laws than those mentioned will apply, and that these laws are easily deducible from the kinetic gas theory and Maxwell's law on the distribution of velocities. Detailed reports of the experiments have been published in *Annalen der Physik*, Bd. xxviii.; 1909.

Molecular Effusion.—According to the kinetic gas theory, the number of molecular shocks which the surface-area A of a wall receives during a second from the surrounding gas is equal to $\frac{1}{4}NA\Omega$, where N is the number of gas molecules in each cm.^{3} and Ω the average velocity of the molecules. If there is an aperture in the wall having an area A, and if N′ and N″ are the numbers of gas molecules at each side of the wall respectively, $\frac{1}{4}A\Omega(N'-N'')$ more molecules are flying through the aperture in the course of a second in one direction than in the other. Taking m as the weight of each molecule, the weight G of the gas flowing through the aperture during a second would be

$$G=\tfrac{1}{4}A\Omega(N'm-N''m)=\tfrac{1}{4}A\Omega(\rho'-\rho'')=\tfrac{1}{4}A\Omega\rho_1(p'-p''),$$

where ρ is specific gravity, p the pressure, and ρ_1 the specific gravity of the gas at the pressure 1 dyn./cm.^{2} and the temperature of the gas. According to Maxwell's law on the distribution of velocities we get $\Omega=\sqrt{\frac{8}{\pi\rho_1}}$, which gives

$$G=\frac{A}{\sqrt{2\pi}}\cdot\sqrt{\rho_1}.(p'-p'').$$

The fact that the weight found is proportional to, and therefore the volume of gas is inversely proportional to, the square root of the specific gravity has been shown by numbers of experiments made by different investigators; but the factor $\frac{A}{\sqrt{2\pi}}$ and the proportionality with the difference of pressure have not been experimentally found earlier, and they prove to apply only when the mean free path is more than about ten times greater than the diameter of the aperture. By a series of experiments with an aperture in a plate of platinum 0·0025 mm. thick, where the area of the aperture was found by means of the microscope to measure 5·21±0·16 millionth square centimetres, I found the following proportions between the observed quantity and that computed from the above formula:—hydrogen, 0·978; oxygen, 0·981.

From another aperture, the area of which was $66{\cdot}0\times10^{-6}$ cm.^{2}, the following proportions were found:—hydrogen, 1·021; oxygen, 1·038.

Consequently, the difference between theory and observation is 2 per cent. to 3 per cent., which is considered chiefly to be due to the difficulty of making an exact determination of the areas of such small apertures. If by computation of the above formula no attention had been paid to Maxwell's law on the distribution of velocities, and all the molecules had been considered as moving with the same velocity, we should have taken $\Omega=\sqrt{\frac{3}{\rho_1}}$, the effect of which would be that the computed values would become 8·6 per cent. greater than if we used Maxwell's formula, and the difference between theory and experiment caused thereby could scarcely be explained as an error of observation.

By the above-mentioned experiments the pressures were measured with McLeod's manometer, and the determinations of pressures checked each other, so that there was not found the slightest indication of a real or apparent deviation from the laws of Mariotte and Gay-Lussac.

The formula may be used for determination of $p'-p''$ if A and G are measured for some gas. In this way I have made an experimental determination of the maximum pressure of mercury vapour at 0°, and a series of higher temperatures up to 46°. By 0° the pressure was found to be 0·0001846 mm. mercury pressure. From the measurements I have obtained the following formula for the vapour-pressure p, given in mm. mercury (common system of logarithms, T=absolute temperature):—

$$\log p=10{\cdot}5724-0{\cdot}847\log T-3342{\cdot}26/T.$$

The mean deviation between the values derived from this formula and those observed amounts to 0·003 of the value, which shows that the constants of the formula are determined with fairly great accuracy. It is seen that if the formula is used for extrapolation to pressures at higher temperatures we get now positive, now negative deviations from the determinations made by other experimentalists, so that the formula in reality expresses the vapour-pressure of the mercury up to 880°, which is the highest temperature at which Cailletet and his collaborators have determined the pressure. At this temperature he found a pressure of 162 atmospheres where my formula gives 158 atmospheres.

Molecular Transpiration.—A series of experiments I have made with relation to the flow of gases through narrow tubes at low pressures has also confirmed Maxwell's law on the distribution of velocities. The calculation of the quantity of gas flowing through the tubes cannot, however, be made without using a new theory for the reflection of gas molecules from a wall. My theory for this reflection of gas molecules, which has been fully confirmed by the experiments, is as follows:—

A gas molecule meeting a wall is reflected in a direction which is absolutely independent of the direction in which it is moving against the wall, and a great number of molecules, meeting a wall, are reflected in every direction according to Lambert's law (the cos. law on the emission of light from a hot body). Consequently, the gas molecules may be considered as having strayed into the wall or as having been absorbed by it, to be emitted afterwards therefrom, provided that the gas and the wall have the same temperature. The calculation of the quantity of gas streaming through the tube is quite simple, though, however, too extensive to be given here. For the weight of gas flowing through the tube in each second we get the following expression:—

$$G=\frac{4}{3}\sqrt{2\pi}.R^3\sqrt{\rho_1}\frac{p'-p''}{L},$$

where R is the radius of the tube, L its length, and p' and p'' the pressures at the ends. By a series of experiments with a tube, the length of which was 2·00 cm., the radius 0·00333 cm., the proportions between the measured values and those calculated from this formula were found to be, for hydrogen, 1·04; oxygen, 1·01; carbonic acid, 1·01.

The formula will, however, only apply correctly when the radius of the tube is small compared with the mean free path. With increasing pressure $\frac{p'+p''}{2}$ (decreasing mean free path), the gas flow of a given value for $p'-p''$ decreases to a minimum, and afterwards increases in order to approach the value which it should have according to Poiseuille's well-known law. That this must be the case may easily be inferred from the kinetic gas theory in connection with the above-mentioned theory as to the interaction between gas molecules and a wall.

MARTIN KNUDSEN.

The University, Copenhagen.

The Germ-layer Theory.

THE germ-layer theory as stated on p. 428 of NATURE (June 10) by Mr. Stanley Gardiner appears in a rather extreme form. Probably all will agree that, not only the germ-layer theory, but every theory of development, presupposes a certain definiteness in structure of germ cells. But if that much is granted, it is not necessary to suppose that the differentiation of protoplasm has proceeded at so early a stage to such an extent as to preclude absolutely the possibility of protoplasm, which has been so far misplaced by experiment as to find itself in a new environment, responding to the influences of the new environment and so developing along a path it would not have followed had the experiment not been performed.

It seems difficult to comprehend what reason can be assigned for regarding those organs of the early phase of the life-cycle which we call germinal layers as being less capable of showing homology than the organs of later phases which we speak of as adult.

Surely the biological principles—whatever they may be—must apply equally throughout all periods of the life-cycle.

The argument from regeneration is hardly conclusive, because one essential of regeneration and budding seems to be the regression of differentiated protoplasm into undifferentiated protoplasm (or, at any rate, the origin in some way or other of an undifferentiated cell mass), that is to say, a regression to a state equivalent to a segmenting egg, namely, a state really prior to that of germ-layer formation.

Finally, it must be remembered that visible differences and resemblances are much less obvious in these early phases of the life-cycle than later, and that the difficulty of observation, owing to the minute size of the objects, is so great that errors of observation, which delay correct interpretations, are far more frequent than is the case with work upon the grosser phases of the life-cycle.

It cannot be conceded that the "anomalies in the formation of the layers in vertebrates" which are "patent to every student" are all capable of substantiation.

Grantchester, June 15. RIC. ASSHETON.

The Pollination of the Primrose.

IT appears that in a previous note on this subject (NATURE, June 17, p. 457) clearness may have been sacrificed to brevity. It is not meant that humming-bird and bee hawk-moths can be regarded as usual or frequent agents in the pollination of the primrose. They are mentioned in proof that some moths do, now and then, visit the flowers, and may presumably aid in their cross-pollination. There can be little doubt, however, that the humble-bee is herein the chief agent, and in this district, I should say, more particularly *Bombus hortorum*.

W. E. HART.

Kilderry, Londonderry, June 19.

FROST AND ICE CRYSTALS.[1]

DURING the past quarter of a century Mr. Wilson J. Bentley has devoted himself with a patient industry deserving of all praise to securing permanent records of the multitudinous forms assumed by water in its crystallised condition. The work has been executed at his home, a farmhouse, situated sixteen miles east-north-east of Burlington, Vermont, near the Canadian border, at an altitude of 1500 feet above sea-level, where the low temperatures experienced every winter are very favourable for the study of these forms. Seven years ago we directed attention (NATURE, 1902, vol. lxv., pp. 264–6) to his beautiful series of photomicrographs of snow crystals; a selection of them was reproduced in the *U.S. Monthly Weather Review*, and was accompanied by a paper in which Mr. Bentley described the methods used for obtaining the photographs, and the facts that could be established from a study of the almost bewildering variety of the forms represented. At the same time, but mainly during the subsequent years, Mr. Bentley has been further engaged in preparing a companion and complementary series of frost and ice crystals, *i.e.* the forms assumed by water that has crystallised immediately upon the surface of the earth. A large number of different types were reproduced in successive numbers of the *Monthly Weather Review* from August to December, 1907, and Mr. Bentley again contributes a description of the apparatus used, and full details with regard to the circumstances under which the several pictures were obtained.

Nearly the whole of the present series represents crystals that were formed during the winters of 1904–5, 1905–6, and 1906–7. For several reasons fewer difficulties were experienced in obtaining photographs of these crystals than was the case in the investigation of snow crystals; they could invariably be photographed in the positions in which they were found, and since, owing to the greater duration of growth, their size is usually much larger, smaller magnifications were required, and, indeed, in pictures of groups of crystals actual reductions were called for. The apparatus used was consequently simpler in character. For the majority of the photographs, in which the magnification did not exceed eight diameters, an ordinary portrait-lens was used in a camera which was fitted with a home-made extension arrangement, and the crystals were illuminated obliquely. For higher magnifications a microscope-objective, of ⅜- or ½-inch focal length, was employed, and the illumination was direct. The second method, which was required for the minute flakes deposited on windows, entailed more trouble in manipulation, because, while the camera was indoors, the diaphragm for cutting off all but direct light was on the other side of the window, and had, of course, to be adjusted for each position of the camera.

The series is divided into three principal groups—hoar-frost, window-crystallisation, and ice—a few sections dealing with hail being appended, and for convenience each group is split up into divisions and subdivisions, according to the shape or the grouping of the crystals. The hoar-frost group is divided into two main divisions—tabular and columnar—but the distinction is apparently one of degree only, and cannot be pressed. We have selected as an illustration of this group a beautiful example of the "open branch or tree-like" structure (Fig. 1). It will be noticed that the stems broaden out into well-developed plates at their terminations. The study of the crystals deposited on windows obviously admits of greater ease of observation, and, since the conditions of the atmo-

[1] "Studies of Frost and Ice Crystals." By Wilson J. Bentley. Pp. 22; with 273 figures on 31 plates. (Reprinted from the *Monthly Weather Review*, 1907.)

sphere obtaining within a dwelling provide more extensive ranges of temperature and humidity, greater diversity in the type of crystals is to be expected; it is not surprising, therefore, to find that three-fourths of the illustrations record forms that appeared on windows. This group is, of course, distinguished from the frost and ice groups, not by any essential difference in the characters of the crystals, but merely by their site. Crystallisation which has resulted from sublimation shows greater variety, and by far the larger number of examples are devoted to window-frost; but the window-ice forms, which occur in comparatively mild weather when a film of dew has first condensed on the surface of the glass, are not without interest. Mr. Bentley has greatly enhanced the value of the series by noting for each example the temperature out of doors and the temperature and degree of humidity within doors. Fig. 2 represents a beautiful example of "branching" window-frost. Its symmetry has been slightly affected by the disposition of the surrounding crystals, one arm exceeding the others in size; indeed, the limitations set by the chance position of adjacent crystals rarely permit of the almost perfect symmetry characteristic of snow-crystals. These fern- or tree-like forms are frequently seen on the windows of both warm and cold rooms, but are most common in unheated rooms of which the temperature ranges from 32° to 5° F. (0° to −15° C.) and the percentage of humidity from 55 to 70. Fig. 3 illustrates a nearly perfect example of the stelliform of window-frost, a slow-growing type that occurs only in cold weather when the temperature indoors is as low as 20° F. (−6·6° C.). The two crystals which we illustrate are fairly typical of the delicate crystallisation that embellishes the windows in frosty weather. Even in photographs their beauty is evident, but, to quote Mr. Bentley, "Only those who have seen frosted window-panes lit up by a bright winter moon, or seen them flash and sparkle under the rays of a winter sun, have seen the full beauty of the frost." Ice, though in appearance a uniform, solid mass, is really composed by the accretion of innumerable discrete crystals. The separate individuals are generally indistinguishable in the mass, but certain of them may be brought to light by slight heating—such as the warmth due to the sun's rays.

Mr. Bentley includes in his series reproductions of three admirable photographs—one is shown in Fig. 4—of "ice-flowers," Tyndall's appropriate term for them, embedded in solid ice; these particular photographs

FIG. 1.—Tabular hoarfrost.

FIG. 2.—"Branching" window-frost.

FIG. 3.—Stelliform window-frost.

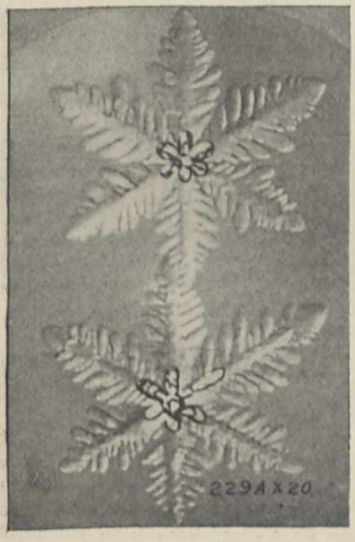

FIG. 4.—"Ice-flowers" in solid ice.

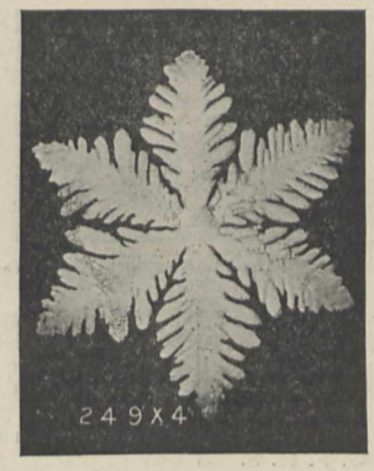

FIG. 5.—"Ice-flower" on freezing water.

FIG. 6.—Pear-shaped hailstone.

were taken by Prof. Benjamin W. Snow, of Wisconsin University. One of the more elaborate ice-flowers that form on the surface of freezing water is illustrated in Fig. 5. Mr. Bentley closes his paper with an interesting discussion of the occurrence and cause of hail in both summer and winter, and of the structure of hailstones. Hailstones have various shapes; they are commonly round, but egg- and pear-shapes are not rare. They invariably contain air-tubes and bubbles; a typical arrangement, shown by a stone which fell in the winter of 1906–7, is depicted in Fig. 6.

Thanks to Mr. Bentley, it is now possible to compare and study every variety of snow, frost, and ice crystals, and the way is clear for the next step, viz. to determine the factors and the conditions governing the several forms. It is strange how little is precisely known of the crystalline form of what in its three different phases is one of the most familiar, necessary, and conspicuous substances in nature. The system is undoubtedly hexagonal, possibly hemimorphic; but the axial ratios quoted in mineralogical text-books are based merely upon exceedingly rough observations made by Nordenskiöld on some snowflakes which fell during the severe winter of 1860. So far as we are aware, no crystal of water has yet been measured with a goniometer, and there is an opportunity for a crystallographer zealous enough to invade a refrigerator for the purpose of measuring a crystal grown under conditions that have been kept as uniform and as favourable as possible. In the course of his paper Mr. Bentley comments upon the curious changes that have often occurred during the growth of certain of the crystals. For instance, in Fig. 1 the crystals were at first narrow, but afterwards became broad and well-defined. This phenomenon may probably be explained as due to a change from the labile to the metastable condition. As Principal Miers has shown, in the labile condition the growth is rapid, and the crystals are narrow and ill-formed; whereas in the metastable condition the growth is slow, and the crystals are large and well-formed. We anticipate that experiments conducted under conditions of humidity and temperature which were accurately determined would be productive of results of considerable interest. It is clearly impossible to be sure of the temperature of a window even when those of the room and of the outer air are known; a slight gust of wind might cause a lowering of some degrees. G. F. H. S.

WATER POWER IN THE UNITED STATES.

IN many of the States of North America water is regarded as one of the most valuable of the natural resources. Unlike timber or minerals, it is inexhaustible, and so long as the rain continues to fall the water resources are being continually replenished. This fact has been more fully realised since the transmission of power to long distances has become practicable owing to the development of electricity.

The State of Wisconsin is probably as favourably situated as any of the States with reference to its water power. Realising this fact, the legislature, in conjunction with the Geological Department of the United States, undertook the surveying of the rivers of the State and the investigation of their adaptability to the generation of power. Six hundred miles of rivers have already been surveyed, and the results recorded in a report issued by the Wisconsin Geological and Natural History Department.

This report states that at the time of its publication water-power installations to the extent of 130,000 horse-power had been developed, this being only a small instalment of the resources of the rivers.

The average grade of the water surface of the rivers surveyed varies from 3 to 8 feet per mile. The average yearly rainfall is 32·30 inches. Dry periods occur in cycles of about twenty-five years, when the rainfall drops to 24·20 inches, and exceptionally dry periods occur about once in fifty years, when the lowest rainfall recorded was 13·50 inches. Owing to the storage effects of lakes and swamps, the low-water run-off is as high as 0·3 to 0·8 foot per square mile of the drainage area. The cutting down of the forests is, however, having a considerable effect on the yield of the rainfall; where clearances have been carried out the rain being less absorbed by the soil and the water reaching the streams more quickly.

The Fox River Paper Company's Mills, Appleton, Wis. Middle Dam.

The most important purposes to which the water power is applied are the paper and woollen mills and for electric light and traction. An example of the extended use of water power for generating electricity is to be found in the works of the small town of Kilbourn, on the Wisconsin River, and its distribution to places 50 miles distant. On the Saint Croix River, where a fall of 50 feet is available, the power developed is equal to 27,000 horse-power, and the transmission extends to a distance of 40 miles. The instalment on the Saint Louis River, when fully developed, will be equal to 200,000 horse-power, and the distance of transmission 75 miles. This instalment, when in full working order, will only be second to the great hydraulic plants at Niagara. On the Fox River there are three dams, and water power is supplied to a large number of paper and pulp factories, and also for factories and electric light and traction, the aggregate power being equal to 35,000 horse-power. The illustration, taken from the report of the Wisconsin Geological Department, gives some idea as to the extent of the factories the works of which are actuated by water power.

SCIENTIFIC RESEARCH IN THE SUDAN.

IT is hardly possible within the short compass of this review to give more than the briefest account of the contents of the very interesting volume referred to below.[1] One of the most important subjects from the point of view of the maintenance of stock and transport is animal trypanosomiasis. Thus, in camels in the French Sudan we have the disease known as Mbori; in dromedaries of the Upper Niger, le Tabaga; in Algerian dromedaries, El debab. A camel disease is also noted in this report at El Obeid, Kordofan, and another occurs in the Sinai peninsula close to the Mediterranean. The elucidation of the problem of the specific character of these trypanosomes and the mode of their transmission is not an easy matter. Trypanosome diseases are by no means confined to camels, but we find them also existing in horses, mules, and donkeys. The losses from these diseases appear to be considerable, but at present little can be done in the way of prophylaxis.

The report indicates that investigation into these various forms is being prosecuted on all sides. Different kinds of piroplasmosis (red-water) of cattle also exist, but researches on this point are at present not far advanced.

Another disease not of insignificance is spirochætosis of domestic fowls. It exists in poultry, geese, and guinea-fowl, and probably will be found common in wild birds, as ten years ago the present writer encountered spirochætes in birds in West Africa. The disease is, so far as is known, transmitted by ticks, of the genus Argas, which abound in the hen-runs. An important peculiarity of the hen spirochæte is the abundance of intracorpuscular forms of these parasites, a condition which does not prevail in other spirochæte diseases.

Dinkas of the White Nile, showing stork-like attitude. From the "Third Report of the Wellcome Research Laboratories at the Gordon Memorial College, Khartoum."

To turn to human diseases, it is uncertain at present whether sleeping sickness exists in the Bahr-el-Ghazal, but unfortunately there is a possibility, if not probability, of it being introduced from the Congo Free State. A useful suggestion is that chiefs should be paid for keeping the watering places near their villages free from trees and scrub, the haunts of *Glossina palpalis*.

Kala-azar, an extremely fatal disease, occurs in the vicinity of Abyssinia. The disease also exists in the Kassala province. A disease known as "Egyptian cirrhosis of spleen and liver," which closely resembles kala-azar, but the nature of which is unknown, is also recorded.

[1] Third Report of the Wellcome Research Laboratories at the Gordon Memorial College, Khartoum. By Andrew Balfour. Pp. 477. (London: Baillière, Tindall and Cox, for the Department of Education, Sudan Government, Khartoum, 1908.) Price 21s. net.

Three interesting sections then follow on protozoal investigations, largely carried out on the floating laboratory; on the helminthes collected in the Sudan; and on the reptiles and poisonous snakes. In the latter we note that the author speaks of "saliva" in connection with the fluid ejected by the spitting cobra (*Naja nigricollis*). The writer has often made these cobras spit on to the glass roof of their cage, but never could convince himself that the secretion came from the fangs. The expectoration, on drying, gives a white powder, whereas snake-venom is usually a pale yellow. The report by the economic entomologist is especially interesting, recording as it does the misdeeds of such pests as the cigarette beetle, that eats cayenne pepper; the white ants, that eat leather camel-bags—though they will not touch green Willesden canvas, "Solignum" also appearing to be an absolute preventive against them—the teredo, that attacks the timber in Port Sudan; the horn beetle, the enemy of the sportsman and trophy hunter; the clothes-beetle, the weevils, the cotton boll-worms, and the locusts, veritable plagues of Egypt.

A complete list of Sudanese mosquitoes, including several new species, is contributed by Theobald.

In an article on the healing art as practised by the Dervishes, the following effective method of amputation is described:—"The limb is stretched out of an opening in the wall or out of a window, and it severed with one stroke of a sharp sword, the stump being then plunged into boiling oil to stop the bleeding." The native belief that the wearing of high pattens is a protection against guinea-worm should be noted by those investigating the mode of entry of this crippling parasite. The physical characters of the Nilotic Negroid tribes, based on the work of the late Dr. Pirrie, forms a fascinating section, and "the call of Africa" is insistent on every page.

The work concludes with chemical investigations into the food-stuffs and very interesting work on the gums. We have said enough, perhaps, to give a slight idea of the interest and value of this report, not only to the scientific, but also to the general reader, and we heartily congratulate the director and his collaborators on the result. It is a magnificent volume, profusely illustrated, but it is just to this magnificence that we venture to raise objection. Its price and bulk will deter many from purchasing it to whom it would be of value. We think it might be possible to issue the work in a number of sections, medical, entomological, ethnological, &c., otherwise we are afraid that the next volume may be twice as bulky and twice as expensive. J. W. W. S.

THE DARWIN COMMEMORATION AT CAMBRIDGE.

THE celebrations in commemoration of the centenary of the birth of Charles Darwin and of the fiftieth anniversary of the publication of "The Origin of Species" are being held at Cambridge this week. The programme commenced on Tuesday, June 22, with a reception of delegates and other invited guests by the Chancellor of the University, Lord Rayleigh, O.M., F.R.S., in the Fitzwilliam Museum. By the kind permission of the master and fellows of Peterhouse, the college gardens were accessible from the museum. On the following day, Wednesday, there was a presentation of addresses by delegates of universities, colleges, academies, and learned societies in the Senate House. After an address by the Chancellor, and the presentation of delegates and addresses, there were a few short speeches. During the afternoon visits were made to the various colleges, and these were followed by a garden party, given by the master and fellows of Christ's College, in the college grounds. In the evening a banquet was held in the new examination hall; after which the master and fellows of Pembroke College gave an at home in the college hall and gardens. To-day (Thursday), the concluding day of the celebration, honorary degrees are to be conferred upon some of the delegates in the Senate House; the Rede lecture is to be delivered by Sir Archibald Geikie, president of the Royal Society, upon "Darwin as Geologist"; and a garden party is to be given at Trinity College by members of the Darwin family.

The delegates upon each of whom the degree of Doctor of Science *honoris causa* is to be conferred are:—Prince Roland Bonaparte, member of the Paris Academy of Sciences; Édouard van Beneden, professor of zoology at Liége; Geheimrat Hofrat Bütschli, professor of zoology and palæontology at Heidelberg; Robert Chodat, professor of botany at Geneva; Francis Darwin, F.R.S., honorary fellow of Christ's College, and formerly reader in botany; Karl F. Goebel, professor of botany at Munich; Ludwig von Graff, professor of zoology and comparative anatomy at the University of Graz, and president-elect of the International Zoological Congress which meets at Graz next year; Richard Hertwig, professor of zoology and comparative anatomy at Munich; Harold Höffding, professor of philosophy at Copenhagen; Jacques Loeb, professor of physiology in the University of California; Edmond Perrier, a member of the Institute of France, distinguished by his able organisation of the Natural History Museum of Paris, over which he presides; Gustav Albert Schwalbe, professor of anatomy at Strassburg; Hermann Graf zu Solms-Laubach, professor of botany at Strassburg; Clement Timiriazeff, professor of botany in Moscow; Frantisek Vejdovsky, professor of zoology in the Bohemian University of Prague; Max Verworn, professor of physiology at Göttingen; Hermann Vöchting, professor of botany at Tübingen; Hugo de Vries, professor of botany at Amsterdam; Charles Doolittle Walcott, secretary of the Smithsonian Institution at Washington; Edmund Beecher Wilson, professor of zoology in Columbia University, New York; and Charles René Zeiller, professor of palæobotany in the École des Mines, Paris.

During the celebration there was an exhibition of portraits, books, and other objects of interest in connection with Darwin, in the old library of Christ's College. The exhibition will remain open until the end of this week. All the many objects exhibited are directly connected with Charles Darwin or his ancestors. In the outer room are all the important portraits made of Charles Darwin during the time he lived. Of these mention should be made of the painting by Sir W. B. Richmond, K.C.B., which shows Darwin in his LL.D. gown, lent by the university; the well-known portrait by the Hon. John Collier, showing Darwin in his long black cloak and holding his hat in his hand, lent by the Linnean Society of London; and the well-known profile by W. W. Ouless, a replica of which hangs in Christ's College Hall, lent by W. E. Darwin. The larger portraits also include two of Mrs. Charles Darwin, by C. Fairfax Murray; one of Robert Waring Darwin, father of the naturalist; and others of Darwin's ancestors, amongst them the painting of his grandfather, Erasmus Darwin, by J. Wright, of Derby. Two crayon sketches of Darwin in middle life, by S. Laurence; water-colour drawings of Down, and of various scenes connected with the voyage of H.M.S. *Beagle*, are also represented here, together with the instruments used by Darwin on board the *Beagle*, and

some specimens of birds and fish collected during that voyage.

In the further room are Woolner's bust; a bust, medallion, and miniature of the Shrewsbury statue, by Horace Montfond; and a large bronze head, by William Couper, of New York, which the American delegates to the Darwin centenary are presenting to Christ's College. The large series of paintings, photographs, and sketches in this room represent Charles Darwin from the age of four to old age, and include Pelligrini's *Vanity Fair* cartoon of the naturalist in his high chair, similar to the one exhibited. Manuscripts, letters, copies of first editions, with Darwin's own notes, and medals and diplomas awarded to him, are present in great numbers, as also are many pictures of Down, Charles Darwin's home.

By the kindness of Mr. Francis Darwin, Charles Darwin's library was on view at the Botany School during the celebration. A few of the most interesting volumes were displayed in the Botanical Museum. The rock-specimens collected by Charles Darwin during the voyage of the *Beagle* were exhibited in the Sedgwick Museum, and the librarian of the University Library arranged an exhibition of MSS. and books illustrating the progress of scientific study.

The delegates selected by universities, academies, colleges, learned societies, and other bodies abroad to attend the celebration included the following:—

America (United States).—University of Michigan, Prof. H. S. Carhart; Johns Hopkins University, Prof. J. Mark Baldwin; University of California, Prof. Jacques Loeb; Brooklyn Institute of Arts and Sciences, Prof. C. B. Davenport; Boston Natural History Society, and Harvard University, Prof. Theobald Smith; Cold Spring Harbour Station for Experimental Evolution, Prof. C. B. Davenport; University of Ohio, Prof. G. Wells Knight; Cornell University, Dr. J. Gould Schurman; University of Wisconsin, Dr. F. B. Power; Mexican Government, Department of Public Instruction, Dr. J. Mark Baldwin; University of Minnesota, Prof. E. Van Dyke Robinson; Yale University and the Peabody Museum of Natural History, Prof. R. H. Chittenden; the Connecticut Academy of Arts and Sciences, Prof. Tracy Peck; New York Academy of Sciences, Mr. C. F. Cox, president; Columbia University, Prof. E. B. Wilson; New York University, Prof. H. M. Biggs; American Museum of Natural History, Prof. D. G. Elliot; University of Pennsylvania, Mr. C. C. Harrison; Philadelphia Academy of Natural Sciences, Dr. A. E. Brown; American Philosophical Society, Dr. H. F. Osborn; Carnegie Institute, Colonel Church; Princeton University, Prof. W. B. Scott and Prof. O. W. Richardson; Smithsonian Institution, Dr. C. D. Walcott; Carnegie Institution, Washington, Dr. R. S. Woodward; National Academy of Sciences, Dr. G. E. Hale; George Washington University, Dr. H. W. Wiley; Academy of Sciences, Washington, Dr. L. O. Howard; Woods Hole, Prof. E. B. Wilson.

America (South).—Universidad de Chile, Domingo Gana.

Austria-Hungary.—Magyar Tudományos Akadémia, Prof. S. Apáthy; Kir. Magyar Tudomány-Egyetem, Prof. Jules Dollinger; Graz Universität, Prof. Ludwig von Graff; Kolozsva Universität, Prof. S. Apáthy; Prague Universita, Prof. F. Vejdovský; Kaiserl. Akad. der Wissenschaften, Vienna, Dr. F. Steindachner and Prof. R. Wettstein; Vienna Universität and the Anthropologische Gesellschaft, Prof. V. Ebner; Zoologisch-botanische Gesellschaft, Vienna, Prof. R. Wettstein; Naturhistorisches Hof-Museum, Vienna, Dr. F. Steindachner.

Belgium.—Université libre de Bruxelles, M. Auguste Lameere; Académie Royale des Sciences, Prof. E. van Beneden; Musée Royal d'histoire naturelle de Belgique, M. E. Gilson; Ghent Université, M. H. Leboucq; Louvain Université, Prof. H. de Dorlodot.

Denmark.—Copenhagen Universitet and Det Kongelige Danske Videnskabernes Selskab, Prof. H. Höffding; National Museet, Prof. H. F. E. Jungersen.

Egypt.—Cairo School of Medicine, Mr. H. P. Keatinge.

France.—Société Linnéene de Normandie and Caen Université, Prof. L. Brasil; Lille Université, Prof. A. Malaquin; Montpellier Université, Prof. O. Duboscq; Nancy Université, Prof. L. Cuénot; Université de Paris, Prof. F. Le Dantec; Institut de France, M. E. Perrier and Prince Roland Bonaparte; École d'Anthropologie, Prof. G. Papillault; Musée d'Histoire Naturelle, M. E. Perrier; Institut Pasteur, Prof. Élie Metchnikoff; École des Mines, M. R. Zeiller; Société d'Anthropologie, Dr. Manouvrier; Société de Biologie, Dr. Eugène Dupuy and Prof. L. Lapicque; Société géologique de France, M. de Margerie.

Germany.—Berlin Universität, Prof. C. Stumpf; Königl. Preussische Akademie der Wissenschaften, Prof. Waldeyer, Prof. Diels, Prof. Engler, and Prof. O. Hertwig; Königl. Museum für Naturkunde, Prof. A. Brauer; Deutsche Botanische Gesellschaft, Prof. A. Engler; Gesellschaft für Anthropologie, Ethnologie und Urgeschichte, Dr. F. von Luschan; Bonn Universität, Prof. Schultze; Breslau Universität and the Schlesische Gesellschaft für vaterländische Cultur, Prof. Kükenthal; Frankfurt, Senckenbergische Naturforschende Gesellschaft, Dr. Ernst Roediger; Freiburg i. B. Universität, Prof. R. Wiedersheim; Giessen Universität, Prof. Spengel; Göttingen Königl. Gesellschaft der Wissenschaften, Prof. M. Verworn; Göttingen Universität, Prof. Berthold; Greifswald Universität, Prof. Erich Kallius; Halle Leopoldinisch-Carolinische Akademie, Dr. R. Hertwig; Halle Universität and Naturforschende Gesellschaft, Prof. J. Walther; Heidelberg Universität, Prof. Bütschli; Jena Universität, Prof. L. Plate; Kiel Universität, Prof. Brandt; Leipzig Universität and Königl. Sächsische Gesellschaft, Prof. Rabl; Marburg Universität, Prof. Korschelt; München Universität, Prof. R. Hertwig; München, K. Bayerische Akademie der Wissenschaften, Prof. Goebel; Münster Universität, Prof. E. Ballowitz; Rostock Universität, Prof. H. Spemann; Strassburg Universität, Prof. Solms-Laubach; Tübingen Universität, Prof. H. von Vöchting; Würzburg Universität, Prof. Theodor Boveri.

Holland.—Koninklijke Akademie van Wetenschappen, Prof. H. de Vries; Koninklijk Zoologisch Genootschap "Natura Artis Magistra," Dr. C. Kerbert; Groningen Universiteit, Prof. J. F. van Bemmelen; Hollandsche Maatschappy de Wetenschappen, Dr. J. P. Lotsy; Leyden Universiteit, Prof. G. C. J. Vosmaer; Utrecht Universiteit, Prof. A. A. W. Hubrecht.

Java.—Buitenzorg, Departement van Landbouw, Dr. J. C. Koningsberger.

Italy.—Catania Università, Prof. W. Bateson, F.R.S.; Genoa Università, Prof. R. Issel; Modena, Società di Naturalisti e Matematici, Prof. A. C. Seward, F.R.S.; Naples, Stazione Zoologica, Dr. R. Dohrn; Società Geografica Italiana, Marchese di San Giuliano; R. Accademia dei Lincei, Conte Ugo Balzani, Lord Rayleigh, O.M., F.R.S., and Sir George Howard Darwin, K.C.B., F.R.S.; Siena Università, Prof. C. Achille Sclavo; R. Istituto Veneto, Dr. G. Veronese.

Japan.—Kyoto University, Prof. G. Kuwaki; Tokyo University, Prof. C. Ishikawa.

Norway.—Christiania Universitet, Prof. H. Mohn.

Portugal.—Coimbra Universidade, Prof. J. A. Henriques; Lisbon, Sociedade de Geographia, Dr. S. Telles; Oporto, Academia Polytechnica, A. F. de Lacerda.

Russia.—Dorpat Universitet, Prof. A. I. Jarotskij and Prof. N. I. Kuznetsov; Helsingfors Universitetet and Finska Vetenskaps Societet, Prof. F. Elfving; Moscow Universitet and Société Impériale des Naturalistes de Moscou, Prof. C. A. Timiriazeff; St. Petersburg Universitet, Prof. V. M. Schimkewitsch; St. Petersburg, Imperatorskaja Akademija Nauk, Prof. V. V. Salensky and Prof. I. P. Borodin.

Sweden.—Lund Universitetet, Prof. J. Forssman; Lund, Kungl. Physiografiska Sällskapet, Prof. O. Nordstedt; Stockholm, Kungl. Svenska Vetenskaps-akademien, Prof. H. Théel and Dr. Svante Arrhenius; Stockholms Högskola, Prof. W. Leche; Stockholm, Naturhistoriska Riksmuseet, Prof. A. G. Nathorst; Stockholm, Kungl. Karolinska Medico-Kirurgiska Institutet, Count K. A. H. Mörner; Uppsala Universitetet and K. Vetenskaps Societeten, Prof. S. G. Hedin.

Switzerland.—Bern Universität, Prof. H. Strasser; Geneva Université, Prof. R. Chodat; Neuchatel Académie,

Prof. Edmond Béraneck; Schweizerische Naturforschende Gesellschaft, Dr. P. Sarasin.

Africa.—University of the Cape of Good Hope; South African College, Prof. H. H. W. Pearson; Grahamstown, Rhodes University College, Bouchier F. Hawkesley; Transvaal University College, Sir Richard Solomon, K.C., K.C.B., K.C.M.G.; Geological Society of South Africa, Prof. A. C. Seward, F.R.S.

Australia.—Adelaide University, Prof. W. H. Bragg, F.R.S.; University of Tasmania, J. Sprent; Royal Society of Tasmania, the Hon. J. McCall; Melbourne University, Dr. C. J. Martin, F.R.S.; Royal Society of Victoria, Prof. A. Dendy, F.R.S.; Sydney University and Royal Society of New South Wales, Prof. A. Liversidge, F.R.S.

Canada.—University of New Brunswick, Dr. C. C. Jones; Nova Scotian Institute of Science, Dr. H. S. Poole; Kingston, Queen's University, Prof. N. F. Dupuis; McGill University, Prof. E. W. MacBride; Royal Society of Canada, Prof. W. H. Ellis; Toronto University, Dr. R. A. Falconer and Prof. T. G. Brodie, F.R.S.; University of Manitoba, Prof. A. H. R. Buller.

India and Ceylon.—Allahabad University, Prof. A. W. Ward; Bombay University, Sir E. T. Candy; Calcutta University, Prof. S. Chandra Mahalanobis; Geological Survey of India, R. D. Oldham; Asiatic Society of Bengal, Lieut.-Colonel H. H. Godwin-Austen, F.R.S.; Punjab University, the Hon. Sir Lewis Tupper, K.C.I.E.; Madras University, Edgar Thurston; Peradeniya, Royal Botanic Gardens, Dr. J. C. Willis.

New Zealand.—Auckland University College, the Hon. W. Pember Reeves; Canterbury University College, Prof. E. Rutherford, F.R.S.; Philosophical Institute of Canterbury, T. V. Hodgson; New Zealand University, the Hon. Sir Robert Stout, K.C.M.G., Prof. Sale, and Prof. J. M. Brown; Wellington, Victoria, University College, H. D. Bell.

Straits Settlements.—Royal Asiatic Society (Straits Branch), J. B. Carruthers.

In addition to these representatives of institutions abroad, delegates were appointed by our own universities, university colleges, and scientific societies to take part in the celebration, and many other distinguished guests were present. The invitations to men of science were, except in a few cases, confined to naturalists, the committee having decided not to invite representatives of the physical sciences as such. Had it not been necessary, on account of space, to make this limitation, there is no doubt the celebration would have been even more remarkable in character than it was. The spirit of Darwin is the spirit of modern science, and every investigator who has been inspired by it would have welcomed an opportunity to assemble with the object of commemorating the greatness of the man and his work. No more brilliant assembly of representatives of the biological sciences throughout the world could, however, have been brought together than that which met on Tuesday at the opening of the celebration. The committee, and particularly the honorary secretaries, Prof. A. C. Seward and Mr. J. W. Clark, are to be congratulated upon the plan of the celebration, and the very successful way in which it has been carried out. Not for many years can Cambridge be the focus of so many investigators of animate nature from far and near as it has been this week. The celebration is of great historic significance, and will long be remembered as a worthy expression of the high estimation in which Charles Darwin's memory is held throughout the scientific world.

NOTES.

ON June 28, 29, and possibly June 30, the third meeting of the Solar Commission of the International Meteorological Committee will be held, under the presidency of Sir Norman Lockyer, K.C.B. The Royal Society has placed a room at the service of the commission, and the meetings will commence at 11 a.m. each day. The following members have notified their intention of being present:—M. A. Angot (France), Prof. H. Birkeland (Norway), Prof. E. von Everdingen (Holland), Sir Norman Lockyer (Great Britain), Dr. W. J. S. Lockyer (Great Britain), Captain H. G. Lyons (Egypt), M. E. Marchand (France), Prof. H. Mohn (Norway), Dr. W. N. Shaw (Great Britain), M. A. Silvado (Brazil), and M. Teisserenc de Bort (France). This commission, it may be remembered, was originated by the International Meteorological Committee at the meeting in Southport in 1903, when Dr. W. N. Shaw proposed that a commission should be appointed to review and discuss meteorological observations from the point of view of their connection with solar physics. Dr. Shaw's motion was adopted, and Sir Norman Lockyer, Dr. Shaw, Prof. Pernter, and M. Angot were elected to serve on this commission, with power to add to their number and to elect their officers. Since then two meetings have been held, one at Cambridge in 1904 and the other at Innsbruck in 1905, with Sir Norman Lockyer as president and the late Sir John Eliot as secretary. The forthcoming and third meeting of the commission will be devoted chiefly, among other items, to the actions taken with regard to previous resolutions concerning the collection and publication of meteorological and solar data, and also to an important statement submitted by Dr. Shaw in relation to the selection of stations from ten-degree square areas.

OF the many scientific organisations, few have made more rapid progress than the Association of Economic Biologists. Founded in November, 1904, it has already held conferences in Birmingham, Liverpool, London, Edinburgh, and Cambridge, and on July 13, 14, and 15 it will meet at Oxford. According to the programme, the annual general meeting will be opened by the president, Dr. A. E. Shipley, F.R.S., on July 13, with an address on some diseases of fish and birds associated with the presence of parasites. The programme is a lengthy and interesting one. Prof. G. H. F. Nuttall, F.R.S., and Dr. Hadwen will read a communication on the successful curative treatment of piroplasmosis, to be followed by others by Prof. E. B. Poulton, F.R.S., on predaceous insects and their prey, and Prof. W. Somerville, on injurious fungi. "The Winter Breeding of the Housefly" is the title of a paper by Mr. F. P. Jepson; Mr. A. D. Darbishire will contribute an important paper on the application of recent discoveries in heredity to economic problems, and Dr. S. A. Neave on the distribution of *Glossina palpalis* and sleeping sickness. Other communications will be made by Messrs. W. E. Collinge, A. J. Grove, C. Gordon Hewitt, C. H. Hooper, R. S. MacDougall, G. W. Smith, and C. Warburton. On the afternoon of Wednesday, July 14, Prof. Somerville and Mr. G. H. Grosvenor will lead an excursion to Bagley Wood. Further particulars of the meeting may be obtained from Mr. Walter E. Collinge, Uffington, Berkhamsted.

THE annual general meeting of the Research Defence Society will be held at the Royal Society of Medicine, 20 Hanover Square, W., on Friday, June 25, at five o'clock. The Earl of Cromer, president of the society, will take the chair. Other speakers will be Sir James Dewar, Sir A. Conan Doyle, the Hon. Walter Guinness, and Prof. Starling.

THE sixth International Congress of Psychology will be held in Geneva on August 3–7. M. Flournoy is to be the president of the congress, and the general secretary is Dr. E. Claparède, 11 Avenue de Champel, Geneva.

THE council of the Royal Society of Arts, with the approval of the Prince of Wales, president, has awarded the Albert medal of the society for the current year to Sir Andrew Noble, K.C.B., F.R.S., "in recognition of his long-continued and valuable researches into the nature and action of explosives, which have resulted in the great development and improvement of modern ordnance."

THE council of the Royal Society has awarded the Mackinnon studentships for the year 1909 as follows:—one in physics to Mr. R. D. Kleeman, of Emmanuel College, Cambridge, for the continuation of his researches on radio-activity, which he proposes to conduct at the universities of Cambridge, Leeds, and Manchester; the other, in biology, has been renewed for a second year to Mr. D. Thoday, of Trinity College, Cambridge, for research into the physiological conditions of starvation in plants and its relation to the responsiveness of protoplasm to stimulation, especially to stimuli affecting respiration.

WE regret to see the announcement of the death of Dr. G. F. Deacon, member of the council of the Institution of Civil Engineers, and president of the engineering section of the British Association in 1897.

DR. W. STIRLING, professor of physiology in the University of Manchester, has been elected a foreign corresponding member of the Turin Royal Academy of Medicine.

IT is announced that Mr. E. H. Shackleton has been elected a Younger Brother of Trinity House, with the approval of the Prince of Wales, who is the master of this corporation. This is the second time only in the history of Trinity House that this honour has been conferred by the master.

M. J. VALLOT has been elected by the Société des Observatoires du Mont Blanc director of the observatory founded by the late M. Janssen, so that he is now director of two observatories on Mont Blanc. He has decided to present to the society the observatory founded by himself. Men of science anxious to carry out researches in the Mont Blanc meteorological observatories are requested to communicate either with the general secretary of the society in Paris, or with M. Vallot at Chamonix during the summer, and at 5 rue François Aune, Nice, or in Paris, during the winter. Publications are invited towards the library in connection with the observatories, and may be sent to M. Vallot at Nice.

THE Institute of France has awarded the Osiris prize, of the value of 4000*l*., to M. Louis Blériot and M. Gabriel Voisin, for their experiments and achievements in aërial navigation. The prize is awarded every three years for the most remarkable contribution to the cause of human progress during that period.

THE first annual dinner of the Society of Tropical Medicine and Hygiene was held on June 18. Colonel Seeley, in proposing the toast "Success to the Society," said that from information he had obtained at the Colonial Office it appeared that half a million people have died of sleeping sickness alone in Uganda, but, owing to the discovery of the method by which it is propagated, the ravages of that disease have been at least reduced to one-tenth of what they were formerly. Sir Alfred Jones, in supporting the toast, remarked that in Liverpool 100,000*l*. has been spent on the work and 28,000*l*. in sending out expeditions. Sir Rubert Boyce, who followed, pointed out that yellow fever is practically a disease of the past in the West Indian group. In the Isthmian Canal zone, in the time of M. de Lesseps, 48,000 men employed on the canal works died, but during the last three years there has not been a single case of yellow fever in that zone. Prof. Ronald Ross, C.B., F.R.S., who occupied the chair, responded, and said that the members of the society now number nearly 350, most of whom are doing their duty in the tropics. This country has, he continued, led the way in research in tropical medicine, and he expressed the hope that it will now lead the way in the practical application of the researches.

THE May number of the *National Geographic Magazine* contains an article by Mr. G. Shiras, illustrated with a large number of reproductions from the photographs of bird-life by Mr. F. M. Chapman which originally appeared in his "Camps and Cruises of an Ornithologist." Among the most striking photographs are those of the great colonies of flamingoes in the Bahamas. Specially interesting are Mr. Chapman's observations on the manner in which young flamingoes feed. For the first three weeks, during which the beak is straight, they pick up their food in the normal manner. After this the beak begins to bend, and feeding is effected by turning the end upside down and scooping up the nutriment. Unlike most birds, flamingoes have the upper half of the beak movable, and by moving this rapidly the mud and water taken into the mouth are strained off, leaving the small bivalves on which these birds feed.

SUBJECTS connected with evolution continue to occupy a prominent place in the *American Naturalist*, the contents of the June number including an article on heredity and variation in the simplest organisms, by Prof. H. S. Jennings, and a second, by Dr. J. A. Harris, on variation in the number of seeds in the pods of the broom (*Cytisus scoparius*). In the former of these the author points out that low unicellular organisms, such as Paramecium, are divisible into races differing by minute but constant features. In each of these races great individual variation in the matter of size is noticeable, but such differences are not inherited. The fundamental constitution of each is almost unaffected by external influences, observations extending over hundreds of generations of thousands of individuals of Paramecium revealing scarcely a single instance of such a change. Systematic and continued selection is without effect in a pure race, and in a mixture of races its effect consists in isolating the existing races, and not in producing anything new.

IN continuation and amplification of the study by Mr. W. C. Hossack of the rats of Calcutta, Captain R. E. Lloyd has undertaken an elaborate investigation into the racial and specific characters of those of India generally, the results of which are published in vol. iii., part i., of the Records of the Indian Museum. The investigation includes, not only the brown and the black rat and their local forms, but likewise *Mus mettada* and its allies, together with the various species formerly included in the genus Nesocia, but now split up into three generic groups. The great feature of the investigation is the enormously large series of specimens of the various forms which have passed through the author's hands, and have furnished materials for elaborate tables of measurements. One result of these extensive comparisons has been to raise in the author's mind grave doubts as to the validity of certain so-called species which have been described of late years. Captain Lloyd is also doubtful as to the advisability of the above-mentioned splitting of the old genus Nesocia, the members of which, by the way, he designates as "mole-

rats," a name usually restricted to the representatives of the genus Spalax. A better title is bandicoot-rats, taken from the ordinary name of the largest species. Captain Lloyd's investigations were undertaken as supplemental to those dealing with rats and plague, and certain very interesting deductions are drawn in connection with this aspect of the investigation. It is shown, for instance, that the brown rat, the great disseminator of plague, is absent from Madras, the only Indian port at present free from plague, where its place in the sewers of the city is taken by the great bandicoot-rat. The inference from this feature in distribution is obvious, although in some degree discounted by the occurrence of plague in districts where the brown rat is rare or unknown.

FROM the report of the director for 1908, we learn that the aquarium of the New York Zoological Society is becoming more and more attractive as a place of popular resort, the number of visitors during the year under review being considerably more than two and a half millions, forming a daily average of nearly seven thousand. During 1908 a sea-water system was installed, with an underground reservoir capable of holding 100,000 gallons, and the result of this has rendered it possible to keep a number of marine animals never previously exhibited in the establishment. It is stated that the difficulties encountered in the heating of sea-water by means of iron and bronze heaters, which corrode and break down, have apparently been solved by the employment of a heavy coiled heater made of chemical lead, which has lasted much longer than others previously tried. No other aquarium has problems to contend with like those which have developed in New York, where sea-water is heated in winter for tropical species and fresh-water refrigerated in summer for northern forms. With warm and cold tanks of both fresh and salt water, there are four distinct water-systems in use. About 200 species of fishes are usually kept in the ninety-four glass-fronted tanks, including from 3000 to 4000 specimens of native marine and fresh-water species and tropical species from the Bermudas. These figures do not include the product of the fish-hatchery. The collection of invertebrates is at present limited to local marine forms. The large ponds contain seals, sea-lions, alligators, crocodiles, turtles, and sturgeons, while in the table tanks are usually shown about twenty species of fresh-water tortoises. During September the large central pond contained two porpoises, and a leathery turtle weighing 840 lb. Unfortunately, some of the lung-breathing marine animals are ill adapted to indoor life, and it may prove undesirable to repeat experiments with those affected by the warm air when the building is heated.

PROF. E. GAUPP, the eminent comparative anatomist of Freiburg, has turned aside, as so many past and present anatomists and physicians have done, to investigate the problem of man's right-handedness. His essay, in which he brings together the best that is known concerning the preeminence of the right hand, has just been published by Mr. Gustav Fischer, of Jena, as the first part of a "Sammlung anatomischer und physiologischer Vorträge und Aufsätze," edited by himself in conjunction with Prof. W. Nagel. He regards right-handedness as a human characteristic, and agrees with those who seek an explanation in the preponderance of the left hemisphere of the brain. This preponderance he thinks may be explained by the asymmetry of the blood-vessels and other organs of the body. The essay, while adding little that is new to the subject, is a clear and useful summary of its literature. English writers are very fully cited, with one notable exception—no mention is made of Prof. Elliot Smith's paper, the most important that has yet appeared. Advocates of ambidextry will be glad to learn that they have gained a supporter in the professor of comparative anatomy of Freiburg.

DR. MAX HARTMANN discusses the meaning of sexuality in relation to the formation of gametes in a very interesting little work ("Autogamie bei Protisten") published by Mr. G. Fischer, Jena, as a reprint from the well-known *Archiv. f. Protistenkunde*. The author briefly describes the various forms which the sexual elements assume, and points out the importance of paying due regard to the sexual fusion of very nearly related gametes. He gives a useful summary of the various forms of sexuality, and traces the gradual disappearance (apomixis) of the latter in extreme cases of parthenogenesis and apogamy. He regards these types as derived from originally differentiated sexual conditions, and supports his view by an interesting review of the protista regarded from this standpoint. Dr. Hartmann very rightly insists on the fact that the sexual process as it presents itself in the higher forms is not a simple function, urging that it includes several distinct processes. He disagrees with Hertwig's views, which would imply a mere restoration of a specific relation between nucleus and cytoplasm, and seems to consider that the essence of sexuality consists in the union of nuclei which have distinct properties, the one more especially related to trophic, the other to kinetic, functions. But he expresses himself with great reserve, and concludes by admitting that, while this conception of the dual nature of the sexual nuclei is a good working hypothesis, it is hardly likely to prove the master key to all the problems of sexuality and fertilisation.

A STRIKING array of new plants is presented by Dr. J. N. Rose in the sixth of his studies of Mexican and Central American plants, published as vol. xii., part vii., of the Contributions from the United States National Herbarium. A new species of Dioon with both kinds of cone, and an Ephedra, were collected in southern Mexico. Four species are added to the strange parasitic genus Pilostyles, making a total of eight American species; all have been found growing on leguminous plants, generally on species of Parosela. The Cactaceæ received special attention on collecting trips, and illustrations are given of *Echinocactus palmeri*, which has a stem 5 feet high; *Opuntia Lloydii*, an arboreal species; and a dwarf creeping plant, *Opuntia vilis*. The author proposes to split up the genus Lopezia with the formation of three new genera, Pseudolopezia, Pelozia, and Jehlia.

AN ecological sketch of the Streletz steppe in the neighbourhood of Kursk is presented by Mr. W. Alechin in the botanical section (series iv., fasc. 1) of *Travaux de la Société des Naturalistes*, St. Petersburg. The area is described as a meadow steppe, in which bushes form the chief feature, while grasses are of subsidiary importance; plants of the composite family are in great abundance. Around the steppe are woods, consisting chiefly of oak trees. The author comes to the conclusion that it is part of an ancient and original steppe formation, and that the woods are innovations. The succeeding fascicle is assigned to a paper, by Mr. W. P. Sawitsch, on the lichen vegetation in the south-west portion of the government of St. Petersburg. A study of the factors regulating distribution points to the importance of light and shade and moisture conditions, combined with the physical nature of the substratum.

IT will be readily understood that bacteria do not lend themselves to ordinary standards of classification. According to two systems adopted, they have been massed into certain main groups or have been arranged according to their reactions in a few standard media. Mr. C. E. A. Winslow contributes an article on the subject to the Bulletin of the Torrey Botanical Club (vol. xxxvi.), in which he advocates a statistical method derived from the analysis of quantitative measurements extending over a large series of cultures. The characters or properties employed for discrimination are first selected by means of a preliminary survey. A special point in the paper is the argument in favour of a classification based on physiological as opposed to morphological characters.

TWO communications dealing with the flora of Prince Charles Foreland, Spitsbergen, are published in the Transactions and Proceedings of the Botanical Society of Edinburgh (vol. xxiii., part iv.). Mr. R. N. R. Brown deals with the flowering plants and ferns collected by Dr. W. S. Bruce on the island in the years 1906 and 1907. *Saxifraga oppositifolia* is the first plant to flower as soon as the snow disappears in June; in early September the autumn falls of snow begin and close over the flowers of *Cardamine pratensis*, *Saxifraga aizoides*, and other late bloomers. The genera Saxifraga and Ranunculus supply thirteen out of a total of fifty-five species. Gamopetalous plants are limited to two composites, a Campanula and a Pedicularis. The mosses and liverworts are described by Mr. J. Hagen. Owing to the short growing period, only one species, *Oncophorus Wahlenbergii*, was found in fruit, and three others bearing antheridia or archegonia.

REFERENCE has already been made in NATURE to the method brought forward by Prof. H. Molisch for using a warm-water bath as a means of forcing plants when in a dormant condition. In response to inquiries, the author has elaborated his paper for publication, with additional illustrations, as a separate pamphlet published by Mr. Gustav Fischer, Jena (price 1.20 marks). The method consists in plunging the plants, preferably inverted, so as to immerse the stems but not the roots, into a water bath maintained at a temperature ranging, according to the plant, from 15° C. to 30° C. After soaking in the bath for about ten to fifteen hours, the plants are placed in a warm, moist chamber, and eventually transferred to the greenhouse. Forsythia, Spiræas, Syringas, and other plants that are usually forced give good results. *Azalea mollis* and *Camellia japonica* did not respond to treatment, and there was no practical result in the case of Narcissus bulbs. The precise nature of the action has not been determined, although it is suggested that the stimulus may be compared with that produced by ether vapour.

THE ninth volume of the *Bulletin du Jardin impériale botanique*, St. Petersburg (parts i. to iii.), contains, amongst other papers, a preliminary communication by Mr. A. A. Elenkin on the plankton, mosses, and lichens in and around Lake Selguer, in the government of Tver. The more important algæ collected in the lake included species of Anabæna, *Ceratium hirudinella*, *Tabellaria fenestrata*, and *Staurastrum gracile*. Some rare lichens were found, notably *Rhizocarpon postumum* and *Acarospora oligospora* growing on rocks, and the type of a new genus, *Placynthiella arenicola*, gathered on sandy soil. A short notice is communicated by Mr. N. A. Busch of a botanical expedition in the Caucasian province of Kuban, when he determined the north-western limit of *Fagus orientalis* and the western limit of *Acer tataricum*.

IN the *Fortnightly Review* for June Mr. E. Clodd discusses the pre-animistic stages in savage religion. He finds these in the conception of the Algonquin Manatou, the Oki or Orenda of the Iroquois, and in the better-known Mana of the Melanesians, which last is defined by Dr. Codrington to mean a supernatural power or influence which operates to effect everything beyond the ordinary power of men, outside the common processes of nature. At the back of the barbaric mind Mr. Clodd finds that in the evolution of the idea of God the passage is made from a vague, inchoate Naturism to a definite, concrete Animism, which draws its support from divers causes, among which he groups "the Opinion of Ghosts, Ignorance of second causes, Devotion towards what men fear, and taking of things Casuall for Prognostique"—to use the classification of the philosopher Hobbes. He does not go farther, as recent speculation is inclined to do, in tracing the origin of the savage conception of Deity to a primitive Monotheism, while Animism is held to explain only the dead material of savage religion—that which concerns the human, the natural, the world of the dead, animated nature, ancestor worship, and so on.

THE Huxley memorial lecture by Prof. W. Z. Ripley, on the subject of the European population of the United States, is published in the current number of the Journal of the Royal Anthropological Institute. He observes that, in contrast to the population of Europe, the white race in America is "artificial and exotic. It is as yet unrelated to its physical environment. A human phenomenon unique in the history of the world is the result." At present the information is too scanty to enable us to judge of the tremendous effects of the introduction into a new country of about twenty-five millions of immigrants since 1820. These hosts have been drawn, not only from the higher races, "but we have tapped the political sinks of Europe, and are now drawing large numbers of Greeks, Armenians, and Syrians." The primary question is whether these various racial groups are to coalesce to form a more or less uniform American type, or whether they are to maintain a separate existence as members of a single government. The process of fusion is aided by the mobility of the American population and by the inequality of sexes among the immigrants, some 70 per cent. of whom are males, a fact which encourages alliances between them and American women. On the other hand, there is considerable concentration among some of the foreign colonies. After an interesting discussion of the problems of race amalgamation, the lecturer points out that the "white man's burden" imposed upon the rulers of India and the Americans in relation to negroes and Filipinos is much less serious than that laid on the statesmen of Canada and the United States of maintaining amidst this engulfing flood of foreigners the ideals of Anglo-Saxon culture and civilisation.

IN an interesting paper entitled "Réflexions d'une Artiste sur les Dessins de la Caverne d'Altamira," M. Lotus Péralté reviews the artistic character of the wall paintings in this cave as described by MM. E. Cartailhac and H. Breuil. He dwells with enthusiasm on these admirable delineations of animal forms as contrasted with the infantile productions of the Hyperboreans, Australians, and Bushmen. The Magdaleneans who produced these drawings are, in his view, the successors of a long-established art school, the "ethnical débris" of a profoundly cultured race, of which the last vestiges disappeared before the inroad of the Neolithic people. The artistic capacity of this earlier race may be readily

admitted, but at present we have no materials to justify the conclusion that they represent a degradation of culture, even though the steps by which this artistic capacity was acquired may remain one of the unsolved problems of ethnology. The evidence of this "cultural break" between the art of the Palæolithic people and its comparative absence in the Neolithic people has been recently discussed by Mr. W. Johnson in his "Folk-memory, or the Continuity of British Archæology," which offers as reasonable a solution of this tangled problem as is possible at present

MR. I. M. CASANOWICZ, in the thirty-sixth volume of the Proceedings of the United States National Museum, gives an account of the collection of rosaries under his charge. It is rather disappointing in numbers and interest when compared with more than one collection in this country, containing only 105 examples, of which twenty-seven belong to the Roman Catholic Church. Strange to say, there is no example of a Brahmanical rosary, while those from Japan, Tibet, and China are of some importance. The rosary in its present form is believed to have started among the Hindus, from whom it was adopted by the Mahâyâna, or northern and most advanced school of Buddhism. Apparently from them it was adopted by the Mohammedans, and some believe that it came to Europe with the returning Crusaders. Some rude mode of counting the repetitions of prayers is recorded by the historian Sozomen to have been in use in Egypt in the fifth century A.D., but the Roman Church attributes its introduction to St. Dominic (1170–1221). Mr. Casanovicz believes that, though the Buddhist and Mohammedan bead chaplets preceded the Christian in order of time, there is not necessarily a causal connection between them. In any case, both in Islam and the early Christian Church the primitive mode of counting the prayers was by means of pebbles or date-stones, and the idea of replacing these by beads threaded on a string may be due to imitation of the practices of eastern religions.

THE U.S. Weather Bureau has favoured us with specimen copies of its meteorological charts of the North Atlantic and North Pacific oceans for July, and seasonal chart for the South Atlantic for June to August, corresponding very closely to the pilot charts issued by the London and Hamburg offices, to which we have frequently referred. The Weather Bureau took over the control of meteorological work on the oceans from the Navy Department a few years ago, and now receives reports from more than 2000 observers on vessels of every nationality. From these reports it prepares daily synoptic charts for the purpose of tracing storm tracks, percentage of fogs, prevailing direction of wind, trade-wind limits, pressure and temperature. It is proposed to include a seasonal chart of the South Pacific Ocean in September next; no charge is made for any of these useful publications, which are of great benefit to the seafaring community.

IN the course of an extended investigation on the residual charges of condensers with dielectrics of various materials, Mr. C. L. B. Shuddemagen, of the Jeffersen Physical Laboratory of Harvard University, has discovered a method of making condensers with pure paraffin wax instead of waxed paper. Such condensers, he finds, show no residual charge, and on this account are likely to be of great importance in future electrical work. In order to prepare the thin sheets of paraffin required, Mr. Shuddemagen dips a thin, smooth board which has been soaked in water for a few days, and is rinsed with water immediately before use, into a bath of liquid paraffin wax. On withdrawing the board it is found to have on either side a thin sheet of paraffin, which is readily detached, and allowed to hang in the air to get rid of all moisture. The thickness of the sheet is determined by the temperature of the bath and of the board, and by the time the board is immersed but 0·5 millimetre has been found most suitable. Any irregularities in the surface of the sheet are smoothed with the blade of a safety razor before the tin foil is placed on the sheets. Mr. Shuddemagen's paper forms Memoir No. 18 of vol. xliv. of the Proceedings of the American Academy of Arts and Sciences.

OUR ASTRONOMICAL COLUMN.

DISCOVERY OF A COMET, 1909*a*.—A telegram from the Kiel Centralstelle announces the discovery of an eleventh-magnitude comet, by Mr. Daniel, at Princeton (N.J.) on June 15.

At 14h. 0m. (Princeton M.T.) on that date the position was R.A. = 1h. 39·9m., dec. = 28° 55′ N., and the motion of the comet was recorded as northerly and rapid.

A second telegram states that this object was observed by M. Javelle at Nice on June 16, when at 13h. 13·3m. (Nice M.T.) the position was R.A. = 1h. 41m. 54s., dec. = 29° 58′ 18″ N.

Thus it appears that the comet is now in the constellation Triangulum, apparently travelling, in a direction a little east of north, towards Andromeda and Perseus; this position rises about four hours before the sun. It is interesting to remark that comet 1907*d*, subsequently a naked-eye object, was discovered by Mr. Daniel on June 14 (1907), and was then of the eleventh magnitude.

A set of elements and an ephemeris, computed by Prof. Kobold, are given in Circular No. 109 of the Centralstelle.

Ephemeris (12h. *M.T. Berlin*).

1909		α h. m.		δ ° ′		Brightness
June 22	...	1 59·5	...	+38 3·9	...	0·8
26	...	2 12·7	..	+42 53 0	...	0·7
30	...	2 27·1	...	+47 4·7	...	0·6
July 4	...	2 42·7	...	+51 0·9	...	0·5
8	...	2 59·4	...	+54 22·9	...	0·4

Perihelion is given as June 3.

A supplement to *Astronomische Nachrichten*, No. 4331, informs us that this comet was discovered independently by M. Borrelly, at Marseilles, on June 14, 14h. 30m. (*Marseilles* M.T.). It should therefore be known as comet 1909*a* (Borrelly-Daniel).

ELEMENTS AND EPHEMERIS FOR WINNECKE'S COMET, 1909.—As Winnecke's comet is due at perihelion in October, Prof. Hillebrand has computed a set of elements and an ephemeris for this return, and publishes them in No. 4330 of the *Astronomische Nachrichten*.

The time of perihelion is given as 1909 October 4·0 (M.T. Berlin), and the ephemeris covers the period June 31 to October 12. During July the comet should apparently travel in a south-east direction through Leo nearly parallel to a line joining δ and β Leonis; on July 18 it should be about 1° south of the former, and on August 2 about 15′ north of the latter, star. The position given for June 31 is α (app.) = 10h. 32m. 46s., δ (app.) = 24° 51·7′ N.

THE RECENT LUNAR ECLIPSE, JUNE 3.—Owing to the persistent clouds, the total eclipse of the moon which took place on June 3–4 was unobservable in London, but that it was well observed in other localities is shown by the reports now published.

MM. Borrelly and Coggia made observations at Marseilles, the results of which are published in No. 23 (June 7) of the *Comptes rendus*.

The former noted the exceptional intensity of the penumbra at the beginning of the eclipse, and a seamy appearance of the umbra which gave the front line of the shadow a sinuous appearance. In the telescope the eclipsed moon appeared rose-coloured, but to the naked eye it was red; many of the lunar circles were visible despite the shadow.

M. Coggia observed that on the approach of the shadow's edge, at 12h. 45m. (Marseilles M.T.), Plato took on a red tint, which became redder until, at 12h. 50m., it appeared like glowing charcoal.

Mr. J. H. Elgie writes that, according to his observations, at Leeds, the eclipse was a "light" one; although at its first encroachment the shadow was dead black, when the disc was fully eclipsed many features could be perceived by the naked eye. The shadow was first seen, without a telescope, at about 11.45 p.m. Mr. Elgie also directs attention to a curious glow in the northern heavens throughout the night, almost suggestive of an auroral display.

THE PHOTOHELIOMETER.—In No. 4, vol. xxix., of the *Astrophysical Journal* (May, p. 313), Prof. Poor describes, and gives the results of, some experiments carried out at the Yerkes Observatory in order to determine the feasibility of employing the heliometer method in the endeavour to detect differences in the solar diameters, polar and equatorial, at different epochs.

Photographs were obtained with two lenses of 2 inches aperture and 25 feet focal length, mounted side by side in the same cell, so as to give overlapping images of the sun. Then two methods of measurement were tried, one in which the diameter passing through the centres of the two images was determined directly, the other in which the solar radius was determined from measurements of the chord common to the two overlapping images. Prof. Poor discusses both methods, and concludes that the second will give the better results. Finally, he concludes that for his researches the photoheliometer is better than the direct photographic method, and gives some practical working hints, *e.g.* wet plates should be used on account of the sharper, clearer images they give. A series of six trial plates, taken during October and November, 1907, gave a mean excess of equatorial over polar radius of 0·95″.

THE ERRORS OF POSITION OF IMAGES PHOTOGRAPHED THROUGH GLASS.—For some time past photographs of star areas have been taken at Harvard College Observatory with the film side of the plate turned away from the object, so that when compared, film to film, with normal negatives of a different epoch, changes occurring during the interval might be readily detected.

So far these have only been used for light changes, and not for changes of position produced by proper motion and parallax. Tests recently carried out by Dr. Schlesinger at the Allegheny Observatory show, however, that such plates may safely be used for determinations of changes of position, for observing through the glass has, in the plates tested, produced no serious error, the mean value of the possible error being of the order of 0·001 mm. On such plates, taken at an interval of ten years, a proper motion of 0·025″ per annum could be readily detected (Publications of the Allegheny Observatory, vol. i., No. 14).

THE NEW INSTITUTE OF PHYSIOLOGY AT UNIVERSITY COLLEGE, LONDON.

BY the completion of the Physiological Institute at University College, London, which has been erected within the past twelve months upon the site of the playground of University College School, the University of London possesses what is probably the finest laboratory of its kind in the country, and one which is perfectly equipped both for teaching all branches of physiology and for the pursuit of original research work. The erection of this institute marks an epoch, not only in the history of the re-constituted University of London, but in the development and advancement of the British school of physiology, a school which was practically non-existent a few decades ago, when nearly all research in this subject was carried out in the laboratories of France and Germany.

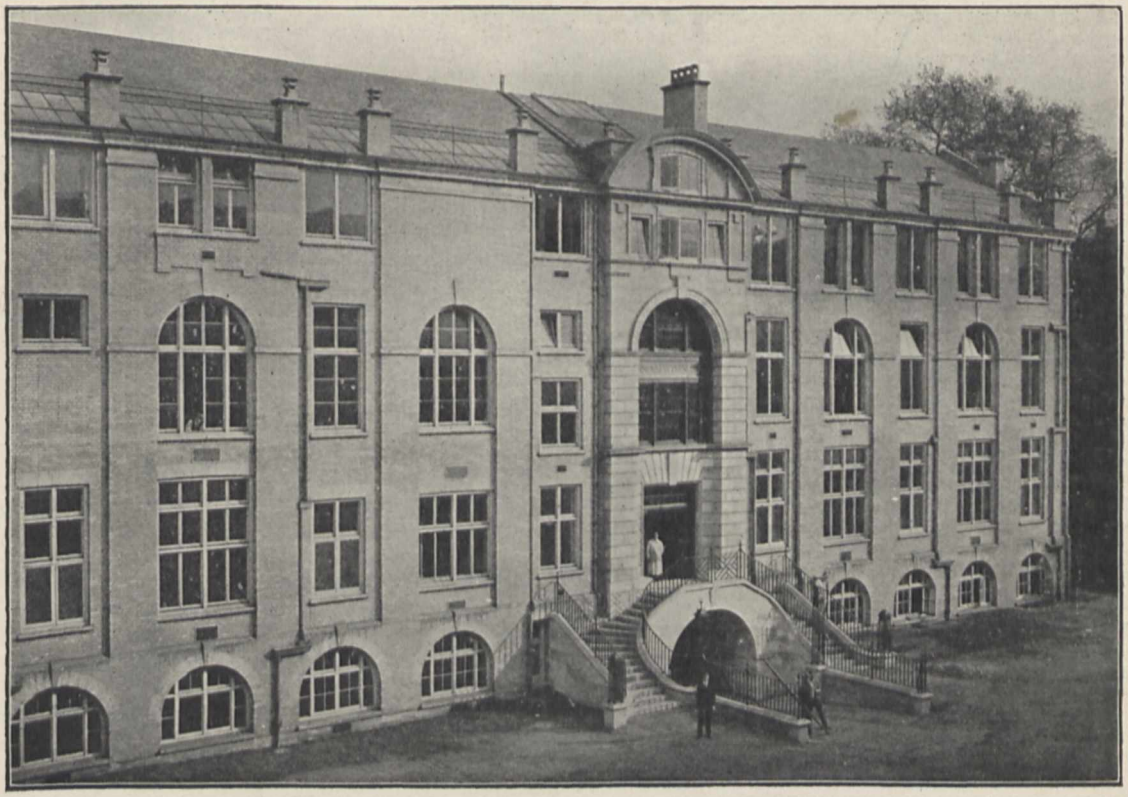

FIG. 1.—Institute of Physiology, north elevation.

It is a matter for congratulation to those who have been instrumental in founding this institute that the subject of physiology is to be both taught and advanced by original work, for in the creation of this science University College may fairly claim to have played a

most important part. British physiologists have long recognised the paramount influence exerted by William Sharpey during his tenure of the professorship of anatomy and physiology, which lasted from 1837 until his retirement in 1873, and the men who came under his influence may be considered to have demonstrated by their work the methods and lines of research along which physiology was in the future to be developed if this science was to take rank with allied experimental sciences and cease to be a subject overladen with speculative views. Michael Foster, Burdon-Sanderson and Newell Martin all acquired their physiological training in the laboratory of University College, and each succeeded in establishing a school of physiology in Cambridge, Oxford, and Baltimore. The study of this science, which is now pursued so successfully in no less than thirteen universities in Great Britain, may indeed be said to have spread over England from Sharpey's laboratory, for a considerable number of those who are at present furthering the progress of experimental medicine received a part, and in some cases the whole, of their training in the physiological laboratory of the college.

The institute of physiology is to be part of an institute of medical sciences which shall include anatomy and pharmacology. The erection of this was possible owing to the generous donations of Dr. Aders Plimmer and Dr. Ludwig Mond, while the expenses of equipment have been met partly by subscriptions and partly by a legacy left by the late Mr. Thomas Webb for the purposes of research. The building is from the designs of Prof. F. M. Simpson, who has admirably carried out the arrangement of the various special laboratories and rooms which Prof. Starling, to whose energy and initiative the institute is really due, has planned and suggested, and in this he has introduced all the most recent improvements that experience gained by visits to other laboratories in this country and abroad has shown are of such importance for the efficient study of physiology.

The development of organic chemistry, and with this of physiological chemistry, has been so great in recent years that the whole ground floor of the building is entirely devoted to rooms and research laboratories in this subject. Owing to the foresight of Prof. Starling, ample provision has been made for the present and future requirements of this part of physiology, which has virtually become a branch of physiology somewhat sharply separated off from purely experimental work. That the solution of many problems must ultimately lie in the hands of those physiologists who are highly trained chemists and physicists is an obvious truth, and in the institute of physiology the importance of this branch of study has been kept in view.

The large laboratory in the west wing will accommodate 100 students. Separate rooms, such as a balance room, distillation room, and one for carrying out four combustions at the same time, occupy part of the east wing. Several other rooms, which can be completely darkened, and are furnished with first-rate apparatus for the purpose, are devoted to special purposes, and in these work can be carried out which requires the use of the spectroscope, polarimeter, or spectrophotometer. A large refrigerating chamber and a "Fabrik-Raum" for the working up of material on a large scale are also provided in the basement. Rooms for experimental physiology and the library occupy the first floor, on which there is also a lecture theatre with seating accommodation for 200 students. A large students' room for histology and experimental physiology occupies the whole of the west wing of the second floor, while the upper wing comprises a demonstration theatre, so arranged that forty students can obtain a full view of any experiment, and a suite of four rooms devoted to the aseptic department.

On June 18 the institute was formally declared open by Mr. Haldane. Among those who received him were the following:—the Vice-Chancellor (Prof. M. J. M. Hill, F.R.S.), the chairman of the college (Lord Reay, G.C.S.I.), the president of the Royal Society (Sir Archibald Geikie, K.C.B.), the president of the Royal College of Physicians (Sir R. Douglas Powell, Bart., K.C.V.O.), the president of the Royal College of Surgeons (Mr. Henry Morris), the president of the Royal Society of Medicine (Sir William Church, Bart., K.C.B.), the principal (Dr. H. A. Miers, F.R.S.), the provost of University College (Dr. T. Gregory Foster), the treasurer of University

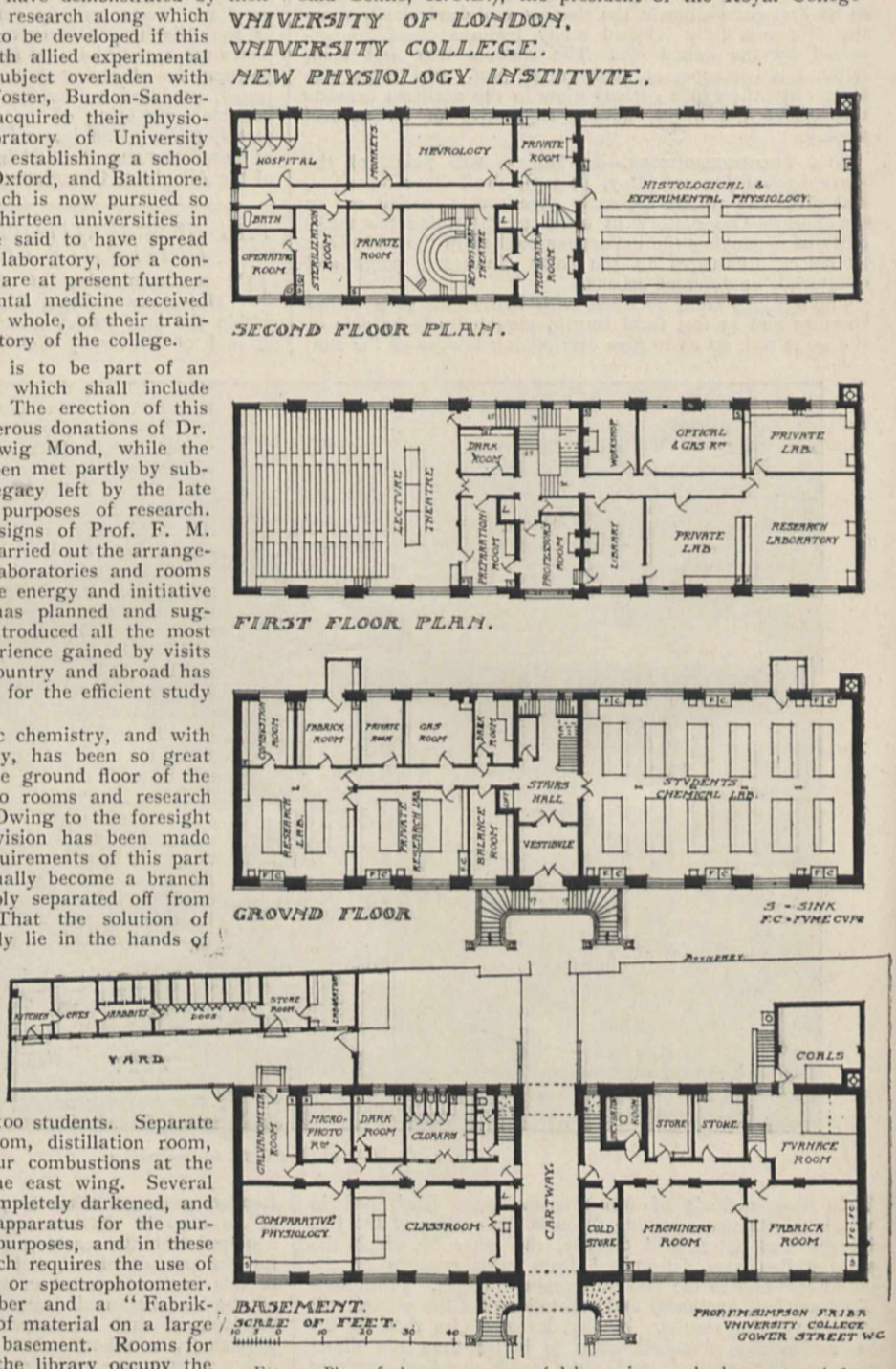

FIG. 2.—Plan of the arrangement of laboratories on the basement and floors of the Institute.

College (Sir Felix Schuster, Bart.), the dean of the faculty of science (Prof. Millar Thomson, F.R.S.), the dean of the faculty of medicine (Prof. Sidney Martin, F.R.S.), the chairman of the military education committee (Prof. D. S. Capper), the secretary of the Royal Society (Dr. J. Rose Bradford), the dean of the college faculty of medical sciences (Prof. G. D. Thane), and the Jodrell professor of physiology (Prof. E. H. Starling, F.R.S.).

In his address, given to an audience which filled the lecture theatre, Mr. Haldane outlined the gradual growth of the facilities for the highest education in science which has been witnessed in this country during the past twenty years, a growth which, he pointed out, has completely upset the somewhat pessimistic prognostications of Matthew Arnold, who, as an authority on this question, expressed the opinion that any extension of the facilities offered by the older universities was most improbable. It is, however, only fair to state that it was with reference to the arts rather than the science side of education that he took this somewhat gloomy view of affairs. Mr. Haldane, who admitted that he appeared to others to be obsessed with a passion for organisation, while avoiding some of those debatable questions which were so intimately bound up with the work of many of those who listened to him, indicated with exceptional lucidity that if any civilised country is to continue to hold its own, abundant facilities must exist for the pursuit of knowledge by research, and that it was unnecessary to support this by arguments must have been apparent to his audience. That in the institute of physiology full provision for the highest teaching in this subject is available, not only for our own countrymen, but for those from American and foreign universities, was also indicated by Prof. Starling, who, after speaking of the international bonds of friendship which the study of science does so much to foster, made clear the truism that in such places as this institute the real work is carried out which supplies the medical profession throughout the world with the knowledge requisite for their successful treatment of disease. Those who have the best interests of their profession at heart know that this is so.

The erection of this institute is largely due to Prof. Starling, whose ideas have been carried out in this building, which, with its admirable arrangements for work and excellent equipment, forms a great addition to the opportunities for teaching and research offered by the University of London.

THE INVESTIGATION OF GASEOUS EXPLOSIONS.[1]

AT the Leicester meeting (1907) of the British Association it was suggested that the investigation of gaseous explosions was a matter which might suitably form the work of a committee of Section G (Engineering), and although the subject is chiefly of interest to engineers because of its bearing on the theory of the internal-combustion engine, the committee appointed has not confined its attention to questions of a purely practical character, but has discussed many questions of scientific importance which might properly be considered of interest to the physical and chemical sections.

In order that the labours of the committee might lead to some result within a reasonable time, the work so far undertaken has been mainly a critical examination and discussion of the results of previous investigations with a view to further research, and to this end the report discusses, at some length, various interesting and important matters which in their opinion require further investigation.

The essential feature in the operation of an internal-combustion engine is the explosion of a mixture of inflammable gases by which is formed a complex mixture of nitrogen, carbon dioxide, steam and oxygen, and the performance of the engine depends primarily on the changes of pressure and volume of the gas, and is only influenced in a slight degree by the nature of the chemical changes and the velocity with which these take place.

The problem is mainly that of the behaviour of gases at high temperatures, and the properties of such gases are completely defined when the relation between pressure and volume at constant temperature is known, and the internal energy is given as a function of the temperature and the density. The first relation is substantially that expressed by Boyle's law for all gases with which we have to deal, while it is sufficient for the present if the internal energy can be expressed as a function of the temperature, and it is with this internal-energy function that the report chiefly deals.

Measurements of the internal energy have been carried out, as a rule, with the gas at either constant pressure or at constant volume, and the experiments of Holborn and Austin and Holborn and Henning on air, steam, and CO_2, at constant pressure, have shown that, with increasing temperature, there is an increase in the internal energy, which is probably not a linear function of the temperature. The principal part of our knowledge of the behaviour of gases at high temperatures has, however, been obtained by explosion experiments in closed vessels, and if we could accurately make the necessary corrections for deducing from the observed pressures in a real explosion the pressures reached in an ideal one, we could obtain an accurate value of the internal-energy function.

The difficulties of making corrections due to the disturbing influences are very great, but in spite of this the study of explosion pressures has been mainly responsible for the knowledge we possess of the energy function, and the committee therefore considers this method and the possible inaccuracies in detail.

If the calorific value of a mixture before combustion is known, and the heat lost at any time after the explosion is determinate, the remaining disturbing causes are due to the want of thermal and chemical equilibrium, and possibly to the motion of the gases; we must therefore determine what effect all these disturbing factors have in altering the observed pressure from which the temperature is inferred.

Much of the loss of heat appears to be due to direct conduction to the walls of the enclosing vessel, but it is probable that loss by radiation is also important, as in some of the experiments considered, where loss by conduction was improbable, the pressures obtained were consistent with a considerable loss by radiation.

The thermal state of the exploded charge has been the subject of much investigation. In a closed vessel the combustion at the point of ignition is completed before any appreciable rise of pressure takes place, and the flame spreads outwards at a velocity which has been estimated at from 120 to 150 centimetres per second, accompanied by a rise of pressure due to the progress of the combustion. The flame, therefore, spreads in an increasingly denser gas, and since the rise of temperature on explosion is nearly independent of the pressures before ignition, the temperatures attained at those places which are reached last by the flame are much below the mean owing to the final adiabatic compression and consequent rise in temperature of the already ignited gas.

At the moment of maximum pressure the temperature varies enormously, as is shown by the measurements of Hopkinson in an approximately cylindrical vessel of 6 cubic feet capacity, where, with a mean temperature of 1606° C., the maximum temperature at the point of ignition was 1900° C., and near the walls about 1200° C.

The temperature of the wall surface in such a vessel is much lower, and in a gas engine, working under normal conditions with a water-jacketed cylinder, the usual temperature is about 200° C., with a fluctuation of rarely more than 10° C. during the whole cycle. Up to the time of maximum pressure there appears to be no appreciable equalisation of temperature, but convection and conduction rapidly obliterate these initial differences. If the specific heat of the gas were constant, the attainment of thermal equilibrium would make no difference to the

[1] First Report of the British Association Committee appointed for the Investigation of Gaseous Explosions, with Special Reference to Temperature. Presented at the Dublin meeting, 1908.

pressure, but, owing to variation of specific heat with temperature, a correction must be made, which in the present state of knowledge is very uncertain, as the distribution of temperature and the variation of the specific heat are not accurately known.

The condition of the gas as regards chemical equilibrium has been the subject of much speculation and research. Calculations by the pv/τ law of the rise of pressure due to the amount of thermal energy liberated give very much greater pressures than are found by experiment, and various theories have been put forward to account for this.

The view that dissociation of the constituents of the ignited charge will account for the discrepancy appears improbable, as there is no conclusive evidence to show that either steam, CO_2, or nitrogen are split up to any extent at the temperatures and pressures obtained, while the fact that in weak mixtures the discrepancy between calculation and experiment is about the same lends no support to the dissociation theory. The cooling effect of the walls plays some part, but the experimental evidence of explosions in vessels of various forms and capacities shows that this cause alone is quite insufficient to account for the difference.

Another view, due to Clerk, is that the combustion of the gas is not complete at maximum pressure, so that in mixtures of all strengths, but especially in weak ones, there is a suppression of heat which materially affects the maximum explosion pressure, and the cooling effect of the walls will have a considerable time effect on the combustion process. It cannot be doubted that combustion is greatly retarded in the neighbourhood of cold metal walls, and some direct evidence is available that such phenomena are mainly of a surface character. Profs. Bone and Dixon are of the opinion that if the effect of cold bodies may be disregarded, the combustion of the charge in the presence of air is practically complete before the attainment of maximum pressure.

The effect of the explosion is also to set up intense vibratory motion in the gas, but it appears unlikely that this has any effect on the mean pressure shown by the gauge. Although the difficulties which arise in the determination of the internal energy are so great, the results of independent observers are in very fair agreement, as is shown by the accompanying diagram, Fig. 1, in which various determinations of the internal energy of a gas-engine mixture are marked and compared with the values for an ideal gas having an internal energy of 4·9 calories per gram molecule per degree.

The experiments of Clerk are particularly interesting, as he used a method of a novel character, which permitted the study of the working fluid in the gas-engine cylinder itself.

An indicator diagram of a gas-engine cycle gives information as to the time of ignition, the work done, and the compression and expansion of the charge. It is possible by rearranging the valve gear to shut in an exploded charge, and the indicator card obtained while the engine is coming to rest affords further information concerning the specific heat and the rate of heat loss to the walls.

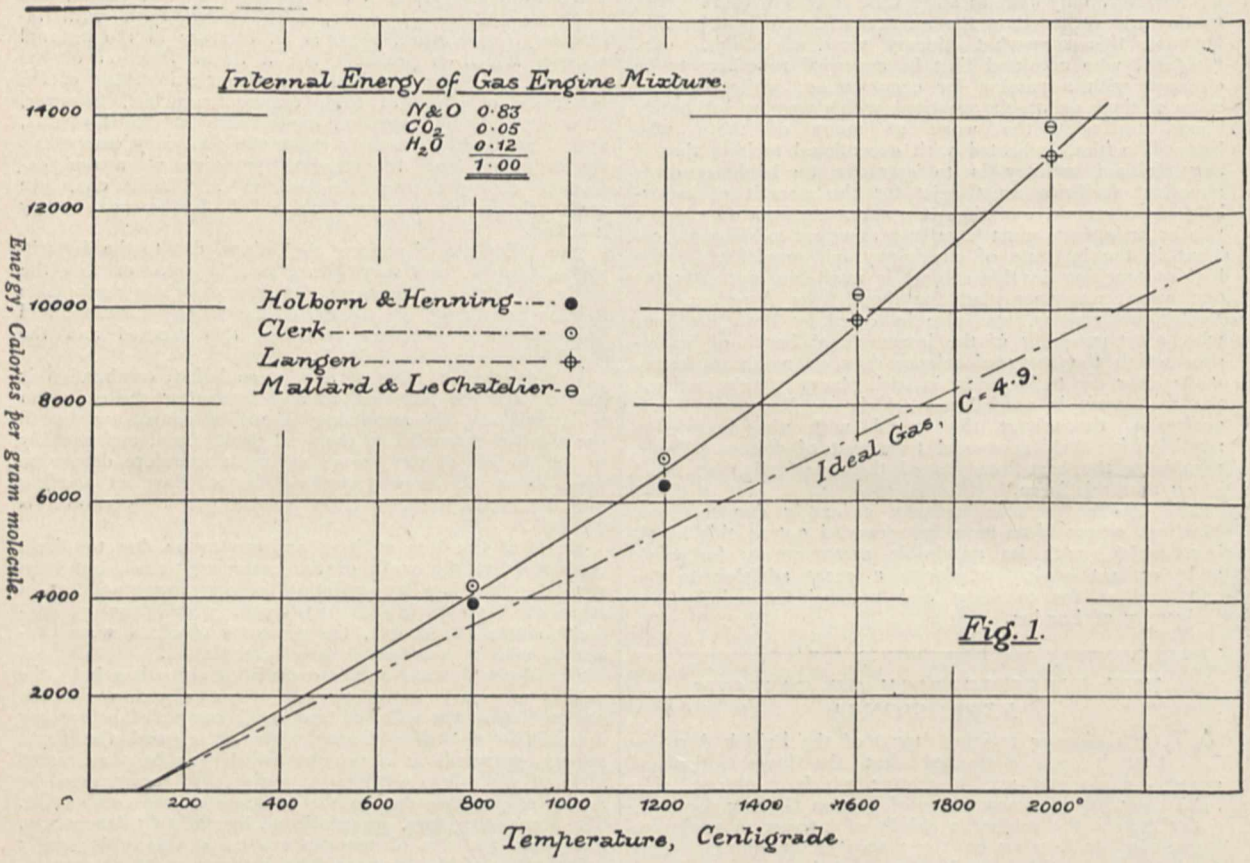

Fig. 1.

A portion of such a diagram is shown in Fig. 2, in which the curve BC represents the first compression of the charge after the valves are shut down, and CD represents the following expansion curve. Usually, the first five or six cycles are distinct, but they ultimately merge into one another as the engine comes to rest. If the gas be compressed or expanded without gain or loss of heat, the specific heat at constant volume can be readily obtained by a consideration of the work areas of the diagram and the end temperatures, but on account of the heat flow to the walls a correction must be made, which can be obtained by a successive approximation process. This heat loss is divided between the expansion and compression, and Mr. Clerk divides it on the assumption that if the mean temperatures in compression and expansion are the same, the heat loss will be the same. The mean tempera-

ture in expansion is rather less than in compression, and therefore the loss is not divided equally between the two.

The results of experiments made in this way give values of the specific heat at constant volume which increase more than 30 per cent. in the range from 100° C. to 1500° C., and tend to a limit at high temperatures, while the observations indicate that this apparent change is accompanied by continued combustion.

Experiments made since the report was issued show that, relative to the mean temperature, the heat loss for air during compression is greater than the loss during expansion; these experiments will be continued to ascertain if such is the case for a gas-engine mixture.

In concluding its discussion of explosion experiments the committee expresses the opinion that "values of the energy obtained from explosion records are not subject to any very great errors on account of heat loss by conduction to the walls of the vessel, or on account of incomplete combustion, but that they are affected by errors of quite unknown amount due, first, to heat radiated, and, secondly, to the want of thermal equilibrium at the time when the pressure is measured. For the purpose of testing the first of these conclusions it is very desirable that further experiments should be made on explosions in vessels of greatly different size, but of similar form. The opinion entertained by the committee that incomplete combustion is a surface-phenomenon, on which this conclusion

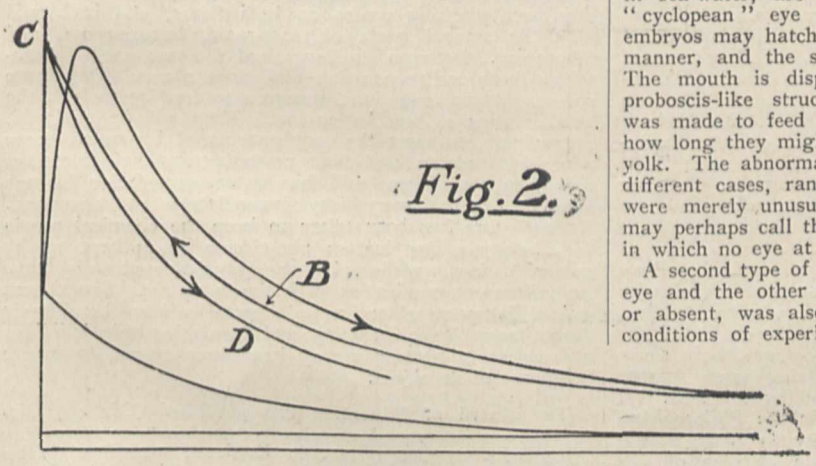

Fig. 2.

as to the validity of the method is based, also requires further confirmation. As regards the second conclusion, further experiment on the actual amount of heat radiated by burning gas is urgently required, and also experiments to confirm or negative the effect of the nature of the wall surface upon the pressure reached in an explosion. The effect of want of thermal equilibrium can be determined up to a point by calculation; but before such calculation can be usefully made, it is desirable that further information should be obtained as to the temperature distribution after an explosion, especially in the neighbourhood of the walls."

In view of the importance of measurements of temperature in connection with gas explosions, the committee considers it desirable that the relations between pressure, volume, and temperature of gas thermometers should be determined at very high temperatures. The nitrogen thermometer has been used with an iridium bulb up to 1600° C., but no other gas has been tested beyond 1100° C. The chief difficulties in carrying out comparisons of gas thermometers have been the absence of any material which is impervious to the gas and sufficiently refractory to withstand very high temperatures. Dr. Harker believes that he is now in possession of a material suitable for gas thermometry up to 1800° C., and he has suggested that an attempt be made to compare thermometers using nitrogen and argon at the highest temperatures possible. If they agree, the probability is in favour of both being in substantial agreement with the thermodynamic scale, but if it is found that they differ, the presumption will be that the argon thermometer is in closer agreement with the thermodynamic scale, as this gas is supposed to be monatomic and incapable of dissociation. The committee hopes that it will be possible to carry on a research of this kind, and that the resources of the National Physical Laboratory will be available for the inquiry.

The report concludes with a note by Prof. Callendar, printed in full as an appendix, and containing a critical examination of the experimental work on "the deviations of actual gases from the ideal state, and on experimental errors in the determinations of their specific heats."

E. G. COKER.

"CHEMICAL" EMBRYOS.

SOME very remarkable observations have been made from time to time during the last twenty years on the effect of chemical stimuli in bringing about abnormalities in developing embryos. The "Lithium larvæ" of the sea-urchin and of the frog, obtained by Herbst and Morgan, are familiar examples of this class of phenomena, but perhaps the most remarkable is the "Magnesium embryo" of the fish, *Fundulus heteroclitus*, described by Charles R. Stockard in the February number of the *Journal of Experimental Zoology*. A large percentage of the embryos of this fish, when subjected during their development to the influence of magnesium salts dissolved in sea-water, are found to possess a single median or "cyclopean" eye in place of the ordinary pair. These embryos may hatch and swim about in a perfectly normal manner, and the single eye is evidently fully functional. The mouth is displaced ventrally, and gives rise to a proboscis-like structure, but, unfortunately, no attempt was made to feed the embryos, so that we do not know how long they might live after the absorption of the food-yolk. The abnormality was present in varying degrees in different cases, ranging from embryos in which the eyes were merely unusually close together, through what we may perhaps call the typical cyclopean condition, to others in which no eye at all was developed.

A second type of monster, with one perfect asymmetrical eye and the other eye of the normal pair either reduced or absent, was also frequently met with under the same conditions of experiment. The author claims that this is the first instance of repeatedly causing, by the use of chemical substances, vertebrate monstrosities such as are known in nature, and his results seem to indicate that the monstrous Cyclops of man and other mammals may not be due to germinal variation, but to some effect of environment during development.

Incidentally, the researches may also throw some light upon another extremely interesting result of recent investigation in the domain of experimental embryology. Several observers, notably Spemann and Lewis, have shown that in amphibian embryos the formation of the lens of the eye appears to be dependent upon stimulation of the superficial epiblast by the developing optic cup. Lewis, for example, has found it possible to transplant the optic cup of a frog embryo, and thereby cause the development of a lens from superficial epiblast quite remote from the normal lens-forming region. Stockard, however, concludes from his researches on Fundulus that lens-formation does not in all cases depend upon a direct stimulus from the optic cup, for his abnormal Fundulus embryos sometimes showed a supernumerary lens developing without any relation to an optic cup.

Why the presence of magnesium salts should cause abnormal eye-development is one of the numerous mysteries of biology which seem likely to remain unsolved for a long time to come. Experimental embryology is still in its infancy, and it is too soon to expect any adequate explanation of such phenomena, but we are beginning to realise that the nature of the environment counts for a very great deal in determining the course of individual development. The most encouraging feature of modern biology is, undoubtedly, the adoption of experimental methods, and such methods bid fair to be as productive in this branch of science as they have already been in chemistry and physics. It would probably be too

much to say that the interpretation of vital phenomena is merely a question of the successful application of chemistry and physics to living protoplasm, but it is certain that in the future chemistry and physics will play a part of constantly increasing importance in the solution of biological problems. A. D.

SPECTROSCOPIC RESEARCHES.

TWO useful papers on the arc spectra of iron and titanium, respectively, appear in the March number of the *Astrophysical Journal*. At the suggestion of Prof. Fowler, Mr. E. J. Evans, of the Imperial College of Science and Technology, undertook the investigation of the less refrangible portions of the these spectra, which are especially important because of the sun-spot visual observations made in the red end of the spectrum. Mr. Evans now gives the wave-lengths for the iron lines between λ 6855 and λ 7412, and for the titanium lines from λ 5866 to λ 7364. For the iron spectrum Rowland had previously given wave-lengths to 6855, whilst Hasselberg had fully investigated the titanium spectrum more refrangible than 5899; Rowland's and Thalén's lists of lines beyond 5899 are incomplete, and it was to fill the *lacunae* that the present investigation was prosecuted. The photographs were taken, either with a Littrow prismatic spectrograph of 12 feet focal length or with a Rowland concave-grating spectrograph of 10 feet radius and 14,500 lines, on "panchromatic" plates, and in the iron spectrum show about ninety lines less refrangible than λ 6855, for sixty-seven of which wave-lengths and intensities are given. Wave-lengths and intensities are similarly tabulated for 100 titanium lines less refrangible than λ 5866, and in both cases the nearest lines in Rowland's list of solar wave-lengths are given for comparison. Of the titanium lines, only twenty-four were ascribed to titanium, or titanium mixtures, by Rowland, and some of those now given are recognised as "fluting" lines found by Hale and Adams in the red end of the sun-spot spectrum.

Until the publication of a recent research by Prof. Wood, the greatest number of lines recognised in the series of spectral radiations of any one element was twenty-nine, which Evershed found in the hydrogen spectrum of the solar chromosphere. In the case of sodium, only seven lines belonging to the principal series were known previously to the results now published by Prof. R. W. Wood. In a paper recently published in the *Philosophical Magazine* he gave provisional wave-lengths for twenty-four lines, and suggested that a large increase of dispersion might reveal many more lines of this series. Having employed greater dispersion, he now gives, in No. 2, vol. xxix., of the *Astrophysical Journal* (p. 97), the wave-lengths of forty-eight lines, thus enabling the Balmer formula to be tested up to $n=50$. Even now there are indications that a yet larger dispersion would extend the series still further. The need for a large dispersion in this work is strikingly illustrated by the fact that the last twenty-two lines now given fall in a region of the spectrum not wider than the distance between the D lines; the wave-length of the twenty-ninth line of the series is 2420·02, whilst that of the fiftieth is 2414·50. One point of special interest disclosed by Prof. Wood's research is that, with very dense sodium vapour, there is an exceptionally strong general absorption extending from the head of the Balmer series to the end of the ultra-violet, that is to say, the vapour is much more transparent to the light between the absorption lines than it is beyond them. So marked is this that the head of the series actually shows *brighter* than the rest of the more refrangible spectrum.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MISS MARY T. FRASER, student at the South-Western Polytechnic Institute, Chelsea, has been elected to the Lindley studentship, University of London. The studentship is awarded to a student qualified to undertake research in physiology, and is held in the physiological laboratory of the University. The amount of the studentship is 100*l*.

UNDER the terms of the charter of the University of Bristol, the faculty of engineering of the University will be provided and maintained by the Society of Merchant Venturers in their technical college. The principal of that college, Prof. J. Wertheimer, will be *ex officio* dean of the faculty, and will also hold the post of professor of applied chemistry in the University, while the following professors in the technical college will hold corresponding posts in the University, viz.:—Prof. J. Munro, professor of mechanical engineering; Prof. E. S. Boulton, professor of applied mathematics; Prof. D. Robertson, professor of electrical engineering; and Prof. W. Morgan, professor of motor-car engineering. Mr. F. R. B. Watson will hold the post of lecturer on mechanical engineering, and Mr. H. A. M. Borland that of lecturer on applied chemistry.

THIS year St. Paul's School reaches her 400th anniversary. The event will be celebrated by an addition of large and excellently furnished new laboratories to the present buildings. These are already nearing completion, and will be officially opened on July 7 by Lord Curzon. The distant separation of the existing physical and chemical laboratories has always been a difficulty, and the limits of the former have been tried to their utmost. The new building has a frontage of 100 feet. It is of red brick, and forms a handsome annex to the big school; its inner walls are lined with white tile. The ground floor will be devoted to physics, the upper floor to chemistry. There are three working rooms on both floors, and each will play the several parts of class-room, lecture-room, and laboratory. Between the large and the two small laboratories there are preparation and store rooms. Two large rooms, one on each floor, measure 40 feet by 50 feet, the smaller ones 40 feet by 25 feet. They will be equipped, respectively, to meet the requirements of beginners, more advanced students, and those preparing for the universities and hospitals. There will thus be accommodation for 130 students, with everything immediately at command. Especial care has been taken to keep the chemical rooms free from noxious fumes; air circulation is kept up by powerful fans, while all the draught cupboards have immediate communication with the outer air. Experiences gained in many of our new laboratories have been freely drawn upon in constructing and furnishing this building, and neither time nor money have been spared to assure fulfilment of its object.

THE Board of Education has published (Cd. 4691) its regulations for secondary schools, which are to come into force from August 1 next in England, excluding Wales and Monmouthshire. The regulations do not vary substantially from those of last year, except with regard to some points on which Sir Robert Morant lays special emphasis in his prefatory memorandum. The tendency of the regulations is towards allowing the school authorities greater liberty in planning the curriculum. The Board insists that the course of education shall be of a generous and civilising type, neither unduly specialised nor defective in essential elements. It must in all cases make adequate provision for instruction, among certain other subjects in physical science, including practical work by the pupils; and, as regards girls, must likewise include practical instruction in the elements of domestic subjects. For older girls science may be dropped, and mathematics restricted to arithmetic, in order to make room for a fuller course in these domestic subjects. It is indicative of the growth of broader views among educationists and teachers to find the permanent secretary writing about the Board that it not only permits, but encourages, "such differentiation of type in relation to local needs as is consistent with a broad and solid general education, and such variation of instruction towards the particular needs and capacities of the pupils as does not interfere with the function of the school as a common organism directed towards the production of trained citizens."

THE annual report of the council of the City and Guilds of London Institute for the year 1908 is provided with a series of exhaustive appendices containing reports by the dean of the City and Guilds Central Technical College, the principal of the Finsbury Technical College, the honorary secretary of the South London Technical Art School, the committee of the Department of Technology,

and the committee of the Leather Trades School. It includes also the address delivered last January at the annual distribution of prizes by Mr. Gerald Balfour. The report of the council summarises the growth in the recent activities of the institute, and provides a clear statement of the precise relations of the Central Technical College with the Imperial College of Science and Technology and with the University of London. The report of the Department of Technology shows convincingly the great extent of the work accomplished by the institute in the direction of improving and extending the facilities for technical instruction throughout the country. During the session under review, that for 1907–8, 3604 classes were registered in one or other of the seventy-six different subjects in technology included in the institute's programme. These classes were held at 402 centres in 299 towns, and were attended by 48,223 students, or 2175 more than in the previous session. There are, it appears, two main causes which impede progress in the technical instruction of artisans; first, there is the difficulty of finding competent teachers, and, secondly, the unduly large proportion of artisan students who enter technical classes without the preliminary knowledge necessary to take full advantage of the instruction they receive. The report points out at the same time that there is no doubt that the teaching of technology has improved greatly during the past decade, and it is satisfactory to find that there is no relaxation of effort on the part of the institute to raise the standard of work in the classes under its care.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, June 11.—Dr. C. Chree, F.R.S., president, in the chair.—The Arthur Wright electrical device for evaluating formulæ and solving equations: Dr. **Russell** and Arthur **Wright.** Special slide resistances are used. If R be the resistance of one of these, and a metallic finger make contact with it at a point where the scale-reading is x, the resistance between this finger and the terminal of the slide is R/x. The scales are graduated as in the ordinary slide-rule. If a number of these slide resistances be connected in parallel, the sum of the currents through them will be proportional to the sum of the readings of the contact fingers. By a null method this current can be balanced against the current going through a single slide resistance X by means of a Wheatstone's bridge arrangement. The reading on X when there is a balance gives the sum of the readings on all the other slides. Similarly, numbers can be subtracted by putting slides representing these numbers in parallel with X, and then obtaining a balance by altering the reading on X. By clamping the contact fingers inclined at certain angles to a rod which can be moved at right angles to the slides, it is easy to obtain the values on X of $f(x)$ when

$$f(x)=ax^m+bx^n+cx^p+\ldots,$$

where the indices m, n, p, . . . may be positive, negative, or fractional, and the coefficients may be positive or negative numbers. A model of this device for solving an equation of any degree consisting of not more than four terms was shown. The inaccuracy of the results found by means of this model is of the order of 1 per cent. Approximate values of the imaginary roots of numerical equations can be found by the device, which can be employed also to solve very complicated equations.—The echelon spectroscope, its secondary action and the structure of the green mercury line: H. **Stansfield.** An investigation of the action of an echelon spectroscope and the results obtained as to the structure of the green mercury line given by an Arons lamp. The echelon spectroscope employed was arranged so that the auxiliary prism could be mounted next to the echelon. The dispersion of the prism may be added to or subtracted from the dispersion of the echelon, and the change in the dispersion obtained gives a method of determining whether two lines in the spectrum belong to the same order. Fabry and Perot spectra are produced by the secondary action of the echelon. When the echelon is tilted the secondary light may be separated from the primary, and parts of the Fabry and Perot circles observed with a wide slit. The secondary light also undergoes the primary echelon treatment, and, with a narrow slit, is confined to the points of intersection of the two systems of spectra. When the echelon is in the ordinary position the secondary spectra are lines similar to the primary echelon lines, and may be observed moving across the broad central line when the echelon table is rotated slowly.—The proposed international unit of candle-power: C. C. **Paterson.** The paper discusses the units of candle-power at present officially accepted in Great Britain, France, the United States of America, and Germany. The authorities in the gas and electric interests in the United States are prepared to adjust their units of candle-power to bring them to a single value, which is to be the same as the British and French units. The paper gives the results of comparisons showing that, within the limits of experimental error, the British and French units are identical. The change involved in the unit maintained at the Bureau of Standards, Washington, is 1·6 per cent. The Hefner unit is almost exactly nine-tenths of the new unit.—Inductance and resistance in telephone and other circuits: Dr. J. W. **Nicholson.** A general formula for the effective inductance of a circuit consisting of two long parallel wires has been given previously, and is suitable for cases in which the current distribution in either wire is affected greatly by the frequency of alternation. Important cases are examined in detail here, and formulæ are obtained capable of immediate use. A calculation of the effective resistance is also made in each case. Throughout the investigation only iron and copper wires as the two extreme cases are considered. The large permeability of iron completely changes the character of the effect of frequency on its self-induction. To all metals greatly used in practice, except iron, the formulæ developed for copper wires may be applied with a nearly identical order of accuracy.—Note on terrestrial magnetism: G. W. **Walker.**—The form of the pulses constituting full radiation or white light: A. **Eagle.**

PARIS.

Academy of Sciences, June 14.—M. Bouchard in the chair.—Some remarks on integral equations of the first species, and on certain problems of physical mathematics: Emile **Picard.**—Some earthquakes which have devastated Provence and Dauphiné: G. **Bigourdan.** A chronological list of the earthquakes on record as happening in these districts between 1282 and 1812.—Presentation of three new sheets of the map of the edible molluscs of the coasts of France, established by M. Joubin: the **Prince of Monaco.**—Observations of the sun made at the Lyons Observatory during the first quarter of 1909: J. **Guillaume.** Observations were made on forty-four days during the quarter; the results are summarised in three tables, showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—The latitude of the Observatory of Athens: D. **Eginitis.** A discussion of the cause of a systematic error of about 1·26″ in the meridian-circle readings.—Observation of the total eclipse of the moon of June 3, 1909, at the Observatory of Toulouse: L. **Montangerand.** A special photographic study of totality.—The pseudo-elliptic or hyperelliptic integrals of the form $\int_0^x \frac{x^p dx}{\sqrt{X_{2p}+z}}$: E. **Vallier.**—A recent note of M. S. Bernstein: S. **Zaremba.**—Differential equations with fixed critical points: J. **Chazy.**—The study of the variations of statistical quantities: Émile **Borel.**—A law permitting the immediate calculation of the approximate profile of a watercourse of given flow when the section of the liquid and the wetted perimeter are algebraic functions of the height of the water: Philippe **Bunau-Varilla.**—The condensation of the radium emanation: A. **Laborde.** After condensing the emanation by cooling in tubes of copper, iron, tin, silver, glass, and silvered glass, the temperature at which the emanation was evolved was measured, and was found to be −153° C. to −155° C. for the four metals, −175° to −179° in glass. The absorptive properties of meerschaum, charcoal, platinum black, and spongy platinum for the emanation were also studied.—A new wave detector for wireless telegraphy and telephony: G. E. **Petit.** The detector consists

of a very fine conducting point resting with a fixed pressure on natural pyrites. It works without a battery, and has the advantage of not being injured by strong waves.—The observation, made parallel to the lines of force, of the unsymmetrical positions and intensities of the magnetic components of certain lines of emission: a new type of position dissymmetry: A. **Dufour.**—The physical origin of the evolution of electricity in chemical reactions: M. **de Broglie** and L. **Brizard.** The production of an electric charge in the cases studied is altogether independent of the chemical reaction.—The magnetic dichroïsm of the rare earths: Georges **Meslin.**—An arrangement for controlling signals at a distance with or without wires: M. **d'Ivry.** A detailed description with diagrams.—Comparisons between nitriles and carbamines: P. **Lemoult.** A thermochemical paper.—Some double sulphates of calcium: M. **Barre.** Owing to the formation of the double sulphate $CaSO_4.(NH_4)_2.SO_4.H_2O$, a salt which is stable between 0° C. and 100° C. in presence of an excess of ammonium sulphate, the solubility of calcium sulphate is largely increased in the presence of ammonium sulphate. Similar results are obtained with potassium sulphate.—The metallic character of an organic group: R. **Fosse.** The pyryl group,

$$\left[C_{10}H_6\begin{matrix}CH\\O\end{matrix}C_{10}H_6\right]',$$

forms compounds which behave with mineral acids, picric acid, and sulphuretted hydrogen in a manner strikingly resembling metallic salts. Pyryl bromide with hydrochloric acid gives pyryl chloride and hydrobromic acid; pyryl chloride is precipitated by hydrogen sulphide, pyryl sulphide forming the precipitate. Boiling hydrochloric acid acting on this sulphide regenerates the chloride, sulphuretted hydrogen being given off.—The action of cacodylic and methylarsinic acids on antimony trichloride: L. **Barthe** and A. **Minet.**—Aromatic alcohols and hydrocarbons derived from fenone: J. **Leroide.**—The β-naphthane diols: Henri **Leroux.**—Results of the geological and mineralogical exploration of Eguéï: G. **Garde.**—The extension in Chaouid of the *tirs*, or fertile lands of western Morocco: Louis **Gentil.**—The possibility of keeping animals alive, after complete ablation of the thyroid apparatus, by adding salts of calcium or magnesium to their food: Albert **Frouin.**—A method permitting the measurement of the dehydration of the organism by the lungs and the skin. The variations of this dehydration with altitude: H. **Guillemard** and R. **Moog.** The loss of weight of the body in unit time is smaller in the mountains than in the plains, and this is also the case with the amount of water eliminated.—Cardiac arythmia and d'Arsonvalisation: E. **Doumer** and G. **Lemoine.**—The treatment of intermittent claudication and of gangrene of the lower extremities by d'Arsonvalisation: A. **Moutier.**—Some biological properties of the *Bacillus endothrix*: Fernand **Guéguen.**—A new case of hermaphroditism in *Oersteidia rustica*: Mieczyslaw **Oxner.**—Demonstration of the existence of an artificial deformation of the skull at the Neolithic epoch in the Paris basin: Marcel **Baudouin.**—The geosynclinals of the chain of the Alps during Secondary times: Émile **Haug.**—The earthquake of June 11, 1909: Alfred **Angot.** This earthquake was completely registered by the seismograph at Parc Saint-Maur, and communications have been received from nine other observatories giving the times recorded.

DIARY OF SOCIETIES.

THURSDAY, JUNE 24.

ROYAL SOCIETY, at 4.30 (Meeting at the Royal Astronomical Society).—(1) On Pressure Perpendicular to the Shear Planes in Finite Pure Shears; and on the Lengthening of Loaded Wires when Twisted; (2) The Wave Motion of a Revolving Shaft, and a Suggestion as to the Angular Momentum in a Beam of Circularly Polarised Light: Prof. J. H. Poynting, F.R.S.—The Effect of a Magnetic Field on the Electrical Conductivity of Flame: Prof. H. A. Wilson, F.R.S.—Studies of the Processes Operative in Solutions. XI.—The Displacement of Salts from Solution by Various Precipitants: Prof. H. E. Armstrong, F.R.S., and Dr. J. V. Eyre.—Thermal Conductivity of Air and other Gases: George W. Todd.—The Possible Ancestors of the Horses living under Domestication: Prof. J. C. Ewart, F.R.S.—The Alcoholic Ferment of Yeast-juice. Part IV.—The Fermentation of Glucose, Mannose, and Fructose by Yeast-juice: Dr. A. Harden, F.R.S., and W. J. Young.—The Electrical Reactions of Certain Bacteria, and an Application in the Detection of Tubercle Bacilli in Urine by Means of an Electric Current: Charles Russ.—The Effect of the Injection of the Intracellular Constituents of Bacteria (Bacterial Endotoxins) on the Opsonising Action of the Serum of Healthy Rabbits: Prof. R. T. Hewlett.—On the Occurrence of Protandric Hermaphroditism in *Crepidula fornicata*: J. H. Orton.—Sensitive Micro-balances, and a New Method of Weighing Minute Quantities: B. D. Steele and Kerr Grant.—The Polarisation of Secondary γ Rays: Dr. R. D. Kleeman.—On the Absorption of Homogeneous β Rays by Matter, and on the Variation of the Absorption of the Rays with Velocity: W. Wilson.—Experimental Researches on Vegetable Assimilation and Respiration. V.—A Critical Examination of Sachs' Method for Using Increase of Dry Weight as a Measure of Carbon Dioxide Assimilation in Leaves: D. Thoday.—And other Papers.

FRIDAY, JUNE 25.

PHYSICAL SOCIETY, at 5.—A Transition Point in Zinc Amalgam: Prof. Carhart.—A Method of Producing an Intense Cadmium Spectrum, with a Proposal for the Use of Mercury and Cadmium as Standards in Refractometry: Dr. T. M. Lowry.—On the Measurement of Wave-length for High Frequency Electrical Oscillations: A. Campbell.—An Electro-magnetic Method of Studying the Theory of and Solving Algebraical Equations of any Degree: Dr. A. Russell and J. N. Alty.—The Sine Condition in Relation to the Coma of Optical Systems: S. D. Chalmers.—Exhibition of a new Fery Thermo-electric Calorimeter: C. V. Drysdale.—An Instrument for Measuring the Strength of an Intense Horizonal Magnetic Field: F. W. Jordan.—On a Method of Determining the Sensibility of a Balance: Prof. Poynting, F.R.S., and G. W. Todd.—The Balance as a Sensitive Barometer: G. W. Todd.

MONDAY, JUNE 28.

ROYAL GEOGRAPHICAL SOCIETY, at 8.45 (In the Albert Hall).—Exploration in the South Polar Region: Lieut. E. H. Shackleton.

TUESDAY, JUNE 29.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—The Social Organisation of the Andamanese: A. R. Brown.

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