THURSDAY, JUNE 24, 1897.

1837—1897.

THERE has been one feeling in the minds of the inhabitants of Britain, and of Greater Britain, during the last week, which has thrown all others into the shade—a feeling of intense patriotism and loyalty to the Queen, mixed with a deep reverence for her personal qualities. It is this feeling which has brought representatives to our shores from every part of the greatest empire which so far the world has known; which has organised the stupendous ceremonial witnessed on Tuesday in the metropolis, a celebration to be worthily crowned on Saturday by the review of the first line of the armed force of the nation.

These most memorable events in the annals of our time—events, indeed, beyond all precedents of former times—which have so emphatically marked Her Majesty's Diamond Jubilee, have naturally been connected in many minds with the progress of the nation during the last sixty years. It is satisfactory to note the general recognition in the daily and weekly press of the importance of the part played by science during that interval in securing the tremendous advance which has been achieved, along many lines, in things pertaining to the increased well-being and usefulness of mankind.

It is very generally recognised that the Victorian age is emphatically the age of science, and indeed so true is this that a hasty sketch of the progress of natural knowledge during the last sixty years would require a volume. So great has been the advance, so rapidly are all benefits conferred by science applied to our daily needs, that it is extremely difficult already to obtain a mental image of many conditionings of life sixty years ago, and it is not a little singular that many of the advances made, which in some cases have profoundly influenced modern thought, and in others have enormously increased the happiness, comfort and usefulness of our lives, are very nearly conterminous with the reign.

How changed are the Imperial conditions even from the year of the famous Great Exhibition, when, in the language of Tennyson, there were poured upon our shores,

> ——"Things of beauty, things of use
> Which one fair planet can produce,
> *Brought from under every star.*"

In the year 1837 the possibility of telegraphy was first realised, and Faraday was at work at frictional electricity. Who can attempt to measure the value of this early electrical and magnetic work, either from the pure science or applied science point of view? Has not the close binding together of the various units of the Anglo-Saxon race which has brought citizens of the Empire from under every star been among the indirect results?

From that year to the present time not a sea, but an ocean of marvels has been discovered. Our view has been obscured by day with wires carrying currents, some of which illuminate our cities and houses at night, while others carry our messages to the ends of the earth. Surely in all this progress in one restricted branch since 1837 we have a clear indication that the study of the useless—useless because it has never been used—is the surest way to discoveries rich in public utility.

It has also been recently pointed out that the art and science of photography are conterminous with the reign.

"In 1837 Daguerre and Fox Talbot were founding photography. The Daguerrotype and Talbotype were given to the world two years later. What would the modern world do without photography, as we know it in this year of Jubilee? It has added ten thousand million stars to the astronomer's stock-in-trade; it is an invaluable ally in the study of the physics and chemistry of distant worlds; while with a grand impartiality it reveals to us the secrets of the infinitely little. Last of all, not content with adding to the pleasures and the knowledge of mankind, it comes to succour human ills, and soon no hospital will be without its aid."

We may note with pride that in the Victorian era Britain has well retained her place, not to say her supremacy, in the realm of ideas. One of the great poets—the makers—of science whose name will go down to posterity with that of Newton has added lustre to the Queen's reign.

But we may warmly congratulate ourselves that something more than science itself has advanced; the importance of its methods and results in relation to the future progress of the nation is at last receiving a tardy recognition.

The progress of science itself and its results are naturally not confined to any one nation under the new world condition of almost instantaneous exchange of thought, but this same possibility of rapid exchange also applies to the transit of raw material. Britain in the past had for years a practical monopoly of coal and iron; this was her strength, but this strength is hers exclusively no longer.

At the present day Britain is distinctly behind Germany in the national endeavour to face the conditions of national peaceful competition as they exist. Our Government has been supine in matters in which the German Government have put forth all their strength, and so, even assuming that the scientific spirit and the individual endowment and advancement have been the same in both countries, we have fallen sadly into arrear as to those educational and scientific institutions on which we must depend for the future production of workers and new discoveries.

There are signs that this condition of things is mending, that the error is being acknowledged by those who, if they choose, can readily correct it. The Duke of Devonshire last week, at the opening of the International Congress on technical education, announced frankly: "We have in this country a Department of Education, but its functions are almost entirely limited to elementary education, and we have not in our Administration any minister who properly corresponds to the Minister of Education of other Governments."

It is as if one should say, "We have in this country a Department of War, but its functions are almost entirely limited to teaching the goose-step to recruits."

Another encouraging sign is to be found in the recent increase in the assistance rendered to the University Colleges, all of which outside the metropolis have been

founded during Her Majesty's reign. At the same time the establishment of similar institutions in other localities is encouraged by the promise of grants to them also under certain specified conditions. But in relation to our advance in this direction, it is a matter of regret to all friends of the higher education that the so-called University of London, which was established in the year before Her Majesty came to the throne, is not yet a University in the true sense. Is it too late to hope that the Jubilee year may yet be signalised by bringing London in this matter up to the level of the smaller cities of the world?

In still another direction an important advance must be noted. We refer to the inclusion of men of science among those upon whom the Sovereign confers distinction for services rendered to the State. More than forty years ago the Queen expressed her desire to include among her Privy Councillors two distinguished men of science, and yet, owing to one cause and another, the conferring of this distinction upon a man of science did not take place till a few years ago, when Huxley was enrolled among the members of that body. There are signs that the opinion is rapidly growing that if the function of a Privy Council is to give wise counsel in the nation's need, the increased utilisation of science in every part of the national machinery, whether it deal with the arts of peace or war, renders it not only desirable but necessary that the ranks of the Privy Council shall be strengthened in this direction. There can be little doubt that in a not distant future the Lords of the Committee of the Privy Council who deal with matters concerning science will contain among them many members of the Royal Society.

There is also another matter to be considered in relation to the Queen's reign. It is the steady increase in the usefulness, the utilisation, and the dignity of the Royal Society. This throws an ever-increasing responsibility upon its Officers, Council and Fellows, among other things in the selection of their successors.

Other vast fields of activity are gradually and necessarily being added to the original ones of discussion and publication, and wisdom as well as knowledge is now essential in the proper direction of its energies. The view, therefore, still held by some, that the Society is a kind of superior college of preceptors of a strictly limited number of branches of knowledge, is rapidly disappearing as Her Majesty's reign continues.

At the present time, on the one hand, the Government does not hesitate to consult the Society when need arises, and, on the other, it rarely refuses to accede to demands made upon it to assist research in various directions where the State influence or machinery, or both, can be utilised. The memorable voyage of the *Challenger* and various eclipse expeditions are excellent cases in point. The gigantic work recently undertaken by the Society in organising the production of an International Catalogue of Scientific Literature has only been rendered possible by the sympathy and assistance of the Government; and the more similar works of large grasp the Society is connected with in the future, the more respected British science will be all the world over, for the responsibility of the Royal Society is no longer confined to these islands.

DUCAL HUSBANDMEN.

A Great Agricultural Estate, being the Story of the Origin and Administration of Woburn and Thorney. By the Duke of Bedford. Pp. 254. (London: John Murray, 1897.)

First Report on the Working and Results of the Woburn Experimental Fruit Farm. By the Duke of Bedford and Spencer Pickering, F.R.S. Pp. iv + 194. (London: Eyre and Spottiswoode, 1897.)

ONE is tempted to believe that agriculture has been in the blood of the Russell family not only by inheritance, but by heredity. It has been to the Earls and Dukes of Bedford what politics has been to some families and drink to others—a deadly recurrent outbreak. It apparently began with a lady, the wife of the third Earl, who, according to Sir William Temple, contrived "the perfectest figure of a garden" at Moor Park. Her offspring in successive generations have been famous improvers of estates, plantations, fields and gardens. It was John, the fourth Duke, who in defiance of the remonstrance of the celebrated Philip Miller, his gardener, thinned his famous plantation of pines and firs, and so that there might result no injury to Miller's reputation as a planter, caused a board to be fixed in the plantation, facing the road, on which was inscribed, "This plantation has been thinned by John, Duke of Bedford, contrary to the advice and opinion of his gardener." The draining, planting and experimenting has gone forward almost continuously from the time when Francis, the fourth Earl, devoted attention, capital and reputation to draining the fen lands. The great drainage works of the Romans, maintained by the monks of Thorney, Crowland, Ely, &c., had fallen out of repair by the end of the sixteenth century, and "it was only on the maps that the rivers [of the fen country] ran into the sea" when he undertook the task afresh. The reward for this, as related by the present Duke, was that Charles I. sent Earl Francis to the Tower, and his son Earl William, who incurred the enmity of the Parliament during the Civil War, had his estates sequestrated for a time. But through bad times and good the Bedfords have been of like mind with Sir Walter's Laird of Dumbiedikes, who, on his death-bed, remarked, "Jock, when ye hae naething else to do, ye may be aye sticking in a tree; it will be growing, Jock, when ye're sleeping." The present Duke has, fortunately both for science and practice, not only maintained the famous Woburn experiments, but has broken out in a new place with the establishment of a splendid experimental fruit farm, designed quite as much for purely scientific as for economic ends. With the scientific advice of Mr. Pickering, who in this matter also appears to his fellow scientific workers in a new character, this great garden has been laid out and the work of record begun. Even in these first years results of interest appear, but they are small compared with what future generations will reap. It is difficult from this first Report to gather more than admiration of the plan; but those who have seen the fruit farm, cannot fail to have carried away the conviction that it is one of the most notable experiments in rural economy now in progress.

In addition to this solid service, his Grace has compiled a statistical account of the management of the estates of

Woburn and Thorney as material for a discussion of the land question. To review it adequately here is impossible, since it would lead one straightway into political discussion. The returns from the Beds, Bucks and Thorney estates, as set forth in the appendix, show the following financial results. "On Thorney the expenditure, from 1816 to 1895, amounted to 1,598,353*l.*, and on Woburn, from 1816 to 1895, it was 2,632,186*l.* After spending nearly four and a quarter millons sterling since 1816 on some 51,643 acres of land, a large proportion of which is some of the best wheat land in England, and after excluding all expenditure on Woburn Abbey, its park and farm, it will be seen that at the present time an annual loss of more than 7000*l.* a year is entailed on their owner." Elsewhere we read: "As to the pleasures to be derived from the ownership of an estate like Thorney, if the reader conjures up a beautiful mansion and park with endless game preserves he is mistaken. They do not exist. The only pleasure which I and my forebears can have derived from Thorney is the kindly feeling which has existed," &c. It would be a fatal mistake to suppose that the Duke has compiled these tables of statistics, and written this most interesting book to demonstrate the philanthropic principles of his ancestors, or to justify his own position as a landlord—"such pride is hardly wrong," as Mr. Gilbert sings—but rather to enable him to have a fling at John Stuart Mill, and to justify all landlords. Without entering on politics, one may point to the weak spot in his argument. He innocently fancies all or most landlords to be as the Russells. If they were, the land agitator would carry on his operations with a plough.

GEORGE MURRAY.

AN ISLAND OF THE EASTERN ARCHIPELAGO.

With the Dutch in the East. By Captain W. Cool (Dutch Engineers). Translated by E. J. Taylor. Pp. viii + 365. (London: Luzac and Co., 1897.)

THE past few years have been marked in a peculiar degree by disturbances in the various colonial dependencies of European nations. Not only in Central Africa —where the recent forward movement for the opening up of the continent has naturally led to collisions with native races—but in many of the older colonies in other parts of the world, it has been necessary for the paramount power to maintain its supremacy by force of arms. The recently translated work of Captain W. Cool gives a detailed narrative of one such war, undertaken by the Dutch in 1894 to deliver the subject population of the island of Lombok from the oppression of their Balinese rulers. The author tells the story of the expedition in a somewhat dramatic style, giving it almost the complexion of a national epic. In fact, accustomed as we are in this country to such small colonial wars, we might be inclined to think that he has attempted to raise it to a level unwarranted by the facts of the case. But the expedition had an importance beyond what might appear at first sight. It may even be said to have formed in some way a turning-point in Dutch colonial history. The difficulties encountered during the Achin war, and the unfortunate experiences of the Flores expedition had seriously threatened the Dutch prestige in the archipelago, and failure or only partial success at Lombok might have been regarded as indicating that Holland was now unequal to the task of maintaining her hold on her extensive colonies in the East. In spite of some reverses, which necessitated the dispatch of considerable reinforcements, the general result of the war was fortunately most successful, and will, it may be hoped, have conferred a lasting benefit on the island in the form of good and settled government for the future.

English literature on the subject of the Eastern Archipelago is so scanty, and the works of Dutch writers—naturally by far the most numerous—are so little known in this country, that any addition to our knowledge of that part of the world is welcome. With regard to Lombok, we believe that almost the only information—obtained at first hand—to be found in English works, is that contributed by Dr. A. R. Wallace, who, in 1856, crossed from side to side of the island; and in his "Malay Archipelago" devotes two interesting chapters to the manners and customs of the people. Apart from the story of the military operations, Captain Cool gives, in his third and fourth chapters, a useful summary of all that is known of the island and its inhabitants, with a sketch (considerably shortened in the English translation) of the connection of the Dutch with it from the time of their first voyages to the Far East. Being confined to the neighbourhood of the west coast, the expedition did not, unfortunately, add much to our knowledge of Lombok, which, though small compared with other islands of the archipelago, is still little known apart from a narrow strip across the centre. Captain Cool's information is therefore necessarily compiled in great part from previously published works, those of Zollinger and Jacobs in particular being largely drawn upon. He gives a most unpleasant picture of the state of morals in the island, the Brahminical Balinese rulers being decidedly worse in this respect than the subject Mohammedan Sassaks. The oppression and tyranny of the former is likewise painted in strong colours, although Wallace thought the Sassaks in his time reconciled to their then new rulers. The island has undoubtedly everything to gain from being brought more closely under the influence of the Dutch authorities.

The author's style is one which hardly lends itself well to exact reproduction in English, and might perhaps with advantage have been somewhat modified by the translator. The short paragraphs, constant use of question and answer, and of the note of admiration, are apt to be worrying. The book contains a sketch-map of Lombok, and some good illustrations, both of scenery and people, and is provided with a full and well-arranged index.

OUR BOOK SHELF.

Die elektrodynamischen Grundgesetze und das eigentliche Elementargesetz. Von Franz Kerntler. 8vo. Pp. 68. (Budapest: Buchdruckerei der Pester Lloyd-Gesellschaft, 1897.)

THOSE who take up the present book with the expectation of finding in it a full and comprehensive sketch of the principles of electro-magnetism will be disappointed. Dr. Kerntler's work might, perhaps, be best described as an essay on "Ampère's Law and Allied Theories,"

since it deals exclusively with that debated point, the action of two elements of current on one another.

So long as Maxwell's theories of the mutual induction of closed circuits are taken as the starting-point, a certain indeterminativeness must inevitably arise in the endeavour to isolate the effects of separate portions of the circuits. It is with the various rival hypotheses required to complete the solution of the problem that the present investigation deals. In the first section we have an account of Ampère's hypothesis and the laws of force resulting from it. The next section deals with the most general law of force, based on the law of the inverse square; this is followed by a section devoted to Maxwell's investigations, and finally Dr. Kerntler propounds a new law of force which, he claims, is free from the objections raised by him against Ampère's, Neumann's, Weber's, and other formulæ. This law is merely obtained by assigning certain values to the arbitrary constants which occur in the expressions for the force-components, and which satisfy the relations found by Stefan. The subsequent applications of the proposed law to finite portions of conductors form an interesting collection of problems.

An important feature is that the author divides the various hypothetical laws into two categories—those which are applicable to determine the action between closed circuits only, and those which give correct results when used to find the action of a closed circuit on an element of current.

In former times, when the doctrine of action at a distance held the field, such an investigation as the present would, doubtless, have attracted many supporters, between whom and the advocates of Ampère's and other laws a spirited controversy might have arisen. At present we have become so accustomed to regarding the seat of electro-magnetic action as residing in the dielectric, that it is difficult to regard any investigation of direction action and reaction between two elements of current as being of more than purely academical interest. Still, the fact that many of our text-books base their introductory treatment, both of electrostatics and of magnetism, on the theory of action at a distance renders it desirable that interest should be resuscitated in these attempted solutions of the corresponding problem for electric currents; and for this, if for no other reason, the present endeavour to establish a new formula cannot fail to be worthy of the attention of physicists. G. H. B.

Catalogue of Tertiary Mollusca. Part i. The Australasian Tertiary Mollusca. By George F. Harris. Pp. xxvi + 407. Eight plates. (London: Printed by order of the Trustees of the British Museum, 1897.)

Catalogue of the Fossil Cephalopoda. Part iii. The Bactritidæ and part of the sub-order Ammonoidea. By Dr. Arthur H. Foord and George Charles Crick. Pp. xxxiii + 303. Illustrated. (London: Printed by order of the Trustees of the British Museum, 1897.)

THE present work by Mr. Harris commences a new catalogue. This first part is devoted to descriptions and figures of the shells of Australasia (exclusive of Cephalopoda), and will be followed, in due course, by other geographical series in the collection. The larger part of the Mollusca and Bryozoa, and the whole of the Brachiopoda, Annelida, Arthropoda, Echinoderma, and Cœlentera, still remain to be recorded, as well as the greater portion of the fossil plants. When complete the catalogue will include at least thirty volumes, and will then contain no more than a brief account of these extensive collections in the Natural History branch of the British Museum.

The classes of Australasian Tertiary Mollusca described by Mr. Harris in the volume under consideration include the Gasteropoda, the Scaphopoda, and the Lamellibranchiata, and the author rightly points out that their study cannot fail to shed much light on certain questions relating to phylogeny, and to assist the zoologist in tracing the origin of many of the principal groups of these divisions of the Mollusca.

The eight plates, drawn by Miss G. M. Woodward, which accompany the text, are of the usual high order of excellence one associates with the publications of the Trustees of the British Museum.

The volume dealing with the Cephalopoda is mainly the work of Mr. Crick, though Dr. Foord, notwithstanding his removal to Dublin, has rendered all the assistance possible, in order to carry the work through the press. As Dr. Woodward points out in his preface, this addition to the catalogue will prove of extreme importance to all those who desire to study the phylogeny of this group, for we are here presented with conclusive evidence that the Goniatites almost imperceptibly pass into the Ammonites. The figures, of which there are one hundred and forty-five, prepared, with few exceptions, by Miss Woodward, assist very much in making the text clear.

The Story of the Mine, as illustrated by the Great Comstock Lode of Nevada. By Charles Howard Shinn. Pp. x + 272. (London: Gay and Bird, 1897.)

WE learn from the editor's preface that this volume is one of a series intended to explain how the Western States of America were explored, how cities sprang up in desert wastes or among mountains difficult of access, and how gradually these States have become the home of a thriving population. The part played by the miner in the wonderfully rapid development of the Great West is dealt with by Mr. Shinn in a masterly manner.

Taking the Comstock Lode as a typical example, he draws a vivid picture of the early prospecting and subsequent working. The pathetic story of the first discoverers, the brothers Grosh, who both perished before they could reap the fruits of their skill and energy, is probably unknown to most English readers; soon they were followed by hardy but ignorant prospectors, who began by working the gold which they chanced to find in the earth thrown up by a gopher, and threw away as valueless the very rich silver ore which accompanied it. An assay of the "blue stuff," carried by a farmer to a distant town, revealed the true wealth of the marvellous vein; but difficulties of all kinds beset the miner in his endeavours to work it. How they were overcome by pluck, perseverance and science, is told in Mr. Shinn's pages; these should be read by every student of mining, for he may glean from them much valuable information, which is usually placed before him in a less tempting fashion in his dry technical manuals. Numerous illustrations add value to the text. The view of the Belcher Mine shows very clearly how the huge underground excavations are supported by "square sets," and might well be copied as a diagram for teaching purposes. The picture of hydraulic mining is excellent, and decidedly better than some similar illustrations which appear in text-books on mining. It is a pity there is no index.

C. L. N. F.

First Stage Sound, Light and Heat. By John Don, M.A., B.Sc. Pp. 307. (London: W. B. Clive, University Correspondence College Press.)

THE syllabus of the Science and Art Department's elementary examination in Sound, Light, and Heat, is the framework upon which this book has been constructed. The facts and phenomena belonging to the branches of physical science named in the title of the book are clearly described, and with due attention to experiment. Teachers of Departmental classes will be attracted to the book by its conciseness, by the summary at the end of each chapter, and by the large number of exercises and problems to be found in its pages.

LETTERS TO THE EDITOR.

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

The Great Submergence.

THE glaciation of the hills and glens all over the west of Argyllshire present phenomena which have for many years convinced me that the chief glaciating agent cannot possibly have been what is called an "ice-sheet." Ordinary glaciers, descending from the hills, have probably been concerned more or less. But the main agency has been, in my opinion, heavy "floe," or floating ice, driven by tides and currents during a submergence and a re-emergence of the land to the extent of at least 1500 feet. The main objection to this view has always been the absence of marine deposits, and especially of marine organisms. It is true that we have very few remaining beds of gravel or sand, and in those, as yet, no mollusca have been discovered. But I have never thought this objection a very strong one, because the submergence may not have been under conditions favourable to molluscan life, and dead shells, carried where they never lived, may easily have long ago been dissolved out. Quite recently, however, shells in great variety have been found at high elevations in Ayrshire, by Mr. Smith, of Kilmarnock. Moreover, these are embedded in the true boulder clay. And where these are wanting, marine microzoa have been detected in abundance by the most skilled and distinguished microscopist of the day. Stimulated by these discoveries, I have lately made a closer search for any remains of loose sands or gravels among our hills. That search has been rewarded by finding a well-marked fragment of an elevated sea-beach at the height of 350 feet above the sea, and in this deposit foraminifera have been found in fair abundance. Another place, quite 500 feet above the sea, has yielded similar evidence; and I have now very little doubt that such evidence will accumulate as the result of further search. This, however, is enough to prove a very recent submergence to a depth which would profoundly alter the distribution of sea and land along all our shores, and would divide the county of Argyll into a group of islands. No reasonable limit can be placed to the possible depth of this submergence. I have no theory as to the causes of it. But it may quite as well have been 1500 as 500 feet; and we must yield to any clear evidence of effects which cannot otherwise be explained. I need not say that the evidence, which in the latest years of his life carried conviction to the mind of the late Sir Joseph Prestwich, that there has been very lately in geological history a great submergence, which was comparatively sudden and comparatively transient, is evidence which no geologist can put aside without the fullest and most candid investigation. ARGYLL.

The Visibility of a Sound Shadow.

TWO months ago I received the following letter from Mr. E. J. Ryves.

"On Tuesday, April 6, I had occasion, while carrying out some experiments with explosives, to detonate 100 lbs. of a nitro-compound. The explosive was placed on the ground in the centre of a slight depression, and, in order to view the effect, I stationed myself at a distance of about 300 yards on the side of a neighbouring hill. The detonation was complete, and a hole was made in the ground 5 feet deep and 7 feet in diameter. A most interesting observation was made during the experiment.

"The sun was shining brightly, and at the moment of detonation the shadow of the sound wave was most distinctly seen leaving the area of disturbance. I heard the explosion as the shadow passed me, and I could follow it distinctly in its course down the valley for at least half a mile: it was so plainly visible, that I believe it would have photographed well with a suitable shutter."

On receiving this note, I asked and obtained permission from Mr. Maxim to be present if a further experiment of the kind were contemplated. I designed and had prepared a special shutter which, on the breakage of an electrical circuit, would in the 40th second make an exposure of about 1/300 second. Unfortunately the battery that I brought with me proved insufficient, so that I had to discard this, and use an ordinary Thornton-Pickard shutter actuated by hand. Neither the exact moment nor duration of the exposure were under such perfect control, and, as events proved, I could not get the exposure until the shadow had passed me. I had, however, fortunately asked Mr. Paul if he would be so good as to take a picture of the explosion with his animatograph. Mr. Hunt, his manager, came himself, and secured a good series.

Returning now to the eye observation: Mr. Ryves informed me he saw the expanding shadow on an intermediate occasion when only about 10 lbs. were detonated. On the day on which I was present (May 19), about 120 lbs. of nitro-compound were detonated, and 10 lbs. of black powder was added to make sufficient smoke to show on the plate. As the growth of the smoke cloud is far less rapid than the expansion of the sound shadow, no confusion could result from this.

At the time of the explosion my whole attention was concentrated upon the camera, and for the moment I had forgotten to look for the "Ryves ring," as I think it might be called; but it was so conspicuous that it forced itself upon my attention. I felt rather than heard the explosion at the moment that it passed. We stationed ourselves as near as prudence would allow at a distance of 120 yards, so that only about one-third of a second elapsed between the detonation and the passage of the shadow; but the precision of observation of coincidence when very rapid movement occurs is so great, that I am quite satisfied that the observation was correct. The actual appearance of the ring was that of a strong black circular line, opening out with terrific speed from the point of explosion as a centre. It is impossible to judge of the thickness of the black shadow; it may have been 3 feet, or it may have been more at first, and have gradually become less in thickness or, possibly, in depth of shade.

I have some difficulty in understanding why the whole ring should be visible if the phenomenon is the same as that which Prof. Mach and I have photographed. In our cases a bullet travelling at a speed greater than that of sound, forms a hyperboloidal shell of compressed air round about it. Light waves passing nearly tangentially, but just entering the shell, are refracted inwards, and thus leave a black line when they fail to strike the photographic plate. As they strike the plate within this black line on a part to which other rays have come nearly direct, an extra bright line is formed within the dark one. That which is essential, however, for the formation of the dark line is the tangency of the incident light.

Now, in the case of a hemispherical explosive wave it is clear that the sunlight can only be tangential over a semicircle, and that the shadow of such a wave should be a semi-ellipse, the eccentricity of which would depend upon the altitude of the sun. There could be no true tangential shadow on the sunward side of the explosion. Observation, however, showed a complete ring. If, as has been suggested to me as possible, the explosive wave does not travel at equal speeds in all directions, but is retarded near the ground, the wave front near the ground might be sufficiently inclined for the sun's rays to be tangential over much more than a semicircle. On May 19, when I made the observation, the sun had an altitude of about 58°, but on April 6, when Mr. Ryves made his first observation, the altitude was only 45°.

Mr. Maxim, with his usual ingenuity, suggested that perhaps what was observed was not a sound shadow at all, but merely a progressive bending down of every blade of grass as the explosive wave passed by. This would no doubt occur, and might be visible, but it is difficult to see how so black a ring should be produced in this way.

The animatograph fails to show any black ring; and this is not surprising, as with the exposure of about 1/100 second the shadow would have to be at least 11 feet thick, in order that some part should remain obscured during the whole exposure. If the black line is just without an equal bright line, as in the bullet photographs, and both are taken in by an exposure, it is hardly to be expected that any definite result should be obtained. As a fact, there is clearly seen a circular light shading, which does—so far as one can judge from the supposed rate of working, and the known distances—expand at about the same rate as the observed shadow, but it is lighter than the ground and shaded, instead of being dark and sharp, as seen by the eye.

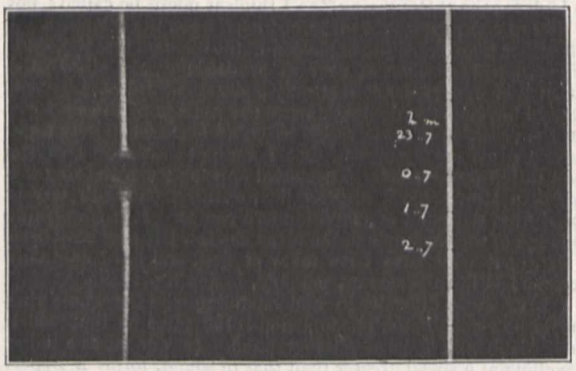
I feel that the imperfect account which I am able to give is of sufficient interest to appear in the columns of NATURE, but I hope that it may induce those who have occasion to detonate heavy charges to make any observations that opportunity allows.

For instance, if the Ryves ring is only visible in direct and brilliant sunshine, that will be evidence in favour of the shadow theory. If it is equally visible when the sun is not actually shining, but when the sky is illuminated by numerous white clouds, that will be evidence of the grass theory.

I may add that our observations were made from the west, and at noon. C. V. BOYS.

An Edinburgh Record of the Indian Earthquake.

A VERY interesting record of the recent earthquake at Calcutta is shown by the photographic apparatus of the bifilar pendulum of this observatory. A few very slight preliminary tremors commenced June 11, at 23h. 18m. G.M.T., and lasted for ten minutes. Violent oscillations then commenced suddenly, and lasted to June 12, 0h. 33m., after which slighter tremors



continued up to 1h. 12m. The oscillations can be traced fully six times the measure of sensitiveness of the instrument on one side of the normal line, and four times on the other, which are together equivalent to a tilt of the supporting frame of about twenty seconds of arc. I enclose a negative of the original photograph, which, however, does not show all the minor details of the effect produced. THOMAS HEATH.

Royal Observatory, Edinburgh, June 15.

Subjective Transformations of Colour.

MR. SHELFORD BIDWELL'S experiments, described in NATURE of June 10 (p. 128), remind me of a phenomenon which can be very easily demonstrated.

A disc is arranged so that a small sector, about one-sixth, is of a bright colour, while the remaining portion is white. If this be rotated slowly, the coloured sector appears to be followed by a ghost of the complementary colour: on quickening the rotation, *the original colour is lost, and the whole disc appears to be of the complementary colour*; but if the rotation be further quickened until flickering ceases, the original colour again predominates. In this way emerald-green may appear to change to pink, or crimson-lake to green.

This seems to be another instance in which the negative after-sensation is stronger than the original sensation. For the success of the experiment it is probably necessary so to adjust the rotation that (*a*) the negative sensation has a longer duration than the original sensation, and (*b*) the next original stimulus shall follow before the after-sensation has entirely faded. If the rotation be too rapid, the negative sensation has not time to develop, and only the original colour is seen.

Mason College, June 12. F. J. ALLEN.

Planetary Orbits, illustrated by a Rolling Ball.

THE interesting article in NATURE, April 29, by R. W. Wood, on the orbits of a steel ball about a magnet pole, suggests to me that it may interest some of your readers to hear of another plan for showing these orbits, which, but for the slight resistance of the air, is very nearly theoretically accurate, and in which the proper initial velocities are easily produced.

The plan consists of causing a true steel ball—of, say, one inch or more in diameter—to roll on a hard and smooth surface of the proper form. The surface on which the *centre* of the ball moves is formed by the revolution of a part of a rectangular hyperbola about a vertical asymptote, and the real surface on which the ball rolls is, of course, a distance equal to the radius of the ball from this imaginary surface at all points.

Fig. 1 is a vertical section, on a very small scale, in which the dotted lines show the rectangular hyperbola and its vertical and horizontal asymptotes, and the full curved lines show the actual surface on which the ball rolls; the interval between the dotted and full curved lines being equal to the radius of the ball.

FIG 1.

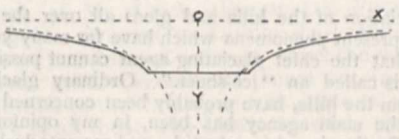


FIG. 2

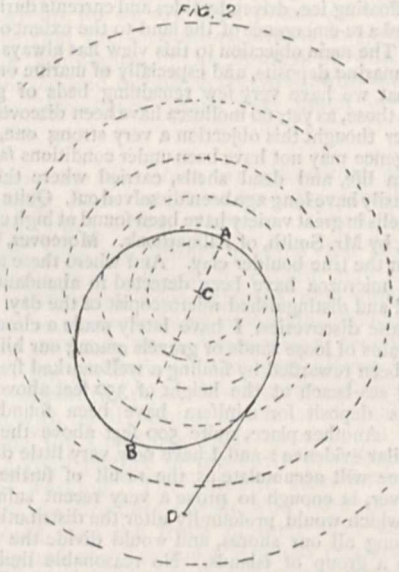


Fig. 2 is a projection on a horizontal plane showing contours of the hyperbolic surface at equal vertical intervals in dotted lines, and also one of the orbits referred to below in full lines.

Suppose the ball to be allowed to roll from the level of the horizontal asymptote, and directed so as not to come too near the centre (C) of the surface, it will describe a path whose projection on a horizontal plane is very nearly a parabola; and—as in the imaginary case of a comet coming from an infinite distance without initial velocity—its energy will be accurately in the inverse proportion to its horizontal distance from the centre of attraction, because the reciprocal of its distance from the centre is proportional to the vertical distance it has fallen, by the well-known property of the rectangular hyperbola. If the ball be allowed to roll from a point higher than the horizontal asymptote, it will describe a hyperbola; and if from a lower point, an ellipse.

To produce an ellipse having any given axis-major as A B, Fig. 2, let the ball roll from a point D, on the hyperbolic surface, whose distance from the centre C is equal to A B, and let it be directed with a straight-edge till it touches the desired orbit.

If we could neglect the resistance of the air and all other small resistances to the rolling of the ball, the actual energy, and therefore the velocity of the ball would be precisely what they ought to be to illustrate planetary motion; the direction of motion not being generally horizontal, however, and the orbit not exactly in one plane.

The fact that a part of a rolling ball's energy is rotational and part translational does not vitiate the experiment, because the proportion of the one part of the energy to the other remains constant.

In the case of a steel ball attracted by a magnet pole, the acceleration would appear to be inversely as some higher power of the distance than the square. In the case explained above, the acceleration is very nearly inversely as the square of the horizontal distance from the centre, and only differs from this proportion in being less, as the actual distance traversed by the ball exceeds its horizontal component, at any point; which may be a very small percentage. GEO. ROMANES.

Craigknowe, Slateford, Midlothian.

THE APPROACHING TOTAL ECLIPSE OF THE SUN.[1]

II.

THE considerations which led me, in 1871, to employ a spectroscope without collimator may here again be summarised. If in an ordinary spectroscope, the straight slit be replaced by a circular one, bright rings replace the bright lines which are ordinarily seen in radiation spectra, and since in the solar surroundings we have chiefly to deal with radiation phenomena, the chromosphere and corona themselves can be used during an eclipse as ring slits, and on account of their distance, a collimating lens can be dispensed with.

In the report on the eclipse of 1875, by Dr. Schuster and myself, the principles of the method, as applying to photographs taken during totality, were stated as follows (*Phil. Trans.*, 1878, Part 1, p. 139):—

"Supposing that the corona and chromosphere only send out the same homogeneous light, one image only will appear on the sensitive plate, the only effect of the prism being to displace the image. As far as the protuberances are concerned we know they give a spectrum of bright lines, and we expect, therefore, to find on the plate each protuberance represented as many times as it contains lines in the photographic region. The different protuberances would be arranged in a circle round the sun, and these circles would overlap or not, according to the dispersive power of the prism and the difference in refrangibility of the lines. . . . If the corona gives a series of bright lines we shall find a series of outlines on the photographs similar to that corresponding to the protuberances. . . . If we find that part of the corona gives a continuous spectrum, that part alone will be drawn out into a band."

To this it may be added, that successive photographs will differ on account of the difference of phase. One part of the chromosphere will be visible at the beginning of totality, and another part at the end. The smaller prominences visible at the beginning of totality are subsequently eclipsed by the moon, and their spectra are consequently absent from later photographs, while a new prominence region makes its appearance. In the same way, the part of the corona the spectrum of which is photographed will vary at different phases, but only in the lower parts.

The results obtained by Prof. Respighi and myself during the eclipse of 1871 in India, in which part of the attack consisted in the employment of slitless spectroscopes—a method of work at which we had arrived independently—indicated the extreme value of such observations.

For my own observations in 1871 I had arranged a train of five prisms without either collimator or observing telescope. "I saw four rings with projections defining the prominences. In brightness, C came first, then F, then G, and last of all 1474K. Further, the rings were nearly all the same thickness, certainly not more than 2′ high, and they were all enveloped in a band of continuous spectrum" (NATURE, vol. v. p. 218, 1872).

Respighi's observations were made with a telescope of 4½ inches aperture, with a large prism of small angle in front of the object-glass. The principal results obtained by him were as follows (NATURE, vol. v. p. 237, 1872):—

"At the very instant of totality, the field of the telescope exhibited a most astonishing spectacle. The chromosphere at the edge, which was the last to be eclipsed, . . . was reproduced in the four spectral lines, C, D_3, F and G, with extraordinary intensity of light. . . .

"Meanwhile the coloured zones of the corona became continually more strongly marked, one in the red corresponding with the line C, another in the green, probably coinciding with the line 1474 of Kirchhoff's scale, and a third in the blue perhaps coinciding with F."

[1] Continued from page 157.

"The green zone surrounding the disc of the moon was the brightest, the most uniform and the best defined."

My observation (Brit. Assoc. Report, 1872, p. 331) was made intermediately between the two observations of Prof. Respighi. The observations may be thus compared:—

Respighi	C	D_3 ...	F.G.	Chromosphere and prominences at beginning of totality.
Lockyer	C	1474 (faint)	F.G.	Corona 80 secs. after beginning of totality.
Respighi	C	1474 (strong)	F.	Later.

I had no object-glass to collect light, but I had more prisms to disperse it, so that with me the rings were not so high as those observed by Respighi, because I had not so much light to work with; but such as they were, I saw them better, because the continuous spectrum was more dispersed, and the rings (the images of the corona) therefore did not overlap. Hence, doubtless Respighi missed the violet ring which I saw; but both that and 1474 were very dim, while C shone out with marvellous brilliancy, and D_3 was absent.

In arranging for the eclipse of 1875 in Siam and the Nicobars, the method was further developed by the introduction of photography, and the first results of this extension were given in the Report of the Eclipse Expedition of that year. They showed clearly that with the rapid dry plates of to-day a considerable increase of dispersion might be attempted.

The object-glass employed on this occasion had an aperture of 3¾ inches and a focal length of 5 feet, while the prism had a refracting angle of 8 degrees.

Two photographs were obtained with exposures of one and two minutes respectively. Both are reproduced in the Report (*Phil. Trans.*, 1878, vol. clxix. Part i. p. 139), and they show only such differences as can be attributed to difference of phase. The dispersion was very small compared with the size of the sun's image, so that the photographs present the appearance of an ordinary photograph of the eclipsed sun, which is slightly distended in the direction of dispersion. The various prominences each show three images, two of which were identified with Hβ, Hγ, while the others were found to correspond to a wave-length of about 3957.

It was suggested (Report, p. 149) that this represented the H and K radiations of calcium, and this is fully confirmed by the results obtained in 1893, to say nothing of results obtained in other eclipses.

I next proceed to remark very briefly upon the photographic results obtained since 1875. In 1878, near the sun-spot minimum, the method was employed by several observers, myself among them, but no *bright* rings were recorded. The maximum sun-spot conditions previously observed had entirely changed; indeed with a slit spectroscope the 1474 line was very feeble, and was only seen by a few of the observers, and hydrogen lines were similarly feeble (*American Journal of Science*, vol xvi. p. 243).

Part of my own equipment for this eclipse consisted of a small grating placed in front of an ordinary portrait camera, and with this I obtained a photograph showing only a very distinct continuous spectrum.[1]

The method was employed by Dr. Schuster in Egypt in 1882; the camera was of 3 inches aperture and 20 inches focal length, with a prism having a refracting angle of 60° (*Phil. Trans.*, vol. clxxv., 1884, p. 262). The single photograph obtained (not reproduced in the Report) was stated to show two rings, which were considered to be due to the lower parts of the corona, and therefore to correspond to true coronal light. The wave-

[1] With a duplicate grating I observed the spectrum of the eclipsed sun, and again in three different orders, saw nothing but continuous spectrum (NATURE, vol. xviii., 1878, p. 459).

length of one of these rings was measured to be 5315; it is due to the green corona line (1474K). The second was stated to be coincident with D_3.

In 1883 the same instrument used in Egypt in 1882 was employed, as well as a 6-inch achromatic telescope, and a concave Rowland grating of 5 feet focus, arranged for taking ring spectra in the first and second orders.

It is stated in the Report (*Phil. Trans.*, 1889 A, vol. clxxx. p. 122) that the photographs "possess no features of interest," and neither reproductions, nor drawings nor measurements are given.

The prismatic camera employed in the eclipses of 1882 and 1883 was again used in the West Indies in 1886. Only the spectra of some prominences seem to have been recorded. There is no mention of rings. The hydrogen lines as well as K and *f* are noted (*Phil. Trans.*, 1889 A, vol. clxxx. p. 319).

While on the one hand the photographic results, to which reference has been made, certainly did not come up to the expectations raised by my observations of 1871; on the other, subsequent solar investigations confirmed my opinion that this was the best way of studying the lower parts of the sun's atmosphere, provided an instrument of much greater light-grasping power could be employed.

I determined, therefore, when arranging for the observations to be made during the eclipse of 1893, to renew the attack with the largest telescope and the greatest dispersion at my command.

The Solar Physics Committee was then in possession of a prismatic camera of 6 inches aperture. I decided, therefore, to employ it, all the more because the work on stellar spectra at Kensington had given abundant proof of its excellence.

The Eclipse of 1893.

The instrument was entrusted to Mr. Fowler, the demonstrator of astronomical physics in the Royal College of Science, who erected it at Fundium in West Africa, and obtained a series of photographs of the greatest value to science. A greater success has never been achieved in eclipse observations.

The object-glass of this instrument, corrected for the photographic rays, was constructed by the Brothers Henry. The correction is such that it is unnecessary to incline the back of the camera, and hence some of the objections which have been made to the use of this form of spectroscope are overcome. The large refracting angle of the prism (45°) obviously increases the value of the instrument for eclipse work.

The camera has a focal length of 7 feet 6 inches, and the spectrum obtained is about 2 inches long from F to K. Rings corresponding to the inner corona are about seven-eighths of an inch in diameter.

The tube is a strong mahogany one, square in section, and it was attached to the declination axis by means of a suitable iron plate. In order to reduce the weight of the instrumental equipment, the heavy iron pillar of the equatorial was replaced by a rough wooden stand which was filled up with concrete after being placed in position. Provision was made for the clock bracket and fine adjustments of the polar axis, and the whole arrangement was quite satisfactory.

Fig. 7 represents the instrument as adjusted for use in latitude 14° 3′ N. When actually at work, the camera was steadied by a stiff wooden rod screwed to the end of the tube, and bearing on the end of the declination axis; this did not interfere with the driving gear and materially contributed to the successful results, as on account of the great weight of the prism it was necessary to bring a large part of the tube forward to the eye end. The brass cap which protected the camera from light other than that which passed through the prism and object-glass, is not shown in the diagram.

As time is very precious during an eclipse, every effort must be made to economise it. I may therefore refer to the manner in which the photographic operations were facilitated by the dark slides used.

The construction of the camera and dark slides, or plate-holders, was based on the plan which I devised for the large pictures of the corona which I hoped to obtain in the West Indies in 1886. The slides are about 13 inches in length by 7 inches broad, and have three compartments, each taking a plate 6 inches by 4 inches.

The camera at the end of the long wooden tube has an opening 6 inches square, and a rectangular frame 24 inches long, with a central aperture 6 inches by 4 inches, and provided with grooves to take the slides, was symmetrically attached to it. A dark slide being placed in the frame, so that the first compartment was opposite the middle of the telescope tube, the shutter was then opened to its full extent, and an exposure made; the plate in the second compartment was next brought to the middle of the frame, by pushing the slide along, and also exposed; again, by moving the slide along, the third plate was brought into position and exposed, after which the shutter was closed and the slide withdrawn. During the exposure of any one of the three plates in a slide, the other two were protected from light by the rectangular frame.

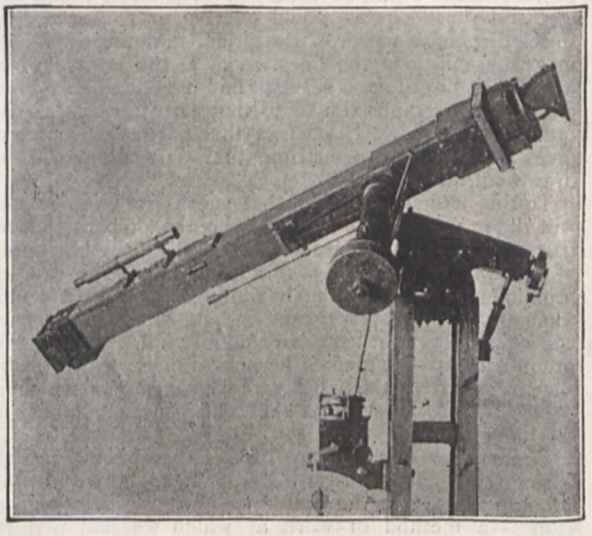


FIG. 7.—The 6-inch prismatic camera arranged for work during the Eclipse of 1893.

The upper edge of each dark slide was notched in three places corresponding to the positions of the three plates which it contained, and, as each plate came to the proper position for exposure, as the slide was pushed along, a spring catch automatically dropped into its place.

Upon the back of each dark slide six numbers were painted in clear white figures. A small series of numbers corresponded to the numbering of the thirty plates to be exposed during the eclipse, and a larger series indicated the exposures to be given to each plate, so that it was unnecessary to refer to any list.

These time-saving devices are of the highest importance in eclipse work, and too much attention cannot be given to them. The arrangements in West Africa worked admirably, and it was possible to change from one plate to another in about a second when a slide was once inserted, and to change the whole slide in five seconds. Longer intervals, however, were allowed to elapse between the exposures, in order that the instrument might steady itself, and to correct the backlash of the driving screw.

The instrument was focussed by photographing the spectra of some of the brighter stars. This is the only satisfactory method of focussing the prismatic camera, as rays from a star fall on the prism under exactly the same conditions as those from the eclipsed sun. If a slit and collimator be employed, identical conditions can only be obtained when the collimator is perfectly achromatic and absolutely adjusted for parallel rays.

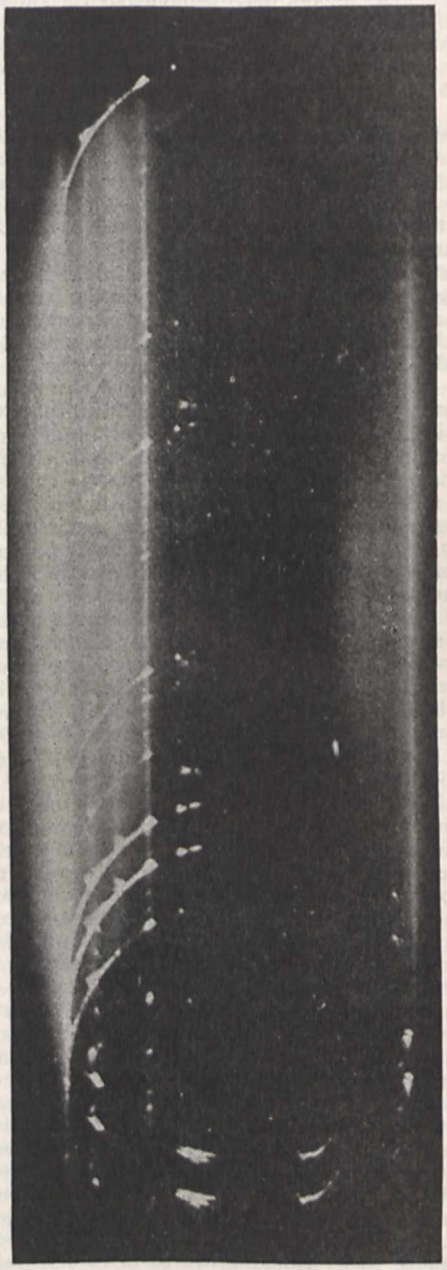


FIG. 8.—Untouched reproduction of photograph (African station) taken very shortly after the commencement of totality, the exposure being "instantaneous." At this phase of the eclipse a considerable arc of the chromosphere was visible, and its spectrum is therefore shown in addition to the spectrum of the higher reaches of some of the large prominences extending beyond the moon's limb. It will be seen that at H and K there are long arcs of chromosphere and prominences, the absent portions being of course obscured by the moon. One very small prominence is especially rich in lines.

I next come to the kind of result obtained by means of the unprecedented optical power employed in 1893, and for this purpose I reproduce two of the beautiful photographs obtained by Mr. Fowler.

It will be seen that we get more or less complete rings when we are dealing with an extended arc of the chromosphere, or lines of dots when any small part of it is being subjected to a disturbance which increases the temperature, and possibly the number of the different vapours present.

The interpretation of these photographs brings us in presence of many interesting and, at the same time, complicated problems. I cannot, however, refer to them here. I have set them out at length in the *Phil. Trans.* (vol. for 1896 A, p. 551).

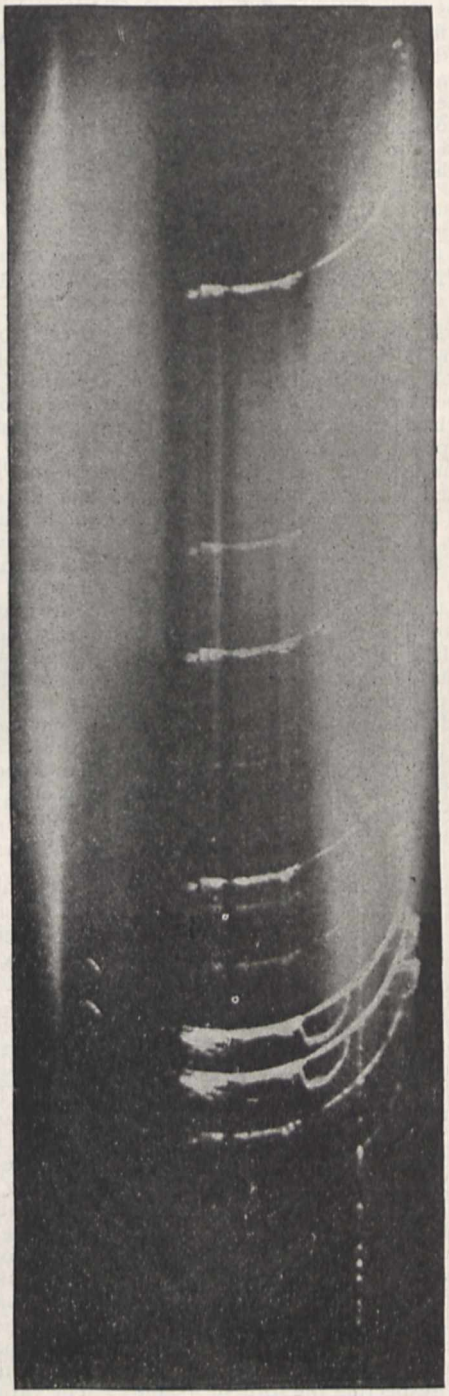


FIG. 9.—Photograph 21 (African station), taken shortly before the end of totality. A portion of the chromosphere on the other edge of the dark moon is now visible in addition to numerous prominences. It will be seen that one of the smallest prominences is rich in lines, and closely resembles that which appears in Fig. 8.

The instrument so successfully employed by Mr. Fowler was not the only one used in 1893. I had been able to equip Mr. Shackleton, one of the computers attached to the Solar Physics Observatory,

with a large photographic spectroscope, deprived of its collimator, for use in Brazil. In this instrument we had two prisms of 60°. The object-glass was a Dallmeyer portrait lens 5D, aperture 3·25 inches, with a focal length of 19 inches. With this he was able to secure a second series of photographs.

The most important results recorded in 1893 may be stated as follows. We not only determined the wave-lengths with considerable accuracy of some 400 lines in the spectra of the chromosphere and prominences, and studied the distribution of the gases and vapour which gave rise to them, but the separation of the spectrum of the corona from that of the chromosphere was made perfectly clear. J. NORMAN LOCKYER.

(*To be continued.*)

WORK AND PROGRESS OF THE GEOLOGICAL SURVEY.[1]

THE first remark that will naturally occur to a geologist into whose hands this Report may come, will probably be one of satisfaction that the account of the work of the Geological Survey for the past year should have been brought out so early, and in a separate form in which the public can purchase it at a low price. But his pleasant surprise will soon be changed into feelings of another kind when he opens the volume and finds it printed, as heretofore, on poor, flimsy paper and in small, close type, so that the perusal of its pages becomes wearisome to the eyes. There could hardly be a stronger contrast to this style of production than that in which the Reports of the United States Geological Survey are issued. These, alike in paper, type and printing, are truly sumptuous publications placed alongside of the miserable efforts of our Stationery Office. Even Canada can afford to present the Reports of its Geological Survey in a form that should make our authorities blush. It is lamentable to see so much excellent scientific work offered to the world in such miserable guise. The Canadian Reports are not only better printed on better paper than ours, but they are actually sold at cheaper rates. Why cannot the mother-country afford to keep up to the level of her transatlantic colony?

The present Annual Report of the Director-General is the longest and most detailed which he has yet issued. It presents a clear picture of the activity of the Geological Survey over all the fields on which the staff is engaged, and enables the public to follow intelligently the progress of the work in the three kingdoms. The volume, or pamphlet of rather more than 100 pages, is divided into three sections, one dealing with the Geological Survey itself, one with the Palæontological Department, and one with the Museum of Practical Geology in Jermyn-street. The section that treats of the Survey consists of two portions, the first of which is devoted to the general statistics and administration of the three branches of the service in England, Scotland, and Ireland. It is interesting to notice in this, as in former Reports, the large extent to which the work of the Geological Survey is made use of for practical purposes. In different ways geology affords valuable information with regard to water-supply, reservoirs, drainage, soils, lines of railway, sites of houses, nature of building materials, and many other questions of daily life. The offices of the Geological Survey have become the recognised headquarters for information of this nature respecting the British Islands. The various Government Departments apply freely for assistance and advice, while the general public continues to make daily inquiries in regard to matters which involve a practical knowledge of geology.

[1] Annual Report of the Director-General of the Geological Survey of the United Kingdom for 1896. London: Printed for her Majesty's Stationery Office, 1897. Price 6*d*.

The scientific results obtained by the Survey during the past year occupy the greater part of the Report, and are full of interest. The narrative of them is arranged in stratigraphical order, beginning with the oldest rocks. We are first taken into the district of Charnwood Forest, and shown the excellent work done there recently by Mr. W. W. Watts. We are then transported into the north-west of Scotland, and watch the labours of Messrs. Peach, Horne, and Clough among the mountains of Assynt and the hills of Skye. The wonderfully complex structure of the country between Cape Wrath and the southern promontory of Skye has now been worked out in detail, most of the maps of that region are published, and we may before long expect a full account of the whole belt of complication from the able band of surveyors who, amidst all the inclemencies of that boisterous climate, and all the physical difficulties of rugged mountain and shaking bog, have so skilfully unravelled the details of one of the most interesting and difficult geological districts in Europe.

In the northern, central and southern Highlands satisfactory progress continues to be made. In the far north Mr. Horne and Mr. Gunn have been at work among the "Moine schists" of Sutherland and Ross-shire. Mr. Barrow and Mr. Cunningham Craig are to be found among the glens and corries of the higher Grampians. Mr. Hinxman is busy among the rocks of Strathspey. On the west side of the country a chain of observers is stationed from the flanks of Ben Nevis to Loch Awe and the hills of Lorne. Mr. Grant Wilson is engaged among the schists and limestones of Loch Linnhe. Mr. Hill has continued his investigation of the metamorphic series around Loch Awe. Mr. Symes has made progress with the volcanic district of western Argyllshire; while Mr. Kynaston has been laying bare the secrets of Ben Cruachan. The work of each of these investigators is succinctly summarised by the Director-General, and attention is called to the more important results obtained in the examination of the younger or Dalradian schists of the Highlands. The mapping is likewise in progress among the metamorphic rocks of the Western Isles, Mr. Wilkinson having now completed the survey of Islay; while Mr. Gunn is prosecuting that of Arran.

One of the most important problems now engaging the attention of the Survey in the Scottish Highlands is connected with the position and relations of a belt of comparatively unaltered strata, wedged in between the schistose rocks and the Old Red Sandstone which has been faulted down against them. These strata, from their lithological characters, their sequence, and their including certain radiolarian cherts, are regarded as probably the equivalents of the closely similar rocks which lie in the Arenig division of the Silurian rocks of the Southern Uplands of Scotland. If such should eventually be proved to be their true age, they will have an important bearing on the age of at least the latest movements to which the Highland rocks owe their contorted and puckered structure. The problem, however, seems to become more difficult the longer it is studied. Last year Mr. Clough, who is engaged on its investigation, has found that no satisfactory line can be drawn between the presumably Lower Silurian strata and the general mass of the rocks of the southern Highlands. If any portion of these rocks should prove to be of Palæozoic age, it would be a notable discovery in British geology. In the meantime we must patiently await the result of the continuation of further research along the Highland border.

The mapping of the Cambrian rocks of the north-west of Scotland has now been completed by the surveys in Skye made last year by Mr. Clough. One of the most singular features of these ancient deposits is the persistence of the same lithological bands for a distance of

100 miles from the mouth of Loch Eriboll into Sleat in Skye. Not only the bands of the Durness limestone, but the "fucoid beds" and the marked subdivisions of the underlying quartzite retain their general characters throughout the whole extent of their outcrop.

The mapping of the Isle of Man has now been completed by Mr. Lamplugh. Much information has been obtained as to the structure of the "Skiddaw Slates" of that island, but no further evidence has been found to fix their true geological age.

The revision of the Silurian formations of the Southern Uplands of Scotland has been brought to a close by Messrs. Peach and Horne, with the assistance of Mr. A. Macconochie. The whole complicated structure of that extensive region has now been unravelled. Among the more interesting recent additions made by these observers to our knowledge of the ground, has been the wide development of volcanic rocks associated with the Lower Silurian sediments. The chief interval of volcanic activity seems to have been the Arenig period; but last year evidence was met with of contemporaneous lavas in the Bala series of Peebleshire. In the Report some valuable details are supplied by Mr. Teall regarding the volcanic series of the Southern Uplands, and also the Galloway granites with their apophyses and attendant metamorphism.

The Silurian areas of Ireland are likewise undergoing revision, with the view of bringing the maps up to the present state of knowledge on the subject. The whole of the country north of Dublin has now been completed by Messrs. Egan and McHenry; while the fossil collector, Mr. Clark, has discovered many new localities for fossils in the Silurian rocks. The revision proceeds upon a careful search for organic remains, and the subdivisions of the Silurian formations are based essentially on the evidence of these remains.

Some important modifications of previously published views were obtained last year by Sir Archibald Geikie and Mr. Kilroe in the west of South Mayo and North Galway. Evidence was gathered which showed that the volcanic rocks of that region, hitherto regarded as of Upper Silurian age, undoubtedly belong to the lower division of the system.

In the Old Red Sandstone, the chief work accomplished by the Survey in 1896 lay in Ross-shire, Arran, and Argyllshire. In the first-named country two hitherto unknown outliers of this formation, capping hills of schist, were found by Mr. Gunn—striking monuments of the denudation of that region. In Lorne considerable progress has been made in the mapping of the interesting volcanic series of the Old Red Sandstone, and some suggestive observations have been made by Mr. Kynaston as to the possible connection of the andesite lavas with the granite of Ben Cruachan.

Among the Carboniferous rocks, the chief task on which the Survey is at present engaged is the revision of the coal-fields on the scale of six inches to a mile. Good progress is reported in the mapping of the great coal-field of South Wales, and a beginning has now been made with the publication of the re-survey. The new maps cannot fail to be of great value in the future development of the mineral resources of this important region. In general, each coal-owner knows only his own ground, and that often very imperfectly. No general acquaintance with the structure and resources of the whole coal-field can be obtained until all the scattered observations at the different mines are correlated and generalised. This, however, is a result which could hardly be effected by private enterprise. It is essentially a national undertaking, and it is this task on which the Geological Survey is now engaged. Mr. Strahan and his colleagues, who are charged with the re-survey, are to be congratulated on the excellent maps which they are producing. Not only are the Coal-measures receiving attention, but the surrounding older formations, the mapping of which is required for the completion of the sheets of the coal-field, are undergoing careful examination, and have already yielded some interesting new results. Thus Mr. Strahan last year discovered that the igneous rocks, which have long been supposed to be intrusive in the Carboniferous Limestone of West Somerset, really include intercalated tuffs, marking the sites of volcanic eruptions during Carboniferous time in the south-west of England.

Strata of Permian age are reported from the northern end of the Isle of Man, where they have been detected in some unsuccessful borings for coal. The younger red sandstones of the Isle of Arran are regarded as not improbably belonging to the same geological system.

Triassic and Rhætic rocks have been mapped over considerable tracts along the southern side of the South Welsh coal-field, and some interesting data have been obtained by Mr. Cantrill regarding the nature and origin of the breccias lying at the local base of these formations.

The most important area of Jurassic rocks examined last year lies in the district of Strath, in Skye, where the ground was mapped by Mr. H. B. Woodward, who has traced the lithological and palæontological subdivisions of the Lower and Middle Lias.

The Cretaceous system over considerable tracts of the south of England was examined during the past year for the purpose of mapping its subdivisions, the clear delineation of which is now found to have so important a bearing in questions of water-supply. Mr. Jukes-Browne is engaged on the preparation of a general memoir on the Upper Cretaceous formations, and has had much assistance from Mr. William Hill, whose extensive and accurate knowledge of the subject has been placed at the service of the Survey.

The field-work in the south of England during 1896 lay, for the most part, outside of the areas of the Tertiary formations. Most of the mapping among rocks of that series was carried on in the west of Scotland, where so large and varied a development of Tertiary igneous masses occurs. Mr. Harker continued his investigation of the eruptive rocks of Skye, and contributes some important facts to the Annual Report. Mr. Hinxman noted two remarkable vents in Raasay, while Mr. Gunn was successful in adding a number of previous unknown particulars to our knowledge of the younger igneous rocks of Arran.

The Superficial Deposits, formerly entirely neglected, now receive a large share of the attention of the Geological Survey. As they thickly cover wide tracts of country, they are of paramount importance in regard to agriculture, water-supply, drainage and many other questions of daily life. It is most desirable, therefore, that their nature and limits should be accurately delineated upon maps. This has been done by the Survey over the whole of the northern half of England, and the same investigation is now in progress in the southern half. When the "Drift Survey," as it is called, is completed, the British Isles will be in possession of a map which will serve as an admirable guide to the farmer, well-sinker, engineer, and generally to the whole of that wide public that is practically interested in the relation of the soils and subsoils to all kinds of sanitary questions.

The Survey, while dealing with these applications of its work, does not lose sight of the intensely interesting geological problems presented by the various superficial formations. The present Report, like its predecessors, contains much fresh information on this subject. From the cwms of South Wales to the downs of Kent, the surveyors have been at work among the various drifts, and the more important of their observations are summarised by the Director-General. Of special interest are Mr. Lamplugh's generalisations regarding the successive stages in the history of the glaciation of the Isle

of Man, and Mr. Bennie's discovery of two ancient lake-bottoms near Edinburgh containing an arctic fauna and flora.

The Second Part of the Annual Report is devoted to the work of the Palæontological Department of the service, and contains a summary of the chief changes, additions and rearrangements made during the year in the palæontological galleries under the charge of Messrs. Sharman and Newton.

The general collections in the Museum form the subject of Part iii., wherein Mr. Rudler reports the principal events in the history of the Museum during 1896. It is satisfactory to observe that the collections continue to attract thousands of visitors, and that not only the general public, but schools, natural history societies, students' clubs, and individual students avail themselves of the admirable educational facilities afforded by the collections.

From what has here been said, it will be seen that the Annual Report of the Director-General of the Geological Survey is not a mere piece of dull statistics, but is an interesting and important contribution to science. It is a volume which will obviously be required in the library of every geologist, for it is crowded with observations which he will find nowhere else. Its publication as a separate work now places it within easy reach, and we trust that its sale will encourage Sir Archibald Geikie to continue the issue of as full a record in future years with perhaps, if the Stationery Office can be propitiated, diagrams illustrative of the more important facts described. In the meantime he and his able staff are to be congratulated on the appearance of so excellent a narrative of strenuous and successful labour.

STYLES OF THE CALENDAR.

AT the approach of the end of a century, this subject naturally comes to the front again; but it has lately been somewhat unexpectedly raised to special prominence by the suggested probability of one at least of the Oriental countries of Europe adopting the usage which, on the initiative of Rome in 1582, all the western nations gradually accepted, England (we say advisedly England *not* Britain, because Scotland adopted it before the union even of the crowns) being the last in 1752. America having been colonised by the western Europeans, and the United States having been still British colonies at the date last mentioned, the Gregorian style is universal in that continent. But eastern Europe, including Russia and all the nationalities of the Balkan peninsula, still adheres to the old Julian style; and this chiefly because the Christians of these countries belong to the Greek or Eastern Church, though it is difficult to see why this should restrain them from falling in with a change which has many conveniences, and would bring their dates into uniformity with those of the Latin, Teutonic, and Scandinavian nations—an object of increasing importance, as intercommunication is constantly becoming more frequent.

It is understood that for some time past, as the nineteenth century is drawing to its close, the question of a change has been discussed amongst the officials and astronomers of Russia; and that a plan was proposed to introduce it not by one operation, but gradually. Probably few persons amongst the general public reflect how essentially twofold the Gregorian alteration was; the object of making our calendar years correspond more accurately during the centuries with the tropical years of astronomers, so that the dates used should for all future time correspond with the equinoxes and other solar seasons, by no means implies the necessity of cancelling a number of days from the calendar so that these should correspond with what they were at some definite epoch in the past. The reason for this latter was purely ecclesiastical, the purpose being that, in celebrating Easter, the full moon following the vernal equinox should be governed by one bearing the same date as it did at the time of the Council of Nicæa. This the Eastern Church appears to have thought of less consequence than did the Western; and, indeed, it cannot be proved that on this point the Council did more than decree, in opposition to the so-called Quartodecimans, that Easter Day should always be kept on a Sunday. However that be, when it was noticed that the vernal equinox (which in the time of Julius Cæsar fell on the 25th of March, but in that of the Council A.D. 325, on the 21st), the question was from time to time agitated at Rome of effecting a change in the Julian reckoning. In passing it may be mentioned that Cæsar and Sosigenes the Alexandrian, who assisted him, were quite aware that the true length of the year was somewhat less than 365¼ days; the important point of the alteration of the calendar then carried out, was the abolition of the former cumbrous system of the Romans by combining a solar and lunar chronology with intercalary months, which were constantly falling into confusion, and the adoption of one wholly solar, the months being made artificial divisions, and it being thought that (the *exact* length of a year being not known) the regular introduction of an additional day every fourth year (making what we call a leap-year) would be quite sufficient for all practical purposes. Pope Sixtus IV. seriously took in hand the question of improving the Julian system, and in consequence of the great reputation of Regiomontanus (as he is commonly called from his birth-place, though his real name was Müller), who was making observations with his friend Walther at an observatory, the first ever made in Europe, erected by the latter at Nürnberg, sent for him to Rome to assist in this object, but, unfortunately, Müller died shortly after his arrival in 1476, which was about three years after the birth of Copernicus. The scheme was therefore again delayed, and was finally executed under the authority of Gregory XIII. in 1582. A century earlier it would have been adopted throughout western Christendom; as it was, the Protestant countries were slow to follow it, and some of the German States at first endeavoured to make some modifications by using a true instead of a calendar full moon, which did not work well in practice, because the moon is not necessarily full on the same day in different localities. England adopted the Gregorian style in its entirety (already, as we have said, used in Scotland), chiefly at the instance of Lord Chesterfield in 1752; and long before the end of last century the same rule was observed over western Europe, no further alteration having been made since, though it has often been noticed that even the Gregorian year is not absolutely accurate.

A definite proposal is now being made in one of the smaller eastern States for the abandonment of the Julian reckoning still observed by them, and the adoption of the Gregorian style. In the *Times* of the 11th inst., Signor Cesare Tondini de Quarenghi informs English readers that he has drawn up a Bill at the request of the Bulgarian Prime Minister, M. Stoiloff, to be shortly laid before the Sobranye for the purpose of effecting this change in Bulgaria; and he also states that he has been informed that Russia is desirous that this example should be thus set before being carried out in that country. How that may be, we are not in a position to know, but it is surely desirable (though even astronomers are not unanimous on the point) that the year should correspond on the whole, and as far as practicable, with its true length, whilst uniformity of usage throughout Christendom, would undoubtedly be a gain of convenience. We would fain hope that some international agreement might be come to by which, after the dropping of a leap-year in 1900, its regular omission at the end of each period of 128 years should be arranged. This would be a more

accurate rule than the Gregorian; and as by either 2000 would be a leap-year, the difference would first show itself in 2028, which, according to this arrangement, would not be a leap-year, whilst by the Gregorian scheme the next omitted leap-year would be 2100. The omission of a leap-year at the end of each period of 128 years was advocated, it may be mentioned, by Sir E. Beckett Denison (now Lord Grimthorpe) in his "Astronomy without Mathematics," and by the present writer in the "Companion to the British Almanac for 1882." Its accuracy may easily be shown. It signifies having 31 instead of 32 leap-years of 366 days in 128 years, and therefore 97 common years of 365 days. Now $365 \times 97 + 366 \times 31 = 46,751$, which, divided by 128, gives 365·2422, the actual length of a tropical year to the fourth decimal. We cannot close without expressing a further wish that some agreement may hereafter be come to amongst Christian nations to celebrate Easter also according to an exclusively solar chronology, by observing it on the first or second Sunday in April. That, however, is independent of the plan now proposed in Bulgaria to abandon the Julian style of the calendar.

W. T. LYNN.

GRANTS TO UNIVERSITY COLLEGES.

IN accordance with an undertaking given by the Chancellor of the Exchequer to a deputation which waited upon him at the end of 1895, with reference to increased aid from public funds for the University colleges, three gentlemen, viz. Mr. T. H. Warren (President of Magdalen College, Oxford), Prof. D. G. Liveing, F.R.S., and Mr. Robert Chalmers, of the Treasury, were appointed in March 1896 to visit the colleges sharing in the grant made to universities and colleges in Great Britain, and to investigate the character and quality of university work done, as well as to inquire generally into the position which each college occupied both financially and in other respects The visits were concluded by the end of last year, and the report came before the Lords of the Treasury about two months ago. The results of the inquiry showed the Chancellor of the Exchequer that a case had been made out for asking Parliament to increase the sum to the colleges sharing in the grant; he therefore recommended that the total grant to the colleges should be increased from 15,000*l.* to 25,000*l.* as from April 1, 1897. The question of the apportionment of this total sum was thereupon referred to a special Committee, whose recommendations, as will be seen from the subjoined Treasury Minute, have been accepted:—

My Lords read the report of the 20th ult. from the Committee appointed by the Treasury Minute of April 5 last to advise this Board in the matter of the apportionment of the increased sum of 25,000*l.* which Parliament has been asked to vote in the current financial year for University colleges in Great Britain.

My Lords accept the apportionment which the Committee propose, viz.:—

The Owens College, Manchester	£3500
University College, London	3000
University College, Liverpool	3000
Mason College, Birmingham	2700
King's College, London	2200
Yorkshire College, Leeds	2200
Durham College of Science	2200
University College, Nottingham	1500
Firth College, Sheffield	1300
University College, Bristol	1200
Bedford College, London	1200
	£24,000
University College, Dundee	1000
Total	£25,000

In deference to the express recommendation of the Committee, my Lords have consented to grant to the Owens College, Manchester, a sum in excess of the *maximum* of 3000*l.* specified in the Board's Minute of April 5, 1897. They desire, however, to make it clear that this increase is made solely in recognition of the pre-eminence of the Owens College, and must not be construed as a precedent for increasing the grant of any other college beyond the normal *maximum*.

My Lords take note of the term of the Committee's report with regard to the Dundee College. In acceding to the Committee's recommendation that "for the present" the college should receive 1000*l.* a year, my Lords are guided, as they understand the Committee to have been guided, by the exceptional position in which the college is now placed with regard to St. Andrews University. My Lords, however, are of opinion that, when the relations between the University and the college are settled, this matter should be subject to reconsideration; and they must not be understood to admit the claim of the college to share permanently in the grant to University colleges.

The Board accept, so far as they are concerned, the recommendation that, with the exception of Dundee College, the above allocation should be settled for a term of five years from April 1, 1897. They also agree that before the end of such term a further inspection should be made on behalf of the Treasury.

My Lords will communicate to the colleges concerned the Committee's recommendation in paragraph 6 of their report that, in certain cases, three-fourths of the additions to the several grants should be devoted to staff purposes.

The future inspection, as recommended by the Committee, should extend to the University Extension colleges at Reading and Exeter, as also to the Hartley Institute at Southampton, and to any other college which, being located in a populous district, may claim to be treated as a fully-equipped college in arts and science.

The Chancellor of the Exchequer invites the Board to consider the qualifications, other than educational, which should be required from a college seeking to share in the grant in future. The Chancellor of the Exchequer submits to the Board that public money should not be contributed to a college which is still in the experimental stage or which has not yet succeeded, though fully equipped, in attracting a considerable number of students in arts and science. He therefore recommends that the financial conditions of participation should be—(1) A total local income for arts and science of at least 4000*l.* a year; and (2) a receipt from fees in the same subjects of at least 1500*l.* a year.

My Lords approve. It only remains for them to record their appreciation of the valuable services which the Committee has been so good as to render to this Board in considering the claims of the respective colleges.

HONOURS FOR MEN OF SCIENCE.

THE honours list issued on Tuesday in connection with the Diamond Jubilee contains the names of a number of men of science upon whom her Majesty has been pleased to confer distinctions.

Dealing first with Fellows of the Royal Society, Mr. Crookes and Dr. Gowers receive knighthoods. In the order of the Bath, Mr. Wolfe Barry, President of the Institution of Civil Engineers, Dr. Frankland, Foreign Secretary of the Royal Society, Dr. Huggins, Mr. Norman Lockyer, Director of the Solar Physics Observatory, Dr. Thorne Thorne, Principal Medical Officer to the Local Government Board, and (naval promotion) Admiral Wharton, Hydrographer of the Admiralty, are appointed K.C.B.

Mr. Christie, Astronomer Royal, and Mr. Niven, Director of Studies at the Royal Naval College, are appointed C.B.

In the Order of the Star of India, Sir Joseph Hooker and Lieut.-General Strachey are promoted to the grade of G.C.S.I.

In addition to the foregoing, Baronetcies are conferred upon Sir Wm. MacCormac, President of the Royal College of Surgeons; Mr. Wilks, President of the Royal College of Physicians; and Mr. Thomas Smith, Surgeon-Extraordinary to her Majesty. Mr. Durston, Engineer-in-Chief to the Navy, is made a K.C.B., and knighthoods are conferred upon Mr. A. R. Binnie, the Engineer to the London County Council, and Dr. Felix Semon.

NOTES.

THE preliminary programme of the International Congress of Mathematicians, to be held at Zürich on August 9-11, has just been issued. The first general meeting of the congress will be held at nine o'clock on the morning of Monday, August 9, in the Aula of the Zurich Polytechnicum. M. Poincaré will commence the proceedings with a paper on the relation between pure analysis and mathematical physics. The next item on the programme is a report of the committee on the object and organisation of the congress; and this will be followed by a paper, by Prof. Dr. A. Hurwitz, on a development of the general theory of analytical functions. The afternoon and evening of Monday will be given to a banquet, a river excursion, and a soirée. On Tuesday, August 10, the congress will meet at 8 a.m. in six different sections, dealing respectively with papers on algebra and theory of numbers, analysis and theory of functions, geometry, mechanics and mathematical physics, astronomy and geodesy, history and bibliography. On Wednesday, August 11, the second general meeting will be held. The organisation of mathematical congresses will then be discussed, and the date and place of the next meeting will be decided upon. On the same day an address will be given by Prof. F. Klein, on the question of higher mathematical instruction, and one by Prof. G. Peano, of Turin, on "Logica mathematica." It is requested that mathematicians who propose to take part in the congress will communicate with Prof. Dr. A. Hurwitz, Falkengasse 15, Zürich, before August 1. A ladies' committee has been formed to look after the comforts of lady visitors while the congress is in session.

PARTICULARS of the construction of the wonderful steam-turbine-driven boat—the *Turbinia*—designed and built by the Hon. C. A. Parsons, were given in NATURE three weeks ago (p. 116). We understand that the *Turbinia* steamed to Cowes last week, stopping at Harwich, without the smallest hitch. On this long run without stop, the complete absence of vibration was greatly appreciated by all on board; from Harwich to Cowes speeds of from sixteen to twenty-eight knots were maintained. The *Turbinia* will be at Cowes and in commission during the review week, for the inspection of visitors and the Press representatives. She is now capable of steaming between thirty-four and thirty-five knots.

THE elevating floor of the Yerkes Observatory at Chicago fell on May 29, just one week after the 40-inch lens had been placed in position. The drop was from its highest elevation, a distance of 45 feet. Fortunately the lens was uninjured, but repairs will take up the entire summer, and will delay the use of the telescope to that extent.

DR. S. A. PAPAVASILIOU has sent us an intimation that he has resigned the directorship of the Service géodynamique de l'Observatoire d'Athènes.

PROF. L. L. DYCHE, of the Kansas State University, has reached San Francisco, *en route* for Alaska, to make arrangements for an expedition to the Pole, beginning next season, and planned to extend over three years or more. He will have provisions for a five years' absence, making the start from the northernmost whaling station.

THE U.S. Secretary of Agriculture has designated a Board, of which Mr. B. Killen, of Oregon City, Ore., chairman of the Board of Regents of the Oregon Agricultural College, and Mr. Evans, of Washington, D.C., are members, to go to Alaska, to investigate the needs of an agricultural experiment station in that territory, and to secure data incident to the establishment of such an institution.

THE Cagnola prize of 2500 lire (100*l.*) and a gold medal having a value of 500 lire (20*l.*), was awarded to Prof. Dr. Ferdinando Sordelli last year for a memoir entitled, "Studi sulla Vegetazione di Lombardia durante i Tempi Geologici," which has just been published as volume xiv. of the *Atti della fondazione scientifica Cagnola*.

PROF. CHARLES L. BRISTOL, of the New York University, and three of his students, with Prof. Tarleton H. Bean, Superintendent of the Castle Garden Aquarium; Dr. W. M. Rankin, of Princeton, and Prof. Wm. H. Everett, of the New York University, sailed from New York for Bermuda on June 3, as a biological expedition. Besides collecting specimens, the party will try to discover a suitable site for a permanent station for the study of marine life. General Russell Sturgis has offered the University a site on his estate at Hamilton.

THE Commercial Museums at Philadelphia, containing industrial exhibits from all the nations of North and South America, including over 75,000 samples of natural produce and industrial products, was opened on June 2, by President McKinley, in the presence of many of the ambassadors of the different American countries, and of special delegates from others. The exhibition is the largest and most complete in many respects that has ever been held. An International Commercial Conference was held in connection with the opening of the museums, under the presidency of Dr. William Pepper, of Philadelphia.

THE United States Weather Bureau has been conducting experiments with kites flown at distances of from one to two miles above the earth, and now it is claimed that it is possible to forecast the weather for a period sixteen hours longer than at present, and more accurately. It is said that the fact has been established that shifting of the wind occurs at the height of a mile above the earth's surface from twelve to sixteen hours before the same change of direction occurs on the surface. Researches by means of high-flown kites and aeroplanes have now been prosecuted so far as to warrant the expectation that within six months the United States Weather Bureau will be able to construct a telegraphic synchronous chart based on conditions of the atmosphere one mile above the earth. This chart will cover the region between the Rockies and the Alleghanies at the outset.

A BOTANICAL society has recently been established at Perth, West Australia, and has been given the designation of the Mueller Botanic Society, as a tribute to the memory of the late Baron von Mueller, who spent the best part of his life in investigating the plants and other products of Australia. Sir John Forrest has been elected president of the new Society; Mr. Wittenoom and Mr. Leake, vice-presidents; and Mr. Skews, secretary.

FURTHER reports of the earthquake in India, on June 12, show that the disturbances were felt over a very extensive area. Considerable damage was done to public and private buildings at Calcutta, and many places in the provinces of Bengal and Assam have suffered very severely. The complete breakdown of telegraphs and other means of communication delayed the reports from Assam regarding the effects of the earthquake in that province. They are now, however, coming in, and present a terrible state of affairs. Reuter reports that at Shillong the shocks of earthquake were so severe and prolonged that everything was levelled with the ground, and many people lost their lives. Gauhati is in ruins. The roads are broken up into chasms, and the railway has disappeared, but no lives were lost. At Goalpara, on the Brahmaputra, the earthquake produced a wave of water which destroyed the bazaar and all pakka buildings. The country is covered with fissures, from which mud and sand are constantly spurting. At Dhubri all pakka buildings have been demolished. The river bank has subsided, the country is flooded, and the crops are ruined. Both at Goalpara and Dhubri there has been serious loss of life. Several places

are cut off from communication, and nothing has been heard from them. Throughout almost the whole of the province of Assam bridges have been destroyed and the roads rent with fissures, so that communication by road is impossible, and the telegraph cannot be used. Further information from Assam shows that the earthquake was slight in Silchar, Kohima, Manipur, Dilbrugarh, and Sibsagar; violent at Barpeta, Nowgong, and Mangaldai, in addition to the places already reported. The Chief Commissioner estimates the mortality from the earthquake in the Cherra Hills at between 4000 and 6000, but details have not yet been received.

THE semi-centennial anniversary of the American Medical Association, held at Philadelphia June 1–4, was attended by President McKinley. About 2500 delegates were present. Dr. Nicholas Senn, of Chicago, presided, and Dr. Nathan S. Davis, of the same city, founder of the Association, was also present. Several hundred papers were read before the various sections.

DR. ARTHUR G. BUTLER, writing in the *Zoologist* (June 15), describes some observations which tell against the assertion that birds build their nests by imitation, and that the reason why many of them at the commencement of the season trifle with building material for some time before they produce a satisfactory structure is that they are unable at once to remember exactly what the character of the nest was in which they first saw the light of day. Different hen canaries, reared in the usual square box of a London breeding-cage, were turned loose by Dr. Butler in aviaries in which no typical finch-like nest existed, and they reproduced nests nearly resembling those of their wild ancestors. A still more convincing proof of the instinctive building habit in birds is given. Dr. Butler turned loose a canary, also cage-bred, in one of his aviaries, late in April. The bird took possession of a square box hung high up on the wirework, and had almost completed a nest therein when it was disturbed. Afterwards it commenced and completed an elaborate cup-shaped nest in a dead bush.

WE are very glad to see that the value of experimental work in agriculture is becoming more widely recognised by British farmers. That this is so, is shown by a petition which agriculturists of the Dunblane district of West Perthshire have sent to the Board of Agriculture in favour of experimental farms. The petition points out that in the United States there are about fifty-four agricultural experimental stations, apart from colleges, receiving Government support to the extent of from 3000*l.* to 4000*l.* each; in France, Denmark, Norway and other countries, large sums are annually expended by Government in aid of agricultural education and research; and in Germany, about a dozen colleges and experimental stations combined receive an average Government grant of about 3000*l.* each. In comparison with this is the fact that in Great Britain the Government grants amount to only about 8000*l.*, which is distributed among eleven colleges and three dairy institutes, and is mostly expended on teaching. The petition goes on to state that a great deal of money is annually lost to farmers through the misapplication of manures, as well as by the injudicious feeding of stock; and though much knowledge has been accumulated by wise and observant farmers, yet this knowledge is being continually lost through want of proper record and confirmation. While some of the suggested remedies for agricultural distress are objectionable, it is believed that a judicious and extended system of experiment would tend, on the contrary, by teaching farmers how to grow larger crops with the same or less expenditure, to increase the supply of home-grown food without increasing its cost.

THE retirement of M. Folie from the directorship of the Brussels Observatory has led to an appeal in both Houses of the Belgian Parliament for the separation of the meteorological service from that of astronomy, which is now the case in nearly all other countries. *Ciel et Terre* of June 1 contains a verbatim account of the speeches made in favour of the separation. The Royal Observatory of Brussels was established in 1826 by A. Quetelet, who presided over the International Maritime Conference at that place in 1853, and whose works on the climate of Belgium, and the "Physics of the Globe" are still considered as models of scientific discussion. The Belgian Meteorological organisation, although dealing with a comparatively small area, is one of considerable importance in the European system. It issues a daily weather chart based upon the reports received by telegraph from nearly fifty inland and foreign stations, a volume referring specially to the observations made at the Observatory, by self-recording and other instruments, and a monthly *Bulletin* containing a summary of the observations made in the country. It supplies daily weather telegrams to the various fishing stations, and storm warnings, when necessary, based on the telegrams received from the Meteorological Office in London, and also issues notices to collieries in the event of unusual falls of the barometer.

MR. H. C. RUSSELL, C.M.G., F.R.S., sends us a description of a very brilliant aurora observed in lat. 47½° S., by Captain Hepworth, of the R.M.S. *Aorangi*, on April 20, while on a voyage from the Cape to Sydney. He thinks the aurora is by far the finest that has ever been seen in the southern hemisphere. It was first observed as a diffused light over the southern arc of the horizon at 6.30 p.m. From this light horizontal flashes soon spread, and flashed upward in every direction, increasing in length and brilliancy, until, at 7.30 p.m., they were shooting across the sky to within 30° of the northern horizon. At 8.30, Captain Hepworth noted that "an arch of bright green light, fading off into yellow, formed over the southern horizon, rose rapidly to a higher and higher altitude, and was followed by similar arches in regular sequence, until there were six distinct arches, their apices being from 10° above the southern horizon to 60° above the northern horizon. They were formed of vertical bands of light from 5° to 20° wide, bright green and yellow at their tops, and of a rosy hue at their bases. Subsequently these arches changed their shapes in all parts of the sky, others forming, but some kind of sinuous curve was always preserved, except in one or two cases. At 9 o'clock a circle formed round the zenith, having a rotary motion, this circular motion having been apparent in all the formations hitherto mentioned. A special feature in this display should be mentioned. These formations all had a westward movement. After 9.15 the aurora was less brilliant, but burst into greater activity a few minutes afterwards, more especially in the northern semicircle. The display lasted until 9.45, gradually fading after 9.30." Mr. Russell adds to this description some interesting remarks on the supposed connection between auroræ and the weather.

THE last number of the *Izvestia* of the Russian Geographical Society contains a dramatic account of M. Pastukhoff's second ascent of the Elbruz. The two summits of this Central Caucasus peak attain, as is known, the altitude of 18,470 feet and 18,340 feet respectively, and consist of two funnel-like craters, situated nearly two-thirds of a mile from each other. The northern and eastern slopes of the peak are covered with a thick *névé*, from which originate fourteen large and several smaller glaciers; they cover an aggregate surface of about sixty-seven square miles, and attain a great thickness, fissures 700 feet deep having been measured in one of them. The lowest level reached by the glaciers is 7640 feet. During the ascent, M. Pastukhoff's companion and one guide were disabled, and had to be left behind, and two nights had to be spent on the glacier,

under the protection of some stone blocks. While the Russian alpinist continued climbing, with one man only, a snowstorm overtook them; and though M. Pastukhoff reached the summit, he could only catch an occasional glimpse of the opposite border of the crater-like funnel, and leave there a tin box, with thermometers, under a big stone. The downward journey was terrible. M. Pastukhoff and his help lost their way, and when the night came they were on a glacier, which they could not identify, surrounded by a labyrinth of fissures. They had again to spend the night in a hole burrowed with their sticks in the snow, covered by one overcoat only, after having had no food all the day. Happily, next morning they fell in with the other guide, who had hastened to go down to a safer place as soon as the snowstorm began, and had carried with him a few biscuits. They soon found their way to the end of the Azau-glacier, where the other members of the party were anxiously waiting for their return.

THE Wellington Caves, situated in the vicinity of the town of Wellington, New South Wales, are remarkable for the large number of fossil remains of extinct animals found in them. The caves were discovered in 1830 by Sir Thomas L. Mitchell. The valley in which they are situated is bounded on each side by hills of limestone rock, rising to a height of about 100 feet on the eastern side, and considerably higher on the other. The floors of the caves are in places thickly covered with loose, dry, red earth which rises in fine dust at every step. At first it was anticipated that numerous fossils would be found in the earth, but after repeated digging only a few fragments of bone, apparently of the kangaroo, were obtained. About 80 feet to the west of the Great Cave is the Breccia Cave, one of the most important and interesting, from a scientific point of view, yet discovered in Australia. The floor is of red earth of considerable depth, the upper portion containing large numbers of bones. In this cave was found a skull, which proved to be the head of an enormous kangaroo. This led Owen to pronounce the opinion that there would be found the remains of a large carnivorous animal, which had been contemporary with the gigantic kangaroo, his view based upon the fact that the herb-eating marsupial must have had a natural enemy. This prediction was subsequently verified, for in 1887 a skull and several jawbones were found, the teeth being in an excellent state of preservation. These remains were ascertained to be those of a lion of a savage and carnivorous nature. It was also a marsupial, carrying its young in a kind of pouch. Other skulls of the animal have been found, but a complete skeleton has yet to be obtained. Mr. Gerard Krefft, who for several years was curator of the Sydney Museum, took much interest in the work of exploring the Breccia Cave, and under his superintendence many hundreds of fossil remains were recovered, not a few of which are now in the British Museum.

THE Superintendent of the National Zoological Park states, in the Smithsonian Report (1895) which has just been distributed, that a spontaneous outbreak of rabies occurred in one of the enclosures for foxes. This is interesting from a scientific point of view; especially as the animals were in perfect health, and, so far as is known, the disease could not have been introduced from without. A single case at first appeared, and this inoculated the entire cage of foxes, seven animals in all being lost. This curious phenomenon is of great interest as bearing upon the sporadic appearance of rabies in the dog.

MR. LAURENCE LAMBE, in a paper on the sponges of the Atlantic coast of Canada, which has just appeared in the *Transactions* of the Royal Society of Canada, gives a complete catalogue with descriptions of the marine sponges hitherto obtained from this coast and from the river and Gulf of St. Laurence. The list embraces thirty-one species, of which seven are new to science.

THE first of a series of contributions to Canadian botany, by Jas. M. Macoun, Assistant Botanist to the Geological Survey of Canada, appeared in vol. vi., No. 1, of the Canadian *Record of Science*, published January 1894. Ten of these papers have been published, the last in the number of the *Record of Science* which has just been issued. These contributions from the herbarium of the Geological Survey, form an addendum to Prof. Macoun's "Catalogue of Canadian Plants," the first part of which was published by the Survey in 1882, the last (Part vi.) in 1892. The first five parts, composing 1050 pages, include all the species of Phanerogams and Vascular Cryptogams known to occur in Canada, with their distribution. Part vi. deals with the Musci. The notes, which have from time to time appeared in the *Record of Science*, are records of species new to science or to Canada, and notable extensions of the known limits of species already recorded. As revisions of American orders and genera have been published, the necessary changes have been made in Canadian nomenclature, so that by means of the papers printed in the *Record of Science*, our knowledge of Canadian botany has been kept strictly up to date. Each of the ten papers already published averages about ten printed pages, with the exception of the last, which is about twice that size. Seventy-eight additions to the Canadian flora have been recorded in these notes, and the range of several hundred species has been greatly extended. They have been reprinted by the Geological Survey of Canada, and may be procured from the Librarian of that department at five cents per copy.

MR. T. H. HOLLAND, of the Indian Geological Survey, whose investigations of the Gohna landslip in 1894 had such successful results in the prevention of subsequent disasters, has now produced a detailed report on a similar subject. The hill-slopes about Naini Tal appear to be in some danger of slips, as in places the divisional planes of the slates dip in the same direction as the surface of the ground and at an angle which, though actually high enough to make slipping possible, is sometimes less than that of the hill-slope: such a condition is obviously extremely dangerous. The investigations include a full contour-survey and a geological mapping of the district, as well as a determination of the angle of repose for the various constituent rocks. The most dangerous sites are indicated, and suggestions for protective operations made where they are worth undertaking. A large number of plates illustrate the report, which is of importance, not only to the residents at Naini Tal, but to all interested in the general phenomena of landslips.

AMONG the articles and other publications which have come under our notice during the past few days, are the following:—Bog-bursts, with special reference to the recent disaster in Co. Kerry, by Mr. R. Lloyd Praeger, in the *Irish Naturalist* for June. Mr. Lloyd Praeger was a member of the Committee appointed by the Royal Dublin Society to investigate the bursting of the Knocknageeha bog in December last (see vol. lv. p. 254), and his paper is a summary, with illustrations of the observations made.—The presidential address, on "The Evidence for the Existence of Man in the Tertiary Period," delivered before the Geologists' Association at the last annual general meeting, by Mr. E. T. Newton, F.R.S., is printed in the May number of the Association's *Proceedings*.—"De verhouding van het gewicht der hersenen tot de grootte van het lichaam bij de zoogdieren," by Dr. Eugène Dubois. This paper, published by the Amsterdam Academy of Scienees (*Verhand. Kon. Akad. v. Wetensch.* Dl. V. No. 10, April), brings together and discusses a large number of observations of the relations between the weight of the brain and total weight of many animals.—The eighth contribution of "Materials for Flora of the Malayan Peninsula" is made to the *Journal* of the Asiatic Society of Bengal (vol. lxv., Part ii., No. 3, 1896), by Dr. George King, F.R.S., Superintendent of the Royal Botanic Garden, Calcutta.

—An interesting paper on early magnetic observations, "Die Anfänge der magnetischen Beobachtungen," contributed to the *Zeitschrift der Gesellschaft für Erdkunde* (vol. xxxii. part 2), by Prof. G. Hellmann, has been reprinted and is now published as a separate paper by W. H. Kuhl, Berlin.—Report on the progress of the Survey of Tides and Currents in Canadian Waters, by Mr. W. Bell Dawson. The report contains some valuable tidal data, and also the results of a general examination of the currents in the interior of the Gulf of St. Lawrence and the Straits connecting it with the Atlantic Ocean.

THE additions to the Zoological Society's Gardens during the past week include two Vervet Monkeys (*Cercopithecus lalandii*, ♂ ♀) from South Africa, presented by Mr. J. W. Lincker; a Squirrel Monkey (*Chrysothrix sciurea*, ♀), a Yellowish Capuchin (*Cebus flavescens*, ♀) from South America, presented by Mr. H. C. Fernando Rohé; a Vervet Monkey (*Cercopithecus lalandii*, ♀) from South Africa, presented by Mr. Alfred Beit; two Common Peafowl (*Pavocristatus*, ♂ ♂) from India, presented by Colonel Stucley; a Rocky Mountain Sheep (*Ovis montana*, ♀) from North America, a Suricate (*Suricata tetradactyla*) from South Africa, two White Ibises (*Eudocimus albus*) from South America, a Pennant's Parrakeet (*Platycercus pennanti*), a Rose Hill Parrakeet (*Platycercus eximius*) from Australia, deposited; two Red Kangaroos (*Macropus rufus*, ♀ ♀), two Peaceful Ground Doves (*Geopelia placida*) from Australia, purchased; a Thar (*Capra jemlaica*, ♀), a Great Kangaroo (*Macropus giganteus*, ♂), a Rufous Rat Kangaroo (*Œpyprymnus rufescens*, ♀), two Squirrel-like Phalangers (*Petaurus sciureus*), a Short-headed Phalanger (*Petaurus breviceps*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ROYAL OBSERVATORY, CAPE OF GOOD HOPE.—Dr. Gill, in his report for the year 1896 to the Lords Commissioners of the Admiralty, sums up the work accomplished during the past twelve months. With regard to the McLean telescope, this is expected to be completely installed and in full working order before the end of the present year. During the last few years, Dr. Gill has somewhat necessarily restricted the amount of observational work in order to make more progress in the computation and publication of many arrears, and it is satisfactory, then, to hear that it has now become possible to again resume a programme of activity. Several important publications have been concluded in the last twelve months. Among them may be mentioned Vol. ii., containing a determination of the solar parallax and mass of the moon, from observations of Iris, Victoria, and Sappho, made in the years 1888 and 1889. Vol i. is also practically complete. The first volume of the Cape Photographic *Durchmusterung* is also ready for distribution, Vol. ii. being in course of printing. The observational work with the transit circle, equatorials, and astro-photographic telescope has been very considerable, and it may be mentioned that all the catalogue plates, with the last-mentioned instrument, have now been obtained. Out of the 230 chart plates, 169 have been satisfactorily exposed. The 7-inch equatorial has also been very busy in the hands of Mr. Innes, and, besides several new variables, 104 new double stars have been discovered. Dr. Gill refers also to the increase in staff and the necessity for a reversible transit circle for refined fundamental work, and mentions that these proposals have been favourably considered by the Lords Commissioners of the Admiralty and of Her Majesty's Treasury.

ZODIACAL RADIANTS OF FIREBALLS.—A remarkable feature about the appearance of slow-moving fireballs is that, as Mr. Denning has pointed out, they are directed from radiants in the western half of the sky and in the neighbourhood of the horizon. A further communication by him to the *Monthly Notices* for May, tells us that not only the most prominent, but the majority of the radiant points determined by observation are found to apparently congregate in a line approximately coinciding with the position of the ecliptic. Although there are a few exceptions to this law, Mr. Denning is nevertheless confident that there is sufficient weight of evidence which is of a suggestive and significant kind. In favour of this view, he gives a table of the observed facts which strikingly corroborate the idea advanced. He draws attention to the importance of accurately recording the directions of flight, and apparent paths among the stars of these bodies when they become visible, and of accumulating data which are necessary for trustworthy results to be based on them. All of us are aware of the great difficulty of accurately observing these strangers in our atmosphere, which come and go at generally most unexpected moments. They are, nevertheless, worthy of special study, and it would be very interesting if they were found to be revolving not only in direct orbits, but in orbits with small inclinations like the Jovian family of comets, as is suggested by Mr. Denning.

THE ROYAL SOCIETY CONVERSAZIONE.

THE second soirée this year took place on June 16. It was very numerously attended, and was more than usually brilliant, as, in accordance with a suggestion made by the President, the officers and many of the fellows appeared in academic or levée dress, to show respect to the Queen's guests who had been invited. The chief exhibits were as follows:—

Electrical effects of uranium: Lord Kelvin, G.C.V.O., F.R.S.

Experiments on kathode rays and some analogous rays: Prof. Silvanus P. Thompson, F.R.S.

Signalling by Hertz waves, as practised by Dr. Oliver Lodge, in 1894, with a Branly tube of filings as receiver, and now adapted to a Kelvin recorder: Dr. Alex. Muirhead.

(1) A selection of dried plants from Tibet, collected by Captain Deasy and Mr. Arnold Pike, Captain Wellby and Lieut. Malcolm; (2) views near the lake, and in the Queen's Cottage Grounds, Kew, by Monsieur and Madame de l'Aubinière: The Director, Royal Gardens, Kew.

(1) Experiments with Röntgen X-rays; (2) experiments with kathode rays; (3) Experiments with oscillatory electrical discharges: Mr. A. A. C. Swinton.

Experiments illustrating a new method of controlling the electric arc in its application to photo-micrography: Mr. T. A. B. Carver, and Mr. J. E. Barnard.

Living specimens of *Proteus anguinus*, Laurenti.—(1) Male and female; (2) pigmented individual from cave; (3) young specimen to show the eyes: Mr. E. J. Bles.

Pelagic animals from the west coast of Ireland: Mr. E. T. Browne.

Specimens of electric figures: Lord Armstrong, C.B., F.R.S.

Stress effects produced by convective electric discharges: Mr. J. W. Swan, F.R.S.

Crystals of diamond, separated from carburised iron: Prof. Roberts-Austen, C.B., F.R.S.

Commensalism amongst marine animals: The Marine Biological Association.

Microscopic image, formed exclusively by diffracted light: Dr. G. Johnstone Stoney, F.R.S.

Examples of animal-forms peculiar to Lake Tanganyika: Mr. J. E. S. Moore.

Microscopic sections of teeth of fossil reptiles: Prof. H. G. Seeley, F.R.S.

Illustrations of the absorption of Röntgen rays by certain elements and their compounds: Dr. J. H. Gladstone, F.R.S., and Mr. Walter Hibbert.

Ancient Egyptian knives and lance-head of flint: Sir John Evans, K.C.B., Treas.R.S.

Models of orchids, by Miss Emett, from plants grown in the Royal Gardens: The Director, Royal Gardens, Kew.

(1) New species of British Mymaridæ (egg parasites) or "Fairy Flies"; (2) aquatic and terrestrial specimens, living: Mr. F. Enock.

Medal struck in gold, silver, and bronze, to commemorate the sixtieth year of the reign of her Majesty the Queen: Mr. Horace Seymour, Deputy Master of the Mint.

Two induction coil contact makers and breakers: Sir David Salomons, Bart.

Demonstration of apparatus for exciting high vacuum tubes for X-ray work: Dr. John Macintyre.

There were the following demonstrations with experiments, and lantern illustrations:—

Signalling through space without wires: Mr. W. H. Preece, C.B., F.R.S.

Photographs illustrating the arrangements of the 1896 eclipse expeditions at Kiö and Novaya Zemlya: Mr. J. Norman Lockyer, C.B., F.R.S.

PROFESSOR MENDELÉEFF ON THE HEAT OF COMBUSTION.[1]

DULONG'S formula, which gives the heat of combustion of different solid and liquid fuels, as depending upon their composition, is, as is known, $\phi = 81\,c + 345\left(h - \frac{o}{8}\right)$, c, h and o representing the percentages of carbon, hydrogen, and oxygen in the fuel.

If a general expression, $\phi = Ac + Bh - Co$, be taken, the numerical value of the coefficient A = 81 must be maintained, because it corresponds to pure charcoal, and all known data (from 8140 to 8060) prove that the figure 81 must really be taken for each per cent. unit of carbon in the fuel (the accuracy of the measurements being within the limits of from 1 to 2 per cent. of the total heat of combustion). For hydrogen, however, the coefficient B = 345 cannot be maintained, because it has been obtained out of data relative to the burning of gaseous hydrogen, while in usual solid or liquid fuel the elasticity of the gas is lost; its hydrogen must be considered as if it were liquefied, and consequently B must not be, according to what is known, more than 300 (admitting, as is usually done, that the water obtained during combustion is in a liquid state).[2]

In order to find the true coefficients suitable for practical purposes, Mendeléeff took the figure $\phi = 4190$, which is quite correct (within 1 per cent.) for pure cellulose, as also the average from 79 most complete measurements for fat coals (by Maler, Alexeyeff, Damski, Diakonoff, Miklaschewski, Schwanhöfer, and Bunge), and the average for naphtha fuel, and he has found:

$$\phi = 81\,c + 300\,h - 26\,(o - s),$$

which formula represents,[3] with an accuracy of from 1 to 2 per cent., the heat of combustion of pure charcoal, coke, coals, lignites, wood, cellulose, and naphtha fuels; of course, it applies to the best determinations only, especially to those which were made in a calorimetric bomb, where the error is less than 1 to 2 per cent.[4]

This formula is an approximate empirical expression of facts; but it corresponds at the same time to the numerical value of the coefficient B for hydrogen, which could be expected from theoretical considerations.[5]

THE SCIENTIFIC REQUIREMENTS OF COLOUR PHOTOGRAPHY.

ON Tuesday evening, June 1, in the Examination Schools, Oxford, Captain W. de W. Abney, C.B., F.R.S., gave the sixth Robert Boyle Lecture before the Oxford University Junior Scientific Club. The President, Mr. R. A. Buddicom, was in the chair, and about 800 members and their guests were present.

The subject chosen by Captain Abney was "The Scientific Requirements of Colour Photography." The following is an abstract of the lecture:—

Colour photography and photography in natural colours are two distinct methods of arriving at the same end, namely, the production of a picture of objects, coloured as they naturally appear to the eye. Both have been accomplished and depend on the application of science, but in the case of the former additional knowledge is requisite of the mode of action of the retina and of theories of colour vision.

In colour photography the theory of colour vision usually adopted is the Young-Helmholtz three-colour theory, in which red, green and blue are selected as primary colours, and not the red, yellow, blue of the artist. Captain Abney pointed out the difference between colour and colour sensation, and placed his colour sensation curves before the audience. These curves enable particular coloured screens to be selected, so that if transparencies from three photographs of the same object, taken one through an orange screen, one through a green, and one through a blue, be each illuminated by its own peculiar coloured light, and the three images be superimposed, the effect is to reproduce a picture of the object in its original colours. The colours of the screens used for taking the negatives must not be such as to allow only monochromatic light to pass. Thus the red screen must allow some orange, the green some yellow, and the blue some green, so that the lights through the three screens overlap somewhat.

The viewing screens, on the contrary, should be as nearly monochromatic as possible. By these means Mr. Ives has, in his chromoscope, been able to present to view photographs of natural objects in the colours in which they appear to the eye.

The next process described was that of Dr. Joly, of Dublin, who, basing his work on the same theory of colour vision as Mr. Ives, reproduces in colour by means of a single negative. This method is essentially founded on what may be called a happy imperfection of the eye. The human eye is incapable of separating points which lie very close to one another. In an engraving, the black lines, close together on a white surface, blend with the white surface to form shades of grey. Dr. Joly's method is to rule lines 1/200 inch broad on a transparent screen, touching one another and being coloured alternately red, green and blue. The lines are of such a depth of colour that the mixture, if made by rotating sectors, would appear white or grey. This screen is used for viewing. To make the negative another exactly similar screen is placed in front of the plate, but the colours of the lines on this differ, just as Mr. Ives' coloured screens for taking the negatives differ from his viewing screens.

When the negative is taken, a transparency is made from it, and the viewing screen is placed behind it, so that the red line covers the place through which the orange negative was taken, and so on. Then, and not till then, the picture appears in its natural colours.

Instead of using transparencies and coloured films, transparent inks may be used to produce pictures by three printings.

The next process described was the oldest, namely, the production of colour by the action of light itself. The present year is its jubilee. Becquerel found that if, instead of iodising a plate, he chlorinised it, and then exposed it to white light, it gradually assumed a violet tint, and if, in this state, he exposed it to the spectrum he was able to obtain the colours of the spectrum on it.

Abney, some years ago, showed that the red tint was due to the lavender-coloured material taking up oxygen, whilst at the violet end the subchloride became further reduced: thus the big molecules formed by the addition of the oxygen vibrated slower, whilst the abstraction of chlorine gave smaller ones vibrating quicker. Since he was able to get the same effect on collodion plates, it is not probable that the colours are due to stationary waves, because, if so, they could only be viewed by reflected light. Unfortunately, however, these colours, from the very manner in which they were produced, were not permanent, and no method has been devised for fixing them.

The last method Captain Abney described of obtaining photographs which showed colour, but not coloured photographs, was that of Lippmann, who found that if, by means of reflection, he obtained stationary waves in the film, on development the silver was deposited between the nodes. On reflecting light from such a "noded" plate, the proper light alone was reflected, and the photograph, viewed at a particular angle, appeared in its natural colours. If looked at by transmitted light, these photographs have merely the appearance of ordinary negatives.

The proceedings closed with a vote of thanks to the lecturer, proposed by Prof. Burdon Sanderson, and seconded by Mr. A. F. Walden.

THE INTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.

THE International Congress on Technical Education, opened by the Duke of Devonshire at the Society of Arts on Tuesday, June 15, was continued on the three following days. Many important papers were read, and there was a large attendance of delegates from the continent and abroad. We have extracted from the *Times* the subjoined brief reports of a few of the papers read and the discussions which took place upon them.

[1] Translated from the *Journal* of the Russian Chemical and Physical Society, vol. xxix. fasc. 2, 1897, pp. 144. (Minutes of meeting of February 18, 1897.)

[2] Maler has also adopted that coefficient, taking C = 30.

[3] The percentage of sulphur was not determined in each measurement, and consequently the coefficient + 26 is determined only approximately.

[4] If the water which is formed during combustion is represented, as it is in reality, in the shape of steam, then 600 aq must evidently be deducted from ϕ; aq representing the weight of water obtained from the combustion of one unit of fuel.

[5] In those cases where different values of ϕ were received for the same composition of coal, the discrepancies could be explained by errors of measurements; there was no foundation to suspect isomerism. A good deal of the now prevailing incertitude is also due to the incomplete data relative to the amount of combustible sulphur.

Several papers on the aims of instruction in chemistry were read on the opening day. In one paper Dr. Otto N. Witt, Professor of Chemical Technology at the Polytechnic School of Berlin, said he could not admit any fundamental difference in the methods of research of pure and applied chemistry, consequently he could not admit the necessity for a difference of instruction for the two. A well-organised instruction in pure chemical science would, in his opinion, be the best preparation of any young chemist for his future career. He held that schools for producing specialists were not wanted ; for specialism came as a matter of course in later life. Chemists were needed who embraced their science as a whole, and who were incapable either of separating practice from theory or theory from practice.

Dr. H. E. Armstrong urged the need of better organisation in regard to instruction dealing with the preparation of the soil for agricultural purposes.

Dr. Gladstone, in the course of a paper on "The Teaching of Chemistry in Evening Continuation Schools," said that when the evening school was situated in the neighbourhood of factories it would be allowable and even desirable that the illustrations should be chosen with some reference to the prevailing industry.

Sir H. Roscoe, in opening a general discussion on the subjects dealt with in the foregoing papers, pointed out that what we in England suffered from was the failure of our manufacturers to see, as they ought to see, the importance of the highest scientific training for their *employés*. Recently he visited some large colour works near Frankfurt, where 100 men were employed, including many highly-trained scientific chemists who had devoted years to original research with a view to making new discoveries. One *employé*, who received 1000*l*. a year, worked for several years without producing any results. But eventually he made a discovery which repaid the firm ten times over and placed an entirely new branch of manufacture in their hands. Scientific teaching had taken up a sound position already, and if manufacturers would only appreciate its value we could turn out scientific men as well as any country in the world.

This view was given support by a paper on "The Teaching of Chemistry," by Prof. G. Lunge, of Zurich, read by Sir H. Trueman Wood. The writer held that, to raise English chemical industry to the foremost rank (which was disputed to it at present in several important branches), it was necessary that the technical management of chemical factories should not be left in the hands of "rule-of-thumb" men, but should be intrusted to real chemists. These men should have a much fuller education than the majority of chemists seem to obtain at present in Great Britain, which meant that they must spend more time and money on their training than they generally did. At college the student should receive a thorough training in scientific chemistry, taking this in its widest meaning, not merely as a "testing" exercise. Next to this, but not to the same extent, he should be taught physics, mineralogy, technology, mechanics, and the elements of engineering. As to whether foremen or even the common workmen should possess a certain knowledge of chemistry and technology, such as may be imparted at Board schools or at night classes for adults, Prof. Lunge was afraid that such knowledge was quite useless to ordinary workmen, who had simply to do as they were told, and who might do more harm than good by trying to apply a superficial idea of the nature of the operations which they had to perform, without possibly having a real insight into them. He did not even think that, apart from isolated exceptions, such knowledge was much good to the foremen, whose duty it was to carry out their instructions and to see that the men did their work as prescribed by the staff, but who were not to meddle with the chemical process itself.

Prof. Silvanus P. Thompson, in discussing the paper, said there should be a distinction between the different branches of the subject. He urged that where a great industry was localised science should be applied to that industry, and an institute should be put there devoted to monotechnical rather than polytechnical instruction. Training in research was absolutely necessary, and specific research should not be undertaken too soon by students who had not been taken through an all-round course in chemistry.

Mr. G. R. Redgrave, Chief Senior Inspector Science and Art Department, read a paper giving an historical retrospect of "The Intervention of State in Secondary Technical Education," in the course of which he urged that something of the nature of the German Realschule, but with a far larger proportion of practical science work and manual training, should be our model for the secondary school in this country.

On Wednesday, June 16, Sir Philip Magnus, in a paper on "Theory and Practice in Trade Teaching," referred to the difficulty of determining the true relation of theory and practice in teaching the technology of any trade, and in the Technical Instruction Act, which expressly forbade the teaching of the practice of a trade in any technical school. But in the great majority of industries the practice of the trade was best acquired in the factory and shop, and the instruction of the technical school should be supplementary only to the experience obtained in commercial work. By this principle nearly all our technical classes were regulated. Although a technical school might be equipped almost as completely as a trade shop the equipment served a very different purpose. Its object is the production of intelligent workpeople, and not the production of saleable commodities. The practice a student obtains in a technical school was intended to enable him to understand appliances of his trade, and to use them with care and judgment.

Mr. S. H. Wells, Principal of the Battersea Polytechnic, pointed out that the greatest of all difficulties in connection with technical classes was undoubtedly the provision of satisfactory and efficient teachers. The first and most natural qualification of a teacher of technical classes was that he should possess a practical knowledge—acquired in the factory or workshop—of the subject to be taught; the second, that he should possess a sound knowledge of the arts and sciences applicable to the subject ; and the third, that he should be able to impart his knowledge to others, to arrange a syllabus of instruction, to manage a class, in a word, to teach.

Prof. Ayrton gave an account of the Central Technical College, South Kensington. He remarked that the facilities for technical instruction in London were increasing every day, but a system of coordination was greatly needed.

Prof. Silvanus Thompson urged the coordination of educational institutions from the highest to the lowest. Dr. Garnett said that if artisans were to be attracted to technical classes the teachers must be acquainted with the practical details of the trades to which the artisans belonged. It was difficult to find theoretical and practical knowledge combined in one man. The presence of practical workmen he had found a great advantage when holding his classes. Prof. Viriamu Jones (Cardiff) believed that artisans would ultimately avail themselves of the best instruction to be obtained in each science bearing on their trade. They would feel that teaching by specialists was better for them than teaching from those who might have learnt but little of the subjects. Mr. Reynolds (Manchester) pointed out the wasteful overlapping that prevailed in connection with technical instruction. The Technical Instruction Act, which forbade the practice of a trade being taught in technical schools, was practically a dead letter in Lancashire, and deserved to be. Prof. Chatterton (Madras) said that the great difficulty in connection with the technical schools in the Madras Presidency was to obtain efficient teachers. Mr. Mundella, M.P., said that proper elementary education was indispensable before working men could derive benefit from special technical instruction. Parliament must raise the limit of age for compulsory attendance at elementary schools to that which prevailed in other countries. If his students had not been well educated in elementary subjects the science master was called upon to make bricks without straw.

The Chairman, Major-General Sir J. Donnelly, in concluding the discussion, referring to the interpretation of the Technical Instruction Act, said technical instructors might teach how a thing was done, but not carry their training so far as to give the rapidity and dexterity of manipulative skill required for the craftsman or journeyman. Looked at in that way, there was no difficulty in working the Act.

Mr. Mundella, M.P., in introducing Prof. T. V. Diefenbach, to read a paper on "Technical Education in Würtemberg," referred to the marvellous progress made by the kingdom of Würtemberg during the last forty years. A commission from England, which visited Würtemberg to inquire into their system of technical education, reported that they had seen no part of Europe more progressive than Würtemberg, and they were assured that there was not a single pauper in the whole country. He wished he could say the same of England.

Sir Joshua Fitch then read a paper on "Some Limitations to Technical Instruction," in which he entirely admitted that our

school instruction had long been too bookish, too little practical, and that the friends of technical instruction were fully justified in calling attention to the grave deficiencies in our system, especially to the want of sounder teaching in physical science and of better training in the application of those sciences to the enrichment of the community and to the practical business of life.

Prof. Oscar Pyferven, of the University of Ghent, who represented the Belgian Government, read a paper on "L'Enseignement Professionnel et l'Initiative Privée en Belgique"; and M. E. Sève (Consul-General for Belgium) read a paper on "Technical and Commercial Instruction in Belgium."

Prof. Wertheimer, principal of Merchant Venturers' Technical College, Bristol, read a paper on the influence of various examining bodies on the progress of technical and commercial education in England. He held that it behoved them to watch closely any attempt to establish new examinations. The technical instruction committees of some County Councils were already instituting examinations of their own; in a very few cases these might be necessary to meet special local requirements. But, as a rule, they were not needed, and it would be wiser to endeavour to modify existing examinations, if necessary, rather than to establish new ones.

On Thursday a paper by Mr. Quintin Hogg, on "Polytechnics," was read by Dr. William Garnett, who also gave an account of the work of the Technical Education Board of the London County Council. In commenting upon the latter paper, Sir John Lubbock said that too much of the money went to the elementary and too little to the higher training of those who were to be the leaders of industry.

The next paper was on "Reforms in the Organisation of Technical Education," by Prof. Silvanus P. Thompson, F.R.S., who said that the provision made on the continent for the higher training in chemistry might be understood from the fact that the entire establishment of the Regent Street Polytechnic, chemical laboratory, gymnasium, swimming bath, theatre, kinematograph, and all, might be accommodated within the space provided for the chemical laboratory alone in the polytechnic at Munich. The chemical laboratory of the polytechnic at Zurich exceeded in contents the whole of the technical schools at the People's Palace. The chemical laboratory of Berlin was larger than the whole building of the City of London College. The physics laboratory at Zurich was considerably larger than the whole building of the Finsbury Technical College, and the cost nearly twice as much.

The remainder of the papers on Thursday dealt with commercial education, the organisation of examinations, and the development of technical instruction in secondary schools.

The concluding session of the conference, held on Friday last, was devoted exclusively to the consideration of papers by ladies on a variety of aspects of technical and secondary education. Mr. Mundella, M.P., presided.

Miss Alice Mitchell read a paper on the "Teaching of Domestic Economy in Girls' Secondary Schools." In the high schools she thought the great failure was the absence of the practical side, for all schools suffered from the want of laboratory facilities.

A paper was read by the Countess of Warwick on "Technical Education in Rural Districts." She said she had undertaken the task believing that a careful development of the subject might help not a little to stay the depopulation of our villages. An intelligent appreciation of natural phenomena and natural laws, when applied to agriculture, might go a long way to relieve the depression from which country districts were so keenly suffering. The elements of chemistry and physics, geology, botany, and zoology might be taught with great advantage to the future farmer or practical agriculturist. We should no doubt some day have a rational system of education, and not a disjointed one, as at present, when due regard would be paid to the co-ordination of subjects of instruction. At present, the great want was co-operation in all branches, but this was likely to remain while every branch of education was under a separate and distinct authority, often antagonistic to each other and encroaching on one another's grounds. In the same town they might see the voluntary schools, board schools, middle schools, grammar schools, and technical classes all being carried on under separate rate authorities, who have no regard for each other's work, and consequently overlapping each other's efforts, in many directions leading to waste of time, money, and energy. District technical schools should be opened within given areas, or a technical side to existing schools be developed; or, perhaps better still, the schools of the whole district should be affiliated, with a technical school attached, for the use of the pupils from all. The money received by county councils for the technical education grant might be well spent in equipping such schools. If a plot of land could be attached to the technical schools, it would be very useful for the purpose of experiment and demonstration in the field.

At the close of a discussion, the Chairman said Lady Warwick's paper was so full of suggestions that it was impossible to comment upon them briefly. It involved educational reforms of the highest importance, and the first was that one public authority in each district should see that education was properly carried out. Lady Warwick had put aside the utilitarian view; nevertheless, this was a subject of considerable moment, both in town and country. Denmark was far ahead of us in agricultural matters, and sent to this country produce to the value of 10,000,000*l.* annually. It was an extraordinary thing that we should have to pay enormous sums of money to foreign countries for supplies which we ought to be able to provide much better at home. They were told that foreigners were more intelligent than our people; and although he did not believe that, we should educate our people and try to make them as intelligent, fruitful, and productive as their foreign competitors.

A large number of other papers were read before the Congress, but the limitations of space prevent us from referring to them.

SCIENTIFIC SERIALS.

American Journal of Science, June.—Bacteria and the decomposition of rocks, by J. C. Branner. In criticism of the somewhat largely prevailing idea that bacteria are the cause of much of what is called the decay of rocks, it must be remembered that nitrifying bacteria not only do not penetrate the rocks themselves to any considerable depth, but they do not even penetrate the soil to a depth of more than three or four feet. Granites are, on the other hand, often decomposed to depths of more than 100 feet.—On Wellsite, a new mineral, by J. H. Pratt and H. W. Foote. This mineral occurs at the Buck Creek corundum mine in Clay Co., North Carolina, associated with albite, felspar, and hornblende. No crystals found exceed 2 mm. in length. They are monoclinic and twinned, brittle, with a vitreous lustre and no apparent cleavage. They are colourless and transparent or white, with a hardness of between 4 and 4·5, and a density of about 2·3. Chemically, it is a barium or calcium hydrated silicate corresponding to the formula $RAH_2Si_3O_{10}.3H_2O$, and is therefore allied to Phillipsite, harmotome, and stilbite.—The magnetic increment of rigidity in strong fields, by H. D. Day. The author employs extremely strong fields in order to bring out clearly the relation between magnetisation and the phenomena of magnetic rigidity. He shows that long after magnetic saturation has been reached the increase of rigidity due to increase of field intensity goes on, and that the limit of the latter is not reached even with the highest field intensities attainable. As the field becomes stronger, the increment of rigidity varies more and more regularly with the twist, the tendency being that in fields indefinitely large the increment of rigidity would be proportional to the twist applied.—The broadening of the sodium lines by intense magnetic fields, by A. St. C. Dunstan, M. E. Rice, and C. A. Kraus. The phenomenon of the magnetic broadening of the sodium lines discovered by Zeemann may be easily observed with the aid of Michelson's interferometer. Light from a Bunsen flame containing a sodium salt is sent on to a plate of plane glass which partly reflects and partly transmits it to a fixed and a movable mirror. The fringes produced in the telescope by their recombination are made less visible by the broadening of the line observed. The curve of visibility gives the amount of the broadening. In the most intense field the broadening is in the ratio of 1 to 1·7. It is proportional to the field intensity.—The relative motion of the earth and the ether, by A. A. Michelson. This was investigated by an interference experiment in which a beam of light was made to travel round a rectangle in a vertical E. and W. plane, and to return along the same path. If the ether near the earth's surface moves with the earth, and the ether above the atmosphere is stationary, there must be some difference of

velocity in the upper and lower paths, which would be indicated by a displacement of the fringes. No such displacement is observed, and hence we must conclude that either the ether is absolutely at rest everywhere, or that the earth drags it with it up to many thousand miles from the surface, or, lastly, that the length of all bodies is altered by their motion through the ether.

Bulletin of the American Mathematical Society, May.—Systems of continuous and discontinuous simple groups, by Dr. L. E. Dickson (read at the April meeting of the Society). This paper is in continuation of some results announced at the Buffalo meeting (August 31, 1896), and consists of four sections. § 1 enumerates the known systems of discontinuous simple groups; § 2 the systems of finite continuous transformation groups which are simple; § 3 gives an elementary deduction of certain groups in § 2, viz. the groups in the $l(2l+1)$ parameters, isomorphic with the general projective group of a linear complex in R_{2l-1}, and a proof of their simplicity; § 4 discusses the semi-simple linear homogeneous groups whose defining function is the sum of n determinants of order $q>2$. The contents of §§ 3, 4 were presented by Prof. Lie (February 19) to his class, and he stated that "the interesting result of § 4 was new, and not what one would have expected."—On the number of roots of the hypergeometric series between zero and one by Mr. M. B. Porter (read at the March meeting). Klein's solution was published in 1890 (*Math. Ann.*, vol. xxxvii.). Solutions by Hurwitz and Gegenbauer are given in the *Math. Ann.* (vol. xxxviii.) and the *Wiener Sitzungsberichte* (vol. c.^{2a}) respectively. The object of the present paper is to apply two theorems of Sturm (*Liouville's Journal*, vol. i.) to the solution of the problem.—Another paper, read at the March meeting, is by Prof. J. Pierpont on modular functions. This treats the subject from the point of view of H. Weber's Memoir, zur theorie der Elliptischen Functionen (*Acta Math.*, vol. vi. p. 329; *cf.* also his Elliptische Functionen und Algebraische Zahlen, 1891).—In the Notes are given the mathematical courses for the summer session at the Universities of Chicago, Leipzig, and Munich.

Bulletin de la Société des Naturalistes de Moscou, 1896, No. 1.—Contributions to the knowledge of the Urticaceæ and the Moraceæ, by M. Golenkin, with one plate. The inflorescence and the disposition of leaves are treated in this second instalment (in German).—A preliminary catalogue of the Lepidoptera of the province of Kazan, by L. Krulikovski, continued (in Russian).—Study of the embryonal development of *Gammarus pulex*, by Marie Rossyskaia-Kojevnikova, with one plate (in French).—Materials for the mycological fauna of the province of Smolensk, by A. Jaczewski (in French). The author has found in that province 550 species of fungi, out of which 408 are new for that region, and he gives the list of these species.—On the structure, function and evolution of the Nematocysts of Cœlenterata, by N. Iwanzoff, with four plates (in German). An elaborate work, made at the zoological laboratories of Naples and Villefranche, to be continued.—On the rotation of the earth, supposed to be fluid in its interior, by Prof. Th. Sloudsky, being a purely mathematical inquiry, continued from a previous number.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 13.—"A Dynamical Theory of the Electric and Luminiferous Medium. Part III. Relations with Material Media." By Joseph Larmor, F.R.S., Fellow of St. John's College, Cambridge. Received April 21.

This series of papers is mainly concerned with the development of electrical and optical theory on the basis that electricity is constituted of discrete atomic charges or electrons. It has been shown in the previous papers that the facts of electrodynamics require this hypothesis and are consistent with it. The hypothesis was arrived at from the point of view of the properties of the æther, the conception of the electron as a permanent strain-centre being a necessary feature of a theory of an elastic æther. This idea is here developed and illustrated by aid of a specification, on Lord Kelvin's lines, of a gyrostatic material structure which would possess the rotational elasticity characteristic of the æther, and at the same time contain such strain-centres. The conception of a medium of elastic solid type containing mobile discrete strain-centres is also touched upon, by way of illustration and contrast.

In the previous papers the relations of electromotive and optical phenomena in matter at rest had been developed on this basis. When the matter is considered as in motion through the æther, or when electric forces on matter are treated, we obtain a definite and sufficient basis of connection between matter and æther by assuming that the electrons are attached to the atoms of matter. On this basis the electric and optical relations of moving material media are here developed at length. The more speculative question, as to how far a constitution of the material atom which makes it consist wholly of a system of electrons describing orbits round each other suffices to represent or illustrate the properties of matter, comes under consideration in various respects: this hypothesis in many of its features would agree with the well-known theory of vortex atoms.

The theory of refraction equivalents is developed, leading to Lorentz's results. The theory of optical dispersion is treated from the generalised standpoint that the molecule vibrates about a configuration of steady motion instead of one of rest: it appears, also, that the formula usually given for the square of the refractive index must be replaced by a similar formula for the Lorentz refraction equivalent.

The character of the mechanical forces that are developed in fluid and solid material media by the electric attractions between the polarised molecules of which they are composed, is considered, and expressions are obtained for them. A distinction is here essential between those forces between neighbouring molecules which are compensated locally, and the ones which give rise to transmitted mechanical force which must be compensated by regular mechanical stress in the medium; somewhat in the manner of the corresponding distinction employed by Young and Poisson in the theory of capillarity. It leads, through the negation of the perpetual motion, to the specification of a function which is the *mechanical* or *organised* energy of the material medium: this is different from the *available* or *free* energy of thermodynamics, which is also represented by an analytical function on account of the negation of the unlimited availability of diffuse thermal energy: it is, of course, also different from the *total* or *aggregate* energy of the molecules of the medium, about which little can be known in detail. The theory of osmotic forces is formulated in relation to the available energy with which they are connected, as they are related to the individual molecules sifted by porous partitions and not to the element of matter in bulk: the known general laws of chemical equilibrium are formulated as corollaries to the same principle. On the other hand, the mechanical forces in a fluid molecular medium polarised in any manner are expressed in terms of the distribution of *mechanical* energy of polarisation. The doctrine of *energetics* (including the conception of temperature), which forms a sufficient basis for the descriptive explanation of the mechanics of statical or steady material systems, thus reposes on the negation of the two types of perpetual motion above mentioned, and therefore ultimately on the discrete constitution of matter.

A thermodynamic application which possesses interest, both from the light it throws on the nature of magnetism and from the circumstances that in it the heat supply is calculated indirectly from the magnetic energy that runs down, is the relation between magnetic susceptibility and temperature in substances not in the very susceptible or ferromagnetic condition. According to the Weberian theory, which fits in with the present view, diamagnetic energy which is not compensated mechanically goes to the induction of Amperean currents in the molecules; while paramagnetic energy not thus compensated goes to orientating the molecules, and thus into heat. It follows that the diamagnetic coefficient is independent of temperature: on the other hand, it is shown that the paramagnetic coefficient should vary inversely as the absolute temperature. These laws were discovered experimentally by Curie, who finds from a very extensive investigation that they have the same order of accuracy at sufficiently high temperatures as the ordinary gaseous laws: at lower temperatures and in ferromagnetic substances the control of the polarised molecules arises in appreciable part from the magnetic interaction of their neighbours, thus vitiating the law as well as introducing effects of hysteresis. The well-known model of Ewing would thus represent an ideal perfect ferromagnetic in which the control arises wholly from the latter cause.

In application of the previous results as to how far physical actions can be considered as transmitted across the æther by elastic stress, the conditions are formulated under which the

correlative principle utilised by Poynting is valid, that the actual rate of change with time of the organised or mechanical energy within any region is expressible explicitly as a surface-integral over its boundary.

The mechanical effects of light-waves are reconsidered in the light of this molecular theory. The conclusion is reached that such effects are wholly associated with absorption of the radiation, that no influence of perfectly transparent media on radiation can provoke a mechanical reaction. There is a mechanical force acting on an absorbing mass, in the direction of the incident radiation and equal to $E(1-m^{-2})$, where E is the energy absorbed per unit time and m is the real part of the index of refraction. Partial analogies are furnished by the mechanical effects of Hertzian radiation on a medium built up of conducting linear circuits, and of sound waves on a medium formed of a system of resonators.

As an application of the law of the mechanical forcive on dielectrics, the changes of dimensions of a condenser under electrification are considered. The problem is found to admit of exact solution if the condenser layer consists of a closed sheet, of any form, but of uniform thickness. In that case the mechanical stress in the material of the sheet proves to be simply of the type of the Faraday-Maxwell stress. The theory is compared with Quincke's experimental results: their main features are verified, including those which led Quincke to assign a wholly non-mechanical origin to the effect: but something less than half the change of volume remains over as an intrinsic electric deformation, not due to the transmitted mechanical forces.

Finally a series of practical illustrations of the mechanical theory are treated, some of which have already been employed for experimental measurement, and which are capable of still further application. The mechanical circumstances attending the refraction of uniform fields of electric force by fluid media are developed. The theory of various arrangements for measuring electric tractions and pressures in fluid dielectrics is worked out. The effect of an electric field on the velocity of ripples on the surface of a conducting or a dielectric fluid is determined: as also are the relations of electric polarisation to vapour tension and fluid equilibrium. The internal mechanical forces in a complete magnetic circuit are examined, and also the traction between the interfaces when it is divided: and the mode of calculation of the stress in a sphere of iron in a uniform magnetic field is indicated, agreeing for this case with Kirchhoff. The mutual influence of stress and magnetisation is analysed, with reference to the experimental investigations of Bidwell.

June 3.—"Mathematical Contributions to the Theory of Evolution. On the Relative Variation and Correlation in Civilised and Uncivilised Races." By Miss Alice Lee, Bedford College, and Karl Pearson, University College. Received April 9.

The numerical constants of this paper were calculated in the hope of reaching some general ideas on comparative variation and comparative correlation in the case of civilised and uncivilised races, and further of determining, if possible, any general law connecting relative sexual variation and relative sexual correlation with the degree of civilisation, and so, with what is probably inversely proportional to the degree of civilisation, namely, the intensity of natural selection.

The following two principles seem to flow from a study of variation in the organs of man:—[1]

(*a*) Civilised man is more variable than uncivilised man.

(*b*) There is a greater equality of variation for the two sexes in uncivilised than in civilised races. Civilised woman appears, on the whole, to be slightly more variable than civilised man.

Both these principles are in accordance with the intensity of the struggle for existence—and the amount, consequently, of natural selection—being greater for uncivilised than for civilised races, and, further, greater for men than for women in the latter races.

The problem of correlation is, however, of a less simple character. While the action of selection can be shown theoretically to reduce variation, it by no means follows that it reduces correlation. Indeed, selection may increase, decrease, or reverse correlation at the very same time as it is reducing variation. We have then the following problems to guide us in the treatment of actual statistics:—

(*a*) Is correlation more intense among civilised than among uncivilised races?

(*b*) How does the relative correlation of the sexes differ in civilised and uncivilised races?

(*c*) Is there any marked prepotency of either sex in the matter of correlation?

These are the problems which the present calculations were designed, not to definitely solve, but to illustrate.

Unfortunately, adequate measurements on living members of uncivilised races are not very numerous, nor for the purposes of correlation generally very satisfactory. Reasons are given in the paper why long bones form more suitable material than skulls, and the measurements made in France by Rollet, and on the Ainos in Japan by Koganei, are discussed at length.

The following results are suggested by a discussion of the measurements.

(1) Civilised man has progressed as a rule on primitive man in size, variation, and correlation.

(2) This progression can hardly be accounted for by increased selection (because of the increased variation), not by decreased selection (because it is inconsistent with the relative changes in male and female size). It might possibly be accounted for by decreased selection and improved physical conditions.

(3) Woman is more variable than man in civilised races.

(4) Woman is more highly correlated than man in civilised races.

(5) In uncivilised races the sexes are more nearly equal in the matter of size, variation, and correlation than in the case of civilised races.

(6) It is impossible to say that civilised woman is nearer to the primitive type than civilised man. While civilised man differs more from the primitive type than civilised woman, so far, probably, as absolute size is concerned, he has made only about half her progress in variation, and hardly any progress at all in correlation.

(7) The causes (*e.g.*, lessening of selection) which tend to increase variation may also increase correlation. In other words, the intensity of the struggle for existence is not necessarily a measure of the intensity of correlation.

Mathematical Society, June 10.—Prof. Elliott, F.R.S., President, in the chair, and subsequently Major MacMahon, R.A., F.R.S., Vice-President.—Mr. W. W. Taylor gave, in some detail, a description of several models of the regular convex and star solids.—The following papers were communicated:—The calculus of equivalent statements (sixth paper), by H. MacColl; on the primitive substitution groups of degree fifteen, by Dr. G. A Miller; and a generalised form of the binomial theorem, by Rev. F. H. Jackson.

EDINBURGH.

Royal Society, June 7.—Prof. Geikie, F.R.S., in the chair.—Sir William Turner read a paper by Dr. Broom, South Africa, on the comparative anatomy of the mammalian organ of Jacobson.—Prof. C. G. Knott gave the concluding paper of the series on magnetic strains, for which the Council has awarded him the Keith Prize for 1893-95. His results may be summarised thus:—All the iron and steel tubes follow approximately the same law as regards their longitudinal dilatation in a longitudinal magnetic field. In moderate fields the dilatation is positive; but it is negative in higher fields. The maximum occurs in field 150 ± 50, according to the thickness of the walls—the thinner the wall, the lower the field corresponding to the maximum dilatation. The great diversity in the volume-changes within the cores shows that the transverse dilatations must be of such a value as to be in some cases less than half the longitudinal dilatation, sometimes greater. This is particularly true of the steel tubes. The behaviour of nickel is much simpler than that of iron. On the whole, the cubical dilatation is determined by the longitudinal dilatation, both being negative and more nearly alike in order of magnitude than in the case of iron. Excepting for the tubes of narrowest bore, the transverse dilatation is positive, and about $\frac{1}{4}$th or $\frac{1}{5}$th of the longitudinal dilatation. The change of volume of a mass of nickel turnings enclosed in a brass tube and placed in the magnetic field is much smaller than the volume-changes in the bores of the tubes. The cubical dilatation is always positive, and increases steadily from $1{\cdot}56 \times 10^{-8}$ in field 107, to $27{\cdot}4 \times 10^{-8}$ in field 570.—In a paper on the solution of equations connecting linear vector functions, Prof. Tait derived a general proposition regarding the commutativeness of strains, and noted connected questions.

[1] See "Variation in Man and Woman," by K. Pearson: "The Chances of Death," vol. i. pp. 256-377, where some 155 cases of human variation for both sexes are dealt with.

—On the electrification of air by uranium and its compounds, by Dr. J. C. Beattie. Experiments were described to test the electric state of the air in the neighbourhood of metallic uranium, or of other metals on which a salt of uranium had been deposited, when these were charged to a positive or negative potential. The method adopted was the electric filter method of Kelvin, Maclean, Galt. It was found that the air drawn away from the negative electrode of a Ruhmkorff inductorium, or from the kathode of a Crookes' tube, or from the wire joining the negative electrode of the coil to the kathode of the tube, was always negatively electrified. On the other hand, the air drawn from the neighbourhood of the positive electrode of the coil, or from the anode of a Crookes' tube, or from the wire joining them, was found to be positively electrified. This positive electrification of the air was always less than the negative corresponding. With uranium insulated in a metal cylinder and connected to the terminal of a battery, while the cylinder and the other terminal were connected to the case of a quadrant electrometer, the air was electrified positively when the uranium was electrified positively, and negatively when the uranium was electrified negatively. With the metal cylinder insulated and joined to one terminal of the battery, while the uranium still inside the cylinder and the other battery terminal were connected to the electrometer case, it was found that the air was negatively electrified when the cylinder was positively electrified, and *vice versâ*. The negative electrification of the air was always less than the corresponding positive electrification. Both attained a maximum value when the difference of potential was between 10 and 20 volts per cm. of air space. The same results were obtained when metals were covered with salts of uranium and then charged to positive and negative potentials. Dr. Beattie also read a note on this subject by Lord Kelvin. The following is an abstract of the note:—The effective conductivity induced in the air by the uranium influence is, of course, greatest in the immediate neighbourhood of the uranium, but there is something of it throughout the enclosure. Hence it may be expected that electricity of the same kind as that of the uranium will be deposited in the air close around it, and electricity of the opposite kind in the air near the enclosing metal surface. And the quantity flowing from either the uranium or from the surrounding metal per sq. cm. of its surface increases but little with increased voltage when this exceeds 5 or 10 volts per sq. cm. Hence, if the dimensions and shapes of the uranium and of the surrounding metallic surface are such, that for small voltage, such as 10 or 20 volts, the electricity lodged in the air by discharge from the uranium preponderates over that discharged from the surrounding metal, the excess must come to a maximum and diminish, may be even down to zero, with greater and greater differences of potential; and at potential differences still greater the electricity lodged in the air from the outer metal may preponderate, and the electricity in the air drawn off and given to the filter be of opposite sign to that of the uranium which was found with the lower voltages. *Provided the configurations are such, and the voltages are so moderate that disruptive discharge does not intervene to any practically disturbing extent.*—On simple formulæ giving approximate values of the roots of the Bessel function of order n and its first derived function, in terms of the roots of (say) $J_9(x) = 0$, $J_9'(x) = 0$, (n even), or those of $J_8(x) = 0$, $J_4'(x) = 0$, (n odd), by Dr. W. Peddie. In this paper were given simple expressions by means of which the roots of $J_n(x) = 0$, $J'_{(n+1)}(x) = 0$ can be obtained when the roots of $J_\rho(x) = 0$, $J'_{(\rho+1)}(x) = 0$ are known ($\rho < n$). These expressions lend themselves readily to numerical calculation, and give values of the roots which become more and more nearly true as x increases. Even for the smaller roots, beyond the first two, the values found are highly approximate when $n - \rho$ is not too great.

Mathematical Society, June 11.—Mr. J. B. Clark, Vice-President, in the chair.—The following papers were read:—On superposition by the aid of dissection (continued), by Mr. R. F. Muirhead; on a method of studying displacement, by Mr. R. F. Muirhead; the isogonic centres of a triangle, by Dr. J. S. Mackay.

DUBLIN.

Royal Dublin Society, March 24.—Prof. E. Percival Wright in the chair.—A paper was presented by Mr. J. E. Duerden, of Kingston, Jamaica, on Jamaican Actiniaria (Part i. Zoantheæ), being communicated through Prof. A. C. Haddon. —Prof. W. J. Sollas, F.R.S., read a paper on an apparatus for submarine observation. Samples of new colours with metallic lustre, mosaics and pavement, lent by the Vitreous Mosaic Co., together with a collection of chemicals made by Harrington Bros. for the glass, china, and enamel industries, and for photography and electro-plating, were described by Prof. W. Noel Hartley, F.R.S.—Prof. E. J. McWeeney gave a demonstration of the bacillus of the bubonic plague.

April 21.—Prof. W. J. Sollas, F.R.S., in the chair.—On the possibility of boring and raising a portion of a coral reef from a great depth, and on an apparatus for demonstrating the folding of rocks due to lateral pressure, by Dr. J. Joly, F.R.S.—The formation of humus, its action in the nitrification of ammonium compounds, by Mr. W. E. Adeney.

May 19.—Prof. W. J. Sollas, F.R.S., in the chair.—Dr. J. Joly, F.R.S., read a paper on the volume change of rocks attending fusion.—Sir Howard Grubb, F.R.S., read some notes on a recent paper by Prof. Hale, of Chicago, respecting the relative merits of reflecting and refracting telescopes, (*a*) when used for visual work, (*b*) when used for photographic work.—Prof. D. J. Cunningham, F.R.S., made some observations on the Cape hunting dogs in the gardens of the Royal Zoological Society, Dublin.

PARIS.

Academy of Sciences, June 14.—M. A. Chatin in the chair.—Experimental verification of the theory of gradually varied flow in open channels, by M. J. Boussinesq.—Fossil forest of *Calamites Suckowii*. Specific identity of *Calamites Suckowii* (Br.), *Cistii* (Br.), *Schatizlarensis* (St.), *foliosus* (Gr.), *Calamocladus parallelinervis* (Gr.), and *Calamostachys vulgaris* (Gr.), by M. Grand 'Eury. In a fossil forest at Treuil, the remains consist almost entirely of *Cal. Suckowii*, of which *Cal. Cistii* formed the part above ground.—Application of the method of Poinsot to non-Euclidian statics, by M. J. Andrade. —Statics and the geometry of Lobatchefsky, by the same.—On the calculation of the resistance of the air to a disc for a velocity of twenty metres per second, by M. P. E. Touche.—On a propelling system for boats, by M. Y. Le Guen. — On the cosmic force curve, by M. Baraduc. — On isometric surfaces, by M. A. Pellet. — On small periodic movements of long-period systems, by M. P. Painlevé. — A mercury interrupter for large Ruhmkorff coils, by MM. E. Ducretet and L. Lejeune. The contact-breaker described, a figure of which is given, possesses the advantages of high speed, and certainty of break, without the danger of the alcohol igniting after long use. It admits of ready adjustment of speed.—On the dynamics of homogeneous chemical reactions, which take place with evolution or absorption of heat, by M. Michel Petrovitch.—Contribution to the history of the iodides of phosphorus, by M. A. Besson. Chemically pure PI_3 has been obtained by the action of dry HI upon PCl_3. It is completely decomposed by water without forming either free iodine or a solid deposit. The solution of PI_3 in carbon bisulphide is completely decolorised when shaken with an excess of mercury. The possible existence of an unstable P_2I_4 is also indicated, the existence of which gives a probable mechanism for the conversion of yellow into red phosphorus by iodine, the equations being $P_2I_4 = P_2I_4 + P$ (red), and $P_2I_4 + P$ (white) $= P_2I_4$.—On a method of oxidation and chlorination, by M. A. Villiers. The presence of a trace of a manganese salt accelerates many oxidations, as, for example, that of oxalic acid by a mixture of hydrochloric and nitric acids. This action is comparable with that of a ferment, and is of importance in vegetable physiology.—Breaking up of the fundamental band of chlorophyll, by M. A. Etard. By reducing the concentration of a carbon bisulphide solution of chlorophyll derived from *Lolium perenne*, the large band 729–635 splits up into three. This method of dilution, together with the superposition of two spectra in the same field, serves to show minute differences existing between chlorophylls derived from various sources.— On the oxidising action of manganous salts and on the chemical constitution of the oxydases, by M. Gab. Bertrand. The salts of manganese act as oxygen carriers to many organic compounds. The results are given of the action of various manganous salts upon hydroquinone in presence of air, and the theory is developed that these salts are partially hydrolysed into free acid and manganous oxide, that the latter takes one atom of oxygen forming MnO_2, and that the organic compound is oxidised by the remaining half molecule of oxygen. —Action of nickel upon ethylene. Synthesis of ethane, by MM.

Paul Sabatier and J. B. Senderens.—On isolauronolic acid, by M. G. Blanc.—Action of acetylene upon silver nitrate, by M. R. Chavastelon. According to the conditions of the experiment, either $C_2Ag_2.AgNO_3$, or C_2Ag_2 is formed.—Determination of resin oil in essence of turpentine, by M. A. Aignan. A portion of the oil is distilled and the rotatory power of the residue measured. It is notably reduced if the oil is adulterated.—On the active principles of some arums, by Mlle. J. Chauliaguet, MM. A. Hébert and F. Heim.—Action of albumoses and peptones in intravascular injections, by M. E. Fiquet.—On the relation of certain layers of lead carbonate to caves and ancient beds of subterranean rivers, by M. De Launay.—The characteristics of Broxburn oil shale, by M. C. E. Bertrand.—Classification and phyllogeny of the Goniatites, by M. Émile Haug.—On the Diceratineæ of the Tithonic beds in the Cevennes, by MM. V. Paquier and F. Roman.—On the Cueva del Drach (Dragon's Cave) in the Island of Majorca, by M. E. A. Martel. This cave is in the Miocene limestone, and is the largest known in tertiary strata. It contains a subterranean lake 177 metres long, and from 4 to 9 metres deep.—Action of the X-rays upon the retina, by M. G. Bardet. The rays produce upon the retina a luminous impression which, although very faint, is quite clear.—Remarks by M. d'Arsonval on the preceding paper.—On the constitution of the large sympathetic nerve; its trophic centres, by M. J. P. Morat.—Experiments on the stimulation of nerves by the electric rays, by M. B. Danilewsky.—On a very grave case of dermatitis following two applications of the X-rays, by M. G. Apostoli.—Local therapeutic action of high frequency currents, by M. Oudin.—The saprophytic form of human and fowl tuberculosis, by MM. Bataillon and Terre.—On the influence of the hypnotic sleep upon the gastralgia of the dorsal tubes, by M. Ed. Spalikowski.—On the results of meteorological observations made in Marchuria and in the neighbouring countries, by M. Michel Venukoff.—On the variation of the surface temperature in soils of different natures, by M. Joseph Jaubert.

NEW SOUTH WALES.

Linnean Society, April 28.—Prof. J. T. Wilson, President, in the chair.—On the fertilisation of *Eupomatia laurina*, by Alex. G. Hamilton. Fertilisation appears to be effected by a small Curculio (an undescribed species of *Elleschodes*, specimens of which are now in the hands of the Rev. T. Blackburn for description), myriads of which, attracted by the scent of the newly-opened flowers, crowd the blossoms to the exclusion of other insects. They feed on the staminodes, eating their way into the heart of the flower. Microscopic examination of individual beetles taken at random showed that the antennæ, tarsi and other parts were coated with pollen. Robert Brown conjectured what happened, but did not see the beetles. Dr. Harvey saw the latter, but he appears not to have published any particulars.—Descriptions of the nests and eggs of three species of Australian birds, by Alfred J. North. Descriptions were given of the eggs of *Cracticus rufescens*, De Vis, from the Herbert River, Q.; *Sphenura broadbenti*, McCoy, from the Otway Forest, Victoria; and *Dendrocygna eytoni*, Gould, from the Macquarie River, N.S.W.—On some new or little-known Australian fishes, by J. Douglas Ogilby. Two new genera were characterised, and ten species of fishes were described as new.—On the development of the Port Jackson shark (*Heterodontus Phillipi*), Part i. early stages, by Dr. W. A. Haswell, Challis Professor of Biology, Sydney University. The hope is not unreasonably sanguine that the embryonic development of a type so ancient as *Cestracion* (*Heterodontus*) might exhibit some important primitive features. With regard to the stages now described, however, any expectations of this kind cannot be said to have been fulfilled; and what impresses one most in the results is the extraordinary persistency of certain characteristics which are not known to have any vital significance. There can be little doubt, for example, that the orange spot, which forms such a striking feature of the egg of an Elasmobranch in its early stages, has been handed down with but little change from Palæozoic times.—Description of a new Helix, by C. E. Beddome. The new species is near *H. mossmani*, Brazier, in its markings, but differs in being umbilicated and white-lipped. *Hab.*, Yeppon, near Rockhampton, Q.—Descriptions of new species of Australian Land Planarians: with notes on collecting and preserving, by Thomas Steel. Seven species of *Geoplana* from New South Wales and Queensland were described as new.—Descriptions of new species of Fijian Land Planarians, by Thomas Steel. One species of *Geoplana* and one of *Rhynchodemus* were described as new; and *Bipalium kewense*, Moseley, was recorded as common under logs on the Navua River, Viti Levu. Mr. Steel exhibited a fine collection of well-preserved and displayed Land Planarians, representing the species described in his paper, and illustrating the modes of preservation and the results after the use of the various preservative media advocated therein. Mr. Steel also contributed the following note on *Peripatus*. "I desire to place on record the occurrence in New South Wales of *P. oviparus*, Dendy, the Victorian form of *Peripatus*. While collecting in January of this year, between Exeter and Bundanoon (Moss Vale District), on turning over a log, I noticed a *Peripatus* which, from its attitude and general appearance, specially attracted my attention. This proved to be a female specimen of the above species, and, so far as I am aware, this is the first occasion on which its occurrence in this colony has been definitely recorded. The lozenge-shaped pattern which characterises most of the specimens found in Victoria is well displayed; and the fact of the ovipositor being fully extruded in the specimen, which I now exhibit, is sufficient guarantee of its identity. When visiting the Australian Museum a few days ago, I had an opportunity of examining the specimens of *Peripatus* preserved there, and I was interested in noticing that those collected by Mr. Helms, in 1889, at Mount Kosciusko belong to the same species. All of the females in the Museum collection from that locality, which I examined, have the ovipositor plainly visible, and in many of them it is fully extruded."

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