THURSDAY, JUNE 8, 1893.

THE ROYAL SOCIETY ELECTION.

HAD it not been for the unnecessary and indiscreet communication to the newspapers of a letter not intended for the public eye, the difference of opinion which made itself manifest at Burlington House last Thursday might have been settled in a purely domestic manner. As it was, it gave rise to comments which, in most cases, were as absurd as they were painful to the persons concerned. But the mischief is done and it would be affectation to deny that a question of considerable moment has been raised and one which will very probably provoke in the future a good deal of discussion and consideration. Clearly, therefore, it has to be faced, and I willingly accede to the wish of the Editor of NATURE to state why I think the policy of the dissentients should not be accepted by the general body of the Fellows of the Royal Society.

I say policy, because I think it must be obvious to every one that the matters involved go a good deal deeper than the personal interests which were at stake. And here I would say at once that looking at the names of the dissentients, it is impossible to suppose that those who proposed to reject the recommendations of the Council were animated by anything but perfect good faith, and a real desire to act in the best interests of the Royal Society. Though I entirely disagree with them, I say this with the more conviction as they were nearly all my own personal friends. The harshest thing I should be disposed to say of their action is that while it had the uncompromising honesty, it also had the unreasonable narrowness of a somewhat provincial point of view.

Every one will I suppose admit that in most administrative matters the English people are above all things practical and are little influenced by considerations of either logical order or of mere symmetry. The Royal Society appears to be a notable case in point. It is unlike any analogous institution, as far as I know, in the world. It is by no means a mere Academy of Science. Looked at historically and from the point of view of actual facts, it is seen to be an association of persons of "light and leading" who wish to promote the interests of science especially in so far as they are a matter of national concern. I use deliberately the rather hackneyed words "light and leading" as descriptive of the qualifications of its members. They fall in fact into the two categories; on the one hand they consist of the most competent experts in different branches of science and on the other of prominent men in the political and social world who are sympathetic to science and desirous of promoting its progress as an indispensable phase of our life and intellectual development as a nation.

Now it seems to me that the real importance of the proceedings of last Thursday was the attack which was virtually made and with some vigour on this position. The dissentients in their printed statement completely ignored its existence. I can only make the excuse for them which Dr. Johnson made when a lady asked him to account for a very palpable blunder in his dictionary. "Ignorance, ma'am, sheer ignorance." It seems therefore worth while to show that in including in the fifteen selected candidates a man of public distinction who was not a professional man of science the Council acted in accordance with well-established tradition and precedent which has not hitherto been seriously challenged.

In other countries where Government is constituted on more bureaucratic lines than it is in this, men of science associate themselves in bodies to which non-scientific members of the community have no access. Such bodies can address the state, and are doubtless listened to with the respect due to expert authority. But the reason is mainly because science under such conditions falls into line with general bureaucratic arrangements. In England the expert as such is more usually listened to with hesitation. It is my belief that if the Royal Society were simply constituted of professional scientific men, its influence in the country would be vastly diminished. Englishmen are distrustful of experts whom they think, and I must admit too often with justice, to be cramped in their general outlook and wanting in knowledge of the world. Furthermore Englishmen are curiously shy of what they don't comprehend. A purely professional Royal Society would be apt to be treated with a kind of ironical respect but otherwise severely left alone as a thing "no fellow can understand."

Now it may be asked reasonably, would this be a desirable state of things? I think it may be shown with little difficulty that in the interests of scientific progress in this country it would not. Consider for a moment the kind of work which the Royal Society does. In the first place, and I suppose the dissentients would say that this is its only proper function, it signalises and marks out those workers in science as to whose integrity and competence it has satisfied itself. But this might be done by a small and exclusive club, and though such a body would be distinguished, it would never enjoy the distinction which attaches to the Royal Society. That distinction rests on the fact that it possesses a quasi-official position in the State. It is therefore on the one hand able to approach the Government of the day with a recognised status and authority to speak; on the other hand it is the supreme scientific tribunal from which the Government can count on obtaining a perfectly impartial judgment on questions of importance to the community. Here it may be replied that a strictly-restricted scientific Academy could equally fulfil those functions. In any other country, I have already admitted that it may be so. But here again national peculiarities must be reckoned with. In this country most important Government business is in all essential features settled in a semi-official way. Preliminary *pour-parlers* ascertain what applications would be acceptable and what will be conceded to them. The official letters which are ultimately exchanged only put on record what has been previously negotiated. It is here that the presence of what I may call a sympathetic lay element in the Society is so invaluable. A statesman or public man by becoming a fellow has solemnly pledged himself to co-operate with his colleagues. A minister therefore who is an F.R.S. cannot refuse, in common courtesy, to lend his ear to representations to which as a politician he might be very willing to be deaf.

No doubt there was a time when this lay element tended to swamp the Society and to destroy its scientific prestige. But the Royal Society is not a thing of yesterday; and accumulated experience has shown the way to the present *modus vivendi* which appears to me to have given the maximum advantage to the scientific world over which the Society presides without the remotest possibility of injurious interference.

It may be well to consider in what this lay element consists. In the first place we have the Sovereign who was the Founder and is always the Patron and may in the future as in the past take an active part in the Society's proceedings. Next there are the Princes of the Blood any one of whom may at any time be summarily proposed for election. The original statutes provided that any one of the rank of Baron or higher should be qualified for election. That privilege was however abolished in the present century, no doubt as opening the door to the lay element too widely. But the privilege was retained for the Privy Council, a body which in its constitution is analogous to the Royal Society inasmuch as access to it can only be obtained outside the Royal Family by conspicuous ability independently of mere rank or birth. And it may be noticed that the analogy is drawn even closer by the recent admission to the Privy Council of a scientific element. Each body has in fact in relation to the State its own field of activity and functions. But they are often not very dissimilar. A committee of the one body may advise the Government on the constitution of a new university; a committee of the other may equally advise it on the methods of obviating explosions in mines. We may have a Privy Councillor discussing at Burlington House Marine Signals or Colour Vision, while a late president of the Society may be occupied at Whitehall in determining whether the Eternity of Future Punishment is a binding article of the English faith.

But besides members of the Privy Council it has been the custom time out of mind to elect into the Society as ordinary fellows men of conspicuous public position and merit, with the proviso, however, that they should in their careers have shown themselves sympathetic to science. Such elections, however, differ *in toto* from the honorary and merely complimentary degrees conferred by the Universities. Such men are brought into the Society, first, in recognition of their services to science, secondly, to confirm them in their interest in it, lastly, that their cooperation may be secured in the performance of the Society's public work. The Society in order to effectively accomplish that for which it exists must be in touch with other fields of national life; it requires and turns to good account its connections with society, with the legislature, with the bench, with Government administration. By including in their number a body of distinguished public men, the Fellows of the Royal Society are able to enormously enlarge their influence and to display themselves as reasonable if hard-headed men of the world, perfectly able to play their part in affairs which concern them on equal terms with those who make the conduct of affairs their only business and by no means as mere recluses in a laboratory. Can any more effective mode be imagined for removing from scientific men that suspicion of impracticable pedantry with which men of science are too often regarded by the uninformed?

In the face of these considerations which I had thought were part of the well-known traditions of the Society I confess that the hubbub of last Thursday somewhat amazed me. It was fought over a man who is preeminently of the kind that the Royal Society has been always willing to coopt. A man of singular modesty but vast learning, a scientific historian with the keenest sympathy for science, a member of the legislature who by his own unaided merit has acquired for himself a conspicuous position amongst the statesmen of the day. If the principle of the admission of laymen is admitted at all, who could be more suitable?

The simple fact is that there was nothing anomalous in the matter. Any one who has taken part in the selection of candidates by the Council will know that there is a regular category for lay candidates presented on their public form. The Council has to make up its list with due regard to the claims of every branch of science. But I think I cannot be far wrong if I assert that in most recent years it has been the practice to select on an average one layman annually. There are at least a dozen in the existing list and the obituary notices abound with them. It is perhaps invidious to mention names but I may single out of those living Sir Henry Barkly, Sir William Jervois, Sir John Kirk, Sir George Nares, Sir Bernard Samuelson, Sir George Verdon, Sir Charles Warren. Any of these men would probably disclaim any pretension to be considered a professional man of science. But each and all of them has rendered great services to it, and the recognition of this by the scientific world is the best way to get other distinguished public men to imitate their example.

If I have discussed the question at some length it is because it seems to me to be one of vital importance to the welfare of the Society. But the dissentients took a further step which if it were to become a precedent would be absolutely disastrous. They not merely proposed that one of the candidates selected by the Council should be rejected but without consulting him proposed that another whom the Council had not recommended should be elected. It is true that in their first circular the dissentients stated that the statutes of the Society left no other course open to them. This however is an entire mistake and I am afraid is rather characteristic of the want of due consideration which characterised the whole proceeding.

It appears to me, putting other considerations aside, unlikely that in so delicate a matter any five fellows can arrive at a sounder conclusion than the twenty-one who form the Council. Any fellow who has been a member of that body must have been struck with the frankness and impartiality with which the merits of the respective candidates are weighed and discussed. And so large a proportion of the Council is changed every year that it would be practically impossible for it ever to come under the control of any one party in the Society, if there be such a thing. It appears to me therefore that all presumption is in favour of the judgment of the Council and I think that experience has shown that in the vast majority of cases it has been exercised wisely.

It will be generally agreed that in no branch of science can those who follow it arrive at a correct estimate of the merits of those who work in other branches without the responsible evidence of men with the necessary technical knowledge. Now this testimony the Council both receives and has the opportunity of carefully sifting. Having arrived at a judgment accordingly, it appears to me that that judgment should not be lightly upset unless in the almost inconceivable case of its being utterly outrageous.

Councils have erred in the past, and I suppose the Council of the Royal Society cannot claim infallibility. It might be necessary therefore for the general body of fellows to correct its action. The election of a fellow is an irretrievable step. To oppose it is a grave but it may be a justifiable procedure. But to over-ride the Council's discretion in not selecting a particular candidate is a much graver one. Non-selection is not an irretrievable injury and if in any one year it may seem to inflict some injustice on a particular candidate its redress when justified by merit is not difficult of attainment on a subsequent occasion. But if a precedent were established for taking the matter out of the nands of the Council, peace and good feeling in the ranks of the Society would soon vanish. In time every election would be the occasion of a conflict and no one who valued his self-respect would care to serve on the Council. Nor is there any reason to think that any substantial gain would accrue. A man may be rushed to the front by a wave of temporary and emotional popularity. Such a man, if the fellows acquired the habit of meddling with the Council's prerogative of selection, might be forced prematurely upon the Society. In the long run it is not improbable that those who resorted to such a practice might live to regret their precipitancy.

W. T. THISELTON-DYER.

VERTEBRATES OF ARGYLL AND THE INNER HEBRIDES.

A Vertebrate Fauna of Argyll and the Inner Hebrides. By J. A. Harvie-Brown and T. E. Buckley. (Edinburgh: David Douglas, 1892.)

PERTINACITY in an endeavour to carry out the results of a fixed idea has almost always been regarded as a virtue, even when the principle involved has seemed to be hopelessly mistaken, and thus the adherents of the Stuart and other lost causes still find sympathisers at the present day; but when none can doubt the value of the idea, the pertinacity with which it is supported, provided that obstinacy is left out, becomes a virtue that in these practical days is not easily exaggerated. Such pertinacity is conspicuously exhibited by the authors of the book before us, Mr. Harvie-Brown and his worthy coadjutor, Mr. Buckley. This "Vertebrate Fauna of Argyll and the Inner Hebrides" is the *fifth* of a series of volumes, the inception of which is vastly creditable to its founder, the gentleman first named, and to all concerned in its production—even to the printer's devil and the binder's apprentice. Some of its predecessors have before received notice in these columns;[1] but it has perhaps never been made clear to the readers of NATURE that this series of books is placing the zoology of the northern Kingdom on a footing which has not been attained, nor is likely to be attained in the southern part of the island, even though there exist particular English works—but this solely so far as ornithology is concerned—of merit superior to any one of the Scottish productions, the volume on Orkney, which is of remarkable excellence, being perhaps an exception. It is not difficult, however, to account to a considerable extent for this superiority: the proportion of persons with a taste for natural history to the general population being presumably the same in both parts of Great Britain, the enormously greater population of England would naturally furnish a larger number than Scotland is able to show. This is not said in derogation of the northern kingdom. It has always been rich in botanists; and, among zoologists, the single name of William Macgillivray is enough to cover it with renown. However much his merits, and especially his originality, may have been obscured or underrated in his life-time, he has already been recognised by those who have taken the trouble to inform themselves, and especially by American writers, as the most original British worker in regard to the vertebrate division of animals, since the incomparable pair—Willughby and Ray. But of Macgillivray this is not the place to speak particularly. On some other occasion we hope we may say more of him, a man whose work by some unhappy fate failed to impress his contemporaries, and whose posthumous volume was oppressed by princely patronage—well-meant but ill-advised. He had little or no experience of "Argyll and the Inner Hebrides," and really does not now come into our story.[1]

As a matter of fact it is hard to say who among old naturalists does deserve special mention in connexion with the Faunal District of which this volume treats. Mr. Harvie-Brown, with the caution characteristic of his nationality, abstains from putting forth the claim of any predecessor; though, as brave men lived before Agamemnon, this district may have had a zoological historian before the laird of Dunipace and Quarter. The late Mr. Henry Davenport Graham—an honest observer if there ever was one—whose pleasant contributions to the ornithology of Iona and Mull, illustrated by some of his humorous and very clever sketches, were published in 1890 as a "relief volume" of the present series, belongs of course to the existing epoch, for he died in 1872; and moreover his observations were confined to but a small portion—the islands just named—of the district. Thus as regards its ancient history from the zoological point of view, we have an absolute void, since the Statistical Accounts (both Old and New) of the county of Argyll and the Isles give as little information to the purpose as does the often-quoted but seldom-read description of Dean Monro, which was only published in 1774, 225 years after it was written.[2]

To come to closer quarters, we are inclined, though we must say so with diffidence, to question Mr. Harvie-Brown's delimitation of his "Faunal District." In principle he is undoubtedly right, though somehow or other the result does not seem to work out well. His principle was laid down in the first volume of the series—that on Sutherland, Caithness, and Western Cromarty—and is the marking out of a district by physical features rather than by political boundaries. No naturalist ought

[1] "A Vertebrate Fauna of Sutherland, Caithness, and West Cromarty," NATURE, xxxi. p. 292; "A Vertebrate Fauna of the Outer Hebrides," NATURE, xl. p. 101.

[1] His portrait is given by our authors in their volume on "The Outer Hebrides."

[2] A reprint of this very rare work was published at Glasgow in 1884 (by Thomas D. Morrison).

to hesitate for a moment in preferring a watershed to a wapentake, since the former has natural limits, while those of the latter may be the consequence of a chapter of accidents. Moreover watersheds, though sometimes difficult to trace and lay down on a map, are as a whole much more to be trusted than some other kinds of boundaries, notably more so for instance than rivers, which in biology, with very rare exceptions, do not furnish a scientific frontier; but some wise man of old has remarked that there is reason in the roasting of eggs, and the faunist certainly ought to exercise some discretion in choosing his watersheds. What difference there may be in the land-fauna of the two sides of the peninsula of Cantire, for instance, we are at a loss to conceive, and yet we have our author's line of demarcation driven remorselessly along its summit ridge from its Mull to West Tarbert, and thence northward, splitting Knapdale in like manner, and shutting out from Argyll the home of Maccallum More—Inveraray itself! If the eastern half of Cantire, with Arran, Bute, Cowall, and goodness knows what beside, are to form another separate district, something may be urged for this view, but if they are to be annexed to Carrick, Kyle and Cunningham—in a word to Ayrshire and the South-West of Scotland, we feel bound to protest against the proceeding as an unnatural union. Arran undoubtedly agrees far more in every essential faunal character with Ardnamurchan than with Ayrshire—that much we venture to affirm, even if we should be sorry to attempt a delimitation between the districts of "Argyll" and "Clyde" further to the northward, or between "Argyll" and "Forth"; but though, as we have said above, we attach great importance in many cases to watersheds, we are inclined to hold ourselves entitled to cut *across* valleys on occasion, and because Loch Lomond drains to the "Clyde" and Loch Katrine to the "Forth," it does not at all follow as a rule, that their upper levels belong to the districts which contain their "carses." In other words the basin plan of dividing a country may be overstrained. Still we gladly admit that the fault is on the right side, and considering the extraordinary way in which so many of its counties interlock, it would be manifestly misleading to attempt to treat Scotland according to the method which is on the whole suitable enough for England, where the counties are much more continent. There is the old story of the man, possibly, it is true, an ignorant southron, who wished to explore Cromartyshire, but never succeeded in finding more than bits of it!

To the naturalist islands have a peculiar fascination of their own, and it is quite pardonable therefore in our authors that, in the introductory portion of their volume, they should devote more space to the description of the Inner Hebrides than to Argyll, properly so called, especially when, as we have already stated, the delimitation of their district cuts off so much of what most people would include therein. Yet thereby they recall the celebrated story told by Sir Walter Scott of the Minister of Cumbrae, which we forbear from repeating; and we must say that in their infinite mercy they might not have so wholly overlooked the interest that appertains to the adjacent mainland. Ardnamurchan, before mentioned, receives its due, but Moidart and Morven, Ardgour and Lochaber, Ben Nevis, the loftiest peak in Great Britain, and the historic Glencoe, the gloriou Loch Etive and the beautiful Loch Awe, receive but scan attention. However our authors have given us, and we are thankful for it, the portrait of two inhabitants of the mainland—the late Peter Robertson and his pony—though, not a word being vouchsafed to show why they are thus honoured, many who take up the volume may wonder at the preference shown to them. The present writer cannot trust his recollection for equine likenesses, but if the beast figured (at p. xii. of the "Preface") was that which bore him on a never-to-be-forgotten day, more than thirty years ago, he has no objection to urge; and undoubtedly the man was worthy of being thus commemorated since, throughout Scotland, no one was more famous for his knowledge of Red Deer than the head-forester of Mona Dhu—the "Black Mount"—while his intimate acquaintance with the animal life of a characteristic Highland district was no less good, and one could not be in his company for half an hour without recognising in him the true naturalist. He was wholly different from the much-writing and much-bewritten "Field Naturalist" of the type with which we have lately become painfully familiar, the man who is all eyes and tongue but has no brains, thinking everything he sees is seen for the first time, and is worth publishing abroad because he has seen it. From one point of view this man is not wrong, since it pays well to contribute a sensational article so based to a nonscientific magazine, while he can do this in safety, for no naturalist will be at the trouble to hurt his feelings by pointing out that what he writes contains nothing more than was known before, and that his specious verbiage alone is new. "Mr. Robertson"—to speak of him as he was spoken of by those who for many years lived under his mildly despotic rule—was a man of retiring character and plain speech, possessed of that admirable manner which, if not inborn, comes only from mixing with all classes of society. He would address a prince of blood royal without a trace of servility, or a cockney sportsman without exciting suspicion of contempt. The *mens sibi conscia recti* kept him from either failing. To no smattering of science did he make pretence, and it was with wonder that he received the application to communicate the results of his experience as to Red Deer to the editor of Macgillivray's unhappy posthumous work already mentioned. Would that the whole of it had been published there! No one could listen to his conversation without perceiving that as an observer of nature he had not wasted his life, and that he had thought over, if not thought out, problems that have puzzled and still may puzzle the best informed of naturalists. But this is enough of him, and we have only said it because our authors have said nothing. We must return to what they tell us.

It is hardly to be doubted that to the naturalist the most interesting of Scottish mammals are the *Phocidæ*—the Seals, and it is curious to look back upon the obscurity in which they were involved until comparatively few years ago—not that we would have any one to suppose for a moment that there is not plenty more to be learnt about them. It is probably not yet known to the majority of British zoologists that, apart from all possible or impossible stray visitors—which may or may not be of casual appearance, such as *Phoca barbata*, *P. annellata*, *P. grœnlandica* and *Cystophora cristata*—we have, as constant residents in our waters, two species—the common *P. vitulina* and the larger and more local *Halichœrus griseus*—animals that differ as much in some of their habits as they do in conformation and appearance. Of the former species we need say little, but concerning the latter the several volumes of this series have given much information, making abundantly clear that it is a native of our seas and therefore a true member of our Fauna, a position that, through want of appreciation of recorded facts, had hitherto been doubtful. But our authors, in this volume at any rate, exhibit laudable caution in not advertising its haunts, leaving those who can "read between the lines" sufficient indication as to where they are, which we maintain to be a perfectly fair proceeding on the part of writers in regard to species subject to persecution. If the hairy coat of the Grey Seal approached in value that of his long-eared and furry cousins of the Southern Seas and North Pacific, the life of his race would not be worth a year's purchase, despite the dangerous character of the waters he frequents. Fortunately it is only his oil that is coveted by his would-be murderers, and that is not a sufficient inducement to them to follow him to some of the asylums he has found. We could tell of one where he feels so secure, from absence of molestation, that he will let a boat come within oar's length of him before he rolls off the rock on which he is basking—and then rather with the air of doing a courteous act in giving place to strangers who may want to land upon the shelf. All the same we fear that one of these days terrible return for his politeness will come upon him and his kindred even in the fortunate islands we have in mind, and we must not dwell longer on this subject lest we should reveal what ought to be a profound secret. But we are bound to admit that the Grey Seal is not the most intelligent animal in the world, hough his long, grave face gives him an expression of wisdom far beyond that conveyed by the chubby countenance of his commoner relative.

Of course the most important members of the Scottish fauna are at present the Red Deer and the Red Grouse—looking only to the amount of money they are the means of bringing into the country, though equally of course it is declared that the greater part of this amount, that which is paid for shooting rents, is not spent in the country. But we suppose the same might be alleged almost everywhere of rent of any kind, and heaven forefend us from dabbling in the mysteries of the "dismal science." Concerning Red Deer much more is to be told than people suppose. The statistics of Jura Forest compiled and privately printed by Mr. Henry Evans, of which an abstract is given by our authors in their Appendix (pp. 239–244) may well set any one thinking, especially as regards the death-rate, which if observed among human beings in any part of the world would set that district down as more unwholesome than any known elsewhere. The mortality is attributed chiefly to what is known as "Husk," which appears due to a "hair-like lung worm" (of what kind we cannot say), and reaches 20 *per cent.* and upwards among the *male* calves before they complete their first year, and when we consider that this is on an island with a comparatively mild climate, where every care is taken of the beasts, the result is indeed extraordinary. It is only when the zoologist is brought face to face with facts of this kind that he can realise what the Struggle for Life must be of which he has read so much, and the depth of his ignorance about it. No wonder then we cannot explain, what seems to be quite certain, the dwindling, that in many places has ended in the extinction, of the Ptarmigan. Our authors appear to attribute it to the moist influence of the Gulf Stream, but we are not conscious of any evidence that this is greater now than it was twenty, thirty or fifty years ago and surely the reason must be sought elsewhere.

We have allowed our notice of this very pleasant book to run to an excessive length, so that we must here surcease from commenting on many passages which really call for remark—most of them for praise and only a few for blame. We certainly should not care to involve ourselves in the mooted question of the alleged Pintail's nest or nests on Hysgeir off Canna (pp. 129–131); but we must protest against our authors' countenancing (p. 167, note) the often-exploded but ever reviving fallacy of Rooks' eggs being served up in place of Plovers'. The curious so-called "Tailless" or "Docked" Trouts ("club-tailed" would be a better name) of certain lochs are treated of by Dr. Traquair. They may perhaps be compared with the somewhat analogous case of the "Crummy" Stags of Jura and Mull, concerning which we are disappointed to find little or no information, which is the greater pity since the introduction of new blood has already diminished and will probably put an end to these interesting local "sports." A few words must, however, be added as to the illustrations, and especially to those from photographs by Mr. Norrie, which are not only well chosen, but for the most part extremely beautiful. The maps too are all effective if not always neat, and the little sketches "let in" to their margins are as pretty as they are accurate. Herein, as throughout the letterpress of the volume generally, the islands are most favoured, and there is only one of the plates which illustrates a scene on the Scottish mainland. So we part from Messrs. Buckley and Harvie-Brown, commending their assiduity, and wishing all success to their next venture, whether Moray or Shetland be its subject.

OUR BOOK SHELF.

Gun and Camera in Southern Africa. By H. Anderson Bryden. With numerous Illustrations and a Map. (London: Edward Stanford, 1893.)

IN this book Mr. Bryden records the incidents which happened in the course of a year of wanderings in Bechuanaland, the Kalahari Desert, and the Lake River Country, Ngamiland. The region is one in which much interest has been taken lately, and colonists and settlers will find in Mr. Bryden's lively pages exactly the sort of information that is likely to be most useful to them. The volume also includes many passages that will be read with pleasure by ethnologists, naturalists, and sportsmen. The illustrations—which are offered as "faithful delineations of places, objects, and people hitherto not often accessible to the camera"—add greatly to the value of the narrative.

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.*]

Mr. H. O. Forbes's Discoveries in the Chatham Islands.

IN reply to Prof. Newton's letter, under the above title, in NATURE of last week (p. 101), in which he refers to the description by me of the Chatham Island Ralline bones under a distinct genus *Diaphorapteryx*, and observes "that one thing seems needed to make the discussion [on the probability of a land connection between the Chatham and Mascarene Islands] real, and that is the proof of the assertion that *Aphanapteryx* ever inhabited the Chatham Islands," I beg to say that in his letter there is a slight confusion of dates, which affects the question of the nomenclature. On July 29 last year I visited Cambridge for the purpose of comparing the bones from the Chatham Islands I had brought with me with the real *Aphanapteryx* remains in the Museum there. It turned out that Dr. Gadow, who was abroad, had laid them aside where Prof. Newton could not place his hand upon them, and I was, therefore, unable to see them. A week or two later. when in Edinburgh at the British Association Meeting, in a note intimating the return of Dr. Gadow, and kindly arranging for my examination of the bones, Prof. Newton adds, "I believe you will want a new generic name for what you have called *Aphanapteryx*," and suggests the name *Diaphorapteryx* instead. I was unavoidably long prevented from revisiting the Cambridge Museum, and so in describing as *Diaphorapteryx* the Chatham Island bones, at a meeting of the British Ornithologists' Club in December, 1892, I accepted the suggestion of Prof. Newton, who alone had till then seen the remains from both localities. On February 23, prior to reading my paper at the Royal Geographical Society, I again visited Cambridge, and in the most kind manner received every facility and assistance both from the Professor and from Dr. Gadow in comparing the specimens. On this occasion I was unable to recognise any sufficient characters, by which, in my estimation, to separate generically the bones from the Chatham Islands from those from Mauritius. This decision I stated at the meeting of the R.G.S. on March 13 last, and more recently in a communication to the Brit. Ornith. Club, which will appear in its forthcoming *Bulletin*. If I mistake not, however, Prof. Newton agreed with me that the Chatham Island form was nearer to *Aphanapteryx* than the latter was to *Erythromachus* of Rodriguez. Some of these remains from Mauritius have been figured by Prof. Milne-Edwards in his "Oiseaux Fossiles de France," and the remainder are fully discussed and illustrated by Dr. Gadow in a shortly-to-be-issued fasciculus of the Trans. Z.S. of London, while those from the Chatham Islands will appear shortly, I hope, in one or other of the scientific journals or Proceedings. After a careful study of all the material I have no hesitation, however, in stating meantime—as those who care will then have an opportunity of judging—that the bones from both regions are generically the same. I maintain also, that even if some osteologists should be disposed (from the somewhat larger size of the Chatham Island bones, though among them I found a number scarcely to be separated on even that ground) to make a generic distinction between them, the question would not only not fall, but I really cannot see that the argument based on their discovery in the New Zealand region would be in the least invalidated, as the forms are unquestionably so very nearly related. The importance of the distribution of the blue Water-hens, and the relationship between the Huias of New Zealand and the *Frigelupus* of Reunion—long ago pointed out by Mr. Wallace—and many other facts as far as birds are concerned recently urged by Dr. Sharpe at the Royal Institution, appears now to a fuller extent by the discovery of those unexpected forms in the Chatham Islands.

I must once more protest against the very erroneous statement that I have invoked this "tremendous hypothesis" to explain the distribution of the closely related forms of these two regions. I adduced, as I have said in my last letter, a great deal of other evidence in my paper at the Royal Geographical Society, which will appear very soon now. In addition to the facts there given I may point out the significance to this question of the results of the investigations of my lamented friend, Mr. W. A. Forbes—an anatomist of the highest acumen—on the genera *Xenicus* and *Acanthisitta* of New Zealand. He found that the affinities of the *Xenicidæ* are with the *Pipridæ* (including the *Cotingidæ*), *Tyrannidæ*, *Pittidæ*, and *Philepittidæ*—groups confined to the New Zealand, the Australian (ranging into the Oriental), the Mascarene, and the Neotropical regions, and that they have no relatives elsewhere. Nor are the following sentences from Mr. Wallace's "Geographical Distribution of Animals" without a bearing on this discussion :—"We have the pigeons and the parrots most wonderfully developed in the Australian region, which is pre-eminently insular, and both these groups have acquired conspicuous colours very unusual or altogether absent elsewhere. Similar colours [black and red] appear in the same two groups in the distant Mascarene islands. . . . Crests, too, are largely developed in both these groups in the Australian region only; and a crested parrot formerly lived in Mauritius—a coincidence too much like that of the colours as above noted, to be considered accidental."

HENRY O. FORBES.

104, Philbeach Gardens, Earl's Court, S.W.

The Fundamental Axioms of Dynamics.

AS Prof. Lodge refers in the letter published in this week's NATURE, p. 101, to my remarks on his paper on the Fundamental Axiom of Dynamics, I shall be obliged if you will allow me to state my views in your columns. Apart from all minor questions it appears to me that the main issue raised by Prof. Lodge is whether the law of the conservation of energy can be *proved* from the fundamental laws of dynamics and the assumption of contact action.

I have not the slightest objection (as he seems to suppose) to the mathematical investigation of physical facts being based on assumptions which are followed out to their logical conclusions, nor do I shrink from using such methods even when they fail in some points or lead to paradoxical conclusions. They may legitimately be accepted as convenient though imperfect mental pictures of the truth, sketches, but not finished drawings.

My objection to Prof. Lodge's "proof" is that in his attempt to avoid the unthinkable by discarding action at a distance, he adopts another equally inconceivable conception, viz. contact action.

He has already laid it down as an axiom that "material particles (atoms of matter) never come into contact." It is only by abstaining from the attempt to define the constitution of the ether that he avoids being driven to the conclusion that its various parts never come into contact either.

The assumption that he really makes is that when two bodies (including in that term both matter and the ether) act immediately upon each other, the distance between the mutually acting parts remains invariable during the action. This is not inconsistent with action at a distance. If then the phrase "contact action" be discarded the assumption of action at constant distance is a proper subject for investigation.

If the assumption be accepted the reasoning based on it is no doubt correct, but the value of the "proof" (regarded as independent or self-contained) depends entirely on the value we assign *à priori* to the fundamental assumption. I doubt whether an argument based upon it would by itself have convinced the world that the conservation of energy is a fact.

If, on the other hand, the assumption is regarded as a more or less arbitrary postulate to be justified, *à posteriori* by the fact that conclusions can be deduced from it which are otherwise known to be true, Prof. Lodge must not represent his course as the ascent of a firm ladder of argument to results which, though paradoxical, must be accepted under penalty of a *reductio ad absurdum*. On the contrary, it lies with him to justify his assumption by the use he makes of it. That the conservation of energy follows is no doubt an argument in its favour, and I for one shall look with interest for the other deductions which Prof. Lodge promises.

ARTHUR W. RÜCKER.

June 2.

IF Mr. E. T. Dixon (NATURE, p. 103) will read what I have previously written on the subject of energy he will find most of his objections anticipated. I have pointed out, as he now does, that so long as potential energy is regarded solely as a "force function" the conservation of energy has no real physical meaning (pp. 532, 533, Phil. Mag., June 1881). I quite agree that potential energy belongs to a system rather than to a particle, but I do not see that the fact has any hostile significance as regards the question of *identity*.

He will also find that I have always hitherto included the connecting medium as one of the "bodies" between which actions and reactions occur. (See for instance, Phil. Mag., June 1885, pp. 483-84, and October 1879, p. 281). I do not propose to continue to do this in future, partly because I find that the word "body" is not generally or conveniently understood to mean ether as well as ordinary matter, and partly because I now realise that there is something more definite to say concerning the function of the ether as regards stress.

But Mr. Dixon seems to suppose that the denial of action at a distance means that material particles are without influence on one another until they touch; that for instance the earth cannot attract the moon unless it is in contact with it; for he says that my contention that material particles never come into contact renders nugatory the whole discussion concerning "contact action."

If this be the sort of meaning which he attaches to the phrase "action at a distance," no wonder he is unimpressed with the arguments of those who deny its prevalence in nature.

OLIVER LODGE.

MAY I make a few corrections of statements which appear in your report of Prof. Lodge's paper on the Laws of Motion (NATURE, p. 117)?

(1) I do not object to the first law on the ground of unintelligibleness, but only to the ordinary mode of enunciating it.

(2) I have not contended that Dr. Lodge's definition of energy as the name given to work done assumes conservation. On the contrary, I have expressly pointed out that it does not.

(3) I did not select the air-gun with its muzzle plugged as an instance of transference of potential energy without transformation. Prof. Lodge had cited the air-gun as an instance of the transformation of Potential Energy into kinetic during transference. I stated that if the muzzle were plugged it would serve *equally well* as an instance of the transference of potential energy without transformation. But I pointed out that both illustrations were defective and proceeded to show that in general the transformation of energy during transference is only partial.

J. G. MACGREGOR.

Hopeville, Bridge of Allan, N.B., June 5.

The Word Eudiometer.

THE following quotation from J. A. Scherer's "Geschichte der Luftgüteprüfungslehre" (Vienna, 1785), may be of interest in connection with Prof. McLeod's letter on the invention of the word "Eudiometer" (NATURE, vol. xlvii. p. 536). After referring to Fontana's Descrizione ed usi di alcuni stromenti per misurare la salubrità dell' aria" (Florence, 1775), Scherer continues (*op. cit.*, vol. i. p. 153), "Bald nach der Herausgabe der gedachten Instrumente machte Hr. Landriani ein neues bekannt, der erste, der es Eudiometer nannte. Er versichert uns er habe seinen Luftgütemesser von Abt Fontana nicht entlehnt. Daher gehört die Ehre der Reformation des Priestley'schen Instruments Hrn. Landriani, die ihm auch Fontana selbst in zwei Briefen einräumt."

Landriani's own statement quoted by Prof. McLeod is thus fully confirmed by contemporary authority. Scherer's book, which has just been purchased for the Owens College from the Kopp library, is full of interesting historical information with regard to eudiometry.

PHILIP J. HARTOG.

Owens College, May 23.

Singular Swarms of Flies.

MR. FROUDE's letter (p. 103) forcibly reminds me of a swarm of flies which overlaid every one who was on the parade at Ventnor, and drove numbers off the pier on the forenoon of a day which certainly fell on or between May 13 and 16, 1891. My diary bears only witness to the fact that I was then at Ventnor, but I shall never forget that as I went towards the black clouds I met a venerable friend, whose white hair, beard, and light coat were literally blackened with flies. The natives, who had had previous experience of such a cloud, ascribed it to the "mackerel fly." My colleagues in the entomological department of the British Museum told me I had witnessed a flight of *Bibio Marci* (St. Mark's fly), and, on reading up the subject, I found no reason to doubt that they had made an accurate diagnosis of a slightly and imperfectly told story.

I have a definite recollection of the flies' rapid disappearance, and I have very little doubt that Mr. Froude has been the witness of a cloud of the same dipterous insect.

F. JEFFREY BELL.

5, Radnor Place, Gloucester Square, W., June 2.

P.S.—The weather was very warm during the days mentioned, but the succeeding (Whit) Monday was marked by a fall of snow in several parts of England. *Absit omen!* I add this as I note that Mr. Froude suggests that the special character of the swarms may have some relation to "some condition of the atmosphere."

THE phenomenon so well and exactly described by your correspondent, Mr. R. E. Froude (NATURE, vol. xlviii. p. 103) was seen the same day and hour—that is, between 1 and 1.30, May 27—at Parkstone, near Poole, Dorset. A party which had driven over from my house, and lunched at the Harbour Hotel, saw every tree-top crowned, as it were, with a smoke-like column of flies, every column with the same slant one way, described by Mr. Froude, only it was not noticed that this was towards the sun. The strange sight was described to me by my daughter, by word and pencil, last Saturday, immediately on reaching home, and confirmed by her companions.

HENRY CECIL.

Bregner, Bournemouth, June 3.

THE ANNUAL VISITATION OF THE GREENWICH OBSERVATORY.

AT the Annual Visitation of this Observatory, which took place on Saturday, June 3 last, the Astronomer Royal presented his report to the Board of Visitors.

The present want of accommodation is felt in all the departments of the Observatory, a number of the staff being at present housed in the Octagon room, which forms part of the Astronomer Royal's official residence. The Admiralty have now authorised the completion of the central octagon by the addition of a story and the erection of the Lassell dome over it.

In place of the old cylindrical dome on the south-east tower, which was dismounted in November last, the new 36-foot dome was erected at the beginning of the year, the work of construction and erection being completed most satisfactorily by Messrs. T. Cooke and Sons.

The electric light installation for the principal instruments proposed last year has been sanctioned, and the necessary generating plant, consisting of gas-engine, dynamo, accumulators, and main leads, has been supplied. It is proposed to set these up on the ground floor of the new south wing.

Referring now to the astronomical observations, the work of observing the sun, moon, planets, and fundamental stars with the transit circle has been considerably increased, owing to the extraordinarily fine weather in the months of March and April, the number of observations being the largest ever recorded. The numerical statement is as follows:—

Transits, the separate limbs being counted as separate observations	8217
Determinations of collimation error ...	304
Determinations of level error	512
Circle observations	7179
Determinations of nadir point (included in the number of circle observations)... ...	461
Reflexion observations of stars (similarly included)	527

The annual catalogue of stars observed in 1892 contains 1710 stars.

The report goes on to say:—

As an illustration of the continuity of fine weather in March and April, it may be mentioned that 2600 transits and 2300 circle observations were made in these two months, the average corresponding numbers for the seven previous years being 945 and 877 respectively; that 70 observations of upper and lower culminations of Polaris were obtained (exclusive of isolated observations, which are only used for azimuth error and not for place of the star), the average for these months in ten years preceding being 22·2, and the greatest in any of these years 38 (in 1885), and that 24 groups of clock stars, extending over more than twelve hours, were obtained, the mean for ten years preceding in March and April being 2·6. In the last case something must be attributed to the special interest shown by the observers recently in obtaining long groups of clock stars.

The apparent correction for discordance between the nadir observations and stars observed by reflexion for 1892 is 0″·25, and has been persistently negative for some months. An investigation of the screws of the microscopes used showed that several of them are the worse for wear.

From the observations of 1892 the west latitude of the transit circle was found to be 38° 31′ 22″·10, a value differing by + 0″·20 from that adopted. Recent investigations have made it probable that the co-latitude undergoes fluctuations of short period: and in comparing the observations in the individual years 1877–86 with the final results in the Ten Year Catalogue, confirmatory evidence of these fluctuations was found. Mr. Thackeray was thus led to undertake an examination of all the observations of N.P.D. of the four close circumpolar stars since 1851. The results were found to accord well with Mr. S. C. Chandler's hypothesis (*Astronomical Journal*, No. 277), and have been communicated to the Royal Astronomical Society (vide *Monthly Notices*, liii. p. 3).

The correction to tabular obliquity of the ecliptic from solar observations in 1892 is + 0″·44, which is rather a large quantity. The discordance between the results from the summer and winter solstices is + 0″·40, indicating that the mean of the observed distances from the pole to the ecliptic is too small by + 0″·20, and thus confirming the stellar observations for co-latitude.

Computing the value from Hansen's lunar tables, the mean error of the moon's tabular place was found to be + 0·083s. in R.A. and + 1″·29 in longitude, as deduced from ninety-five observations in 1892; this agrees well with the results obtained in 1891. The mean value of these quantities for the ten years 1883–92 are + 0·044s. and + 0″·61. The mean error of the moon in N.P.D. for 1892 was − 0″·27.

Owing to great pressure of longitude and other work, the work with the altazimuth was suspended from May to October 18, 1892, the number of observations falling below that usually recorded. The total number in the year ending May 10, 1892, is—

Azimuths of the Moon and Stars ...	... 167
,, ,, Mark I. ...	... 62
,, ,, Mark II. ...	... 64
Zenith distances of the Moon... ...	... 62
,, ,, ,, Mark I. ...	... 60
,, ,, ,, Mark II. ...	... 62

The provision of the new universal transit-circle to replace the existing altazimuth, and to serve as a duplicate meridian instrument for fundamental determinations, with suitable building and dome, having been sanctioned by the Government, its construction has been entrusted to Messrs. Troughton and Simms, who are now preparing the working-drawings. This instrument will be erected to the north of the Magnetic Observatory. Some difficulty seems to have occurred with regard to the sidereal standard clock, which on June 26 was found to have stopped. An examination soon showed that the oil on the escape pivots had thickened. At the beginning of this year the maintaining power was strengthened, and the barometric inequality adjusted.

Owing to the fact of the new dome only being recently completed, the tube of the 28-inch refractor, together with the declination axis cones, declination circle, and clamping circle is not yet completed. The object glass is at the Observatory, and ready for mounting.

Last May the Merz refractor (12¾ inch) of the south-east equatorial was mounted in place of the Lassell 2-feet reflector, the same mounting carrying the Thompson 9-inch photographic telescope.

Since February Mr. Lewis has used this instrument for double-star work, and he has made 545 measures of position angle, and 609 of distance of 85 pairs; 32 pairs being less than 1″ apart, 26 between 1″ and 2″, 8 between 2″ and 3″, and 19 over 3″.

With regard to occultations, 26 disappearances and 7 reappearances of stars by the moon have been observed, including 7 disappearances and 3 reappearances observed during the lunar eclipse of May 11, 1892, and 10 disappearances of stars below the *Nautical Almanac* limit of brightness (6·5), approximately predicted by Mr. Crommelin. Disappearance of Uranus behind the Moon on July 3, an occultation of 73 Piscium by Jupiter on May 23, and 62 phenomena of Jupiter's satellites were also observed. All these observations are completely reduced to February 26, 1893.

Among other miscellaneous observations made may be mentioned:—Observations of comets, differences of R.A. and N.P.D.'s of Saturn and γ Virginis, on the occasion of their conjunction; and of Mars and Ceres at the time of their conjunction, &c.

With the Astrographic equatorial 722 plates, with a total of 1812 exposures, have been taken on 161 nights in the year ending May 10, and of these 116 have been rejected, viz. 57 from photographic defects, 6 from mechanical injury, 12 from mistakes in setting, 6 from the plate being wrongly placed in the carrier, 7 from failure in clock driving, and 28 from interference by cloud. The following statement shows the progress made with the photographic mapping of the heavens in the year, May 11, 1892, to May 10, 1893:—

	No. of Photos taken.	Successful Plates.
Astrographic Chart (exposure 40m.) ...	200	... 183
Plates for Catalogue (exposures 6m., 3m., and 20s.)...	367	... 288
Number of Fields photograped for the Chart	—	... 172
Number of Fields photographed for the Catalogue	—	... 271
Total number of Fields photographed since the commencement of the work for the Chart	—	... 176
Total Number of Fields photographed since the commencement of the work for the Catalogue	—	... 299

It has been made a practice to take a trail on each night on a catalogue plate as a check on the orientation, and during the past year 127 plates with trails have been thus secured.

With the same instrument, and included in the 722 mentioned above, were taken photographs of Nova Aurigæ (49), for zero of scales and orientation (36), lunar eclipse, May 11 (4), Comet Holmes (2), Saturn (5), conjunction of Saturn and γ Virginis (16), &c.

Experimental plates of Jupiter, Saturn, double stars, &c., have also been taken with the image enlarged about fourteen times by a secondary magnifier, consisting of a triple cemented concave lens of 1⅜ inches diameter, and 3 inches focus, supplied by Mr. T. R. Dallmeyer. The results, as the report states, are very promising.

No spectroscopic observations have been made during the past year, the regular observations for stellar motion in the line of sight having been interrupted by the dismounting of the south-east equatorial, and there being great pressure in the solar photographic work. The telescope and camera of the Dallmeyer photoheliograph were again removed on September 9, 1892, from the wooden dome, where the new buildings obscured the horizon, to the first floor of the new museum, where they were remounted on stand No. 3, which was simply placed on the floor and found sufficiently steady. From this position it was possible to photograph the sun during about two hours each day.

In the year ending May 10, 1893, photographs of the sun have been taken with this instrument on 180 days, and of these 410 have been selected for preservation, besides twenty-two photographs with double images of the sun for determination of zero of position.

The photographic telescope has been in regular use as a photoheliograph since January, 1893, and photographs of the sun have been obtained with it on eighty-nine days, of which 158 have been selected for preservation. In all, with one photoheliograph or the other, a record of the state of the solar surface has been secured on 220 days during the year. A new enlarging lens by Messrs. Ross and Co., which appears to be very free from distortion, was fitted to the Thompson photoheliograph on December 13, and has been used regularly for the eight-inch photographs of the sun. Taking into account the India and Mauritius photographs received from the Solar Physics Committee, solar pictures for 362 out of 366 days are available for measurement. The photographs show that solar activity has throughout the past year been fully maintained, the mean daily spotted area for the years 1890, 1891, 1892, being 100, 566, and 1230 respectively.

The great solar activity mentioned above has its reaction also in the number of computers employed, for the report says that to cope with this unexpectedly severe sun-spot maximum it has been necessary to largely increase the number of computers employed on this work, and a further addition will probably be required, if, as seems likely, the solar activity continues to increase.

With regard to the magnetic observations, the registration has been carried on as in former years, the new photographic processes recording with clearness and delicacy many rapid magnetic movements that occur during magnetic storms.

The disturbance of the earth current registers due to the trains running on the City and South London Electric Railway still continues, and is of about the same magnitude as before. The substitution of a non-magnetic silver pointer for the upper magnetic needle in the galvanometers for the earth current apparatus, as mentioned in the last report, has proved very successful, the scale values, which used to vary considerably, having since remained remarkably constant.

In view of the approaching introduction of a dynamo into the Observatory grounds for electric lighting, experiments have been made to determine the possible effect on the magnetographs of the dynamo unshielded and with triple iron shield. These experiments were carried out at Messrs. Johnson and Phillips's factory, Charlton, the deflection of the declination magnet of the portable unifilar magnetometer being observed at distances of 20 and 40 feet respectively due west (magnetic) of the dynamo, the poles of which were in the east and west direction (magnetic), thus giving the maximum deflecting effect. At the Royal Observatory the poles of the dynamo will be north and south (astronomical), and it will be placed at a distance of about 170 feet from the magnets and nearly due south (magnetic). Making due allowance for this, the experiments at Charlton would give the following results:—

Effect on	Declination Magnet	or	Horizontal Force Magnet.
Dynamo unshielded ...	... 4″		·00008
Dynamo with triple shield ...	0″·5		·00001

the effect on the horizontal force magnet being expressed in parts of the whole horizontal force. The corresponding displacements of the magnetograph registers would be only 1/2000th of an inch for declination and 1/400th of an inch for horizontal force, in each case with triple shield to the dynamo.

The following are the principal results for the magnetic elements for 1892:—

Mean declination (approximate)	17° 18′ west
Mean horizontal force ...	3·9613 (in British units)
	1·8265 (in metric units)
Mean dip	67° 18′ 42″ (by 9-inch needles)
	67° 19′ 45″ (by 6-inch needles)
	67° 21′ 7″ (by 3-inch needles)

Meteorological observations have been continuously maintained during the past year, and the reductions are in the following state:—

The observations of barometer, thermometers, anemometers, rain-gauges, and sunshine-recorder (corrected, where necessary, for instrumental error) are reduced up to the present time. On the photographic sheets all the time-scales are laid down, and the hourly ordinates are read out for the dry and wet bulb thermometers to the end of the year 1892, and for electrometer to the end of July 1892. The table of principal changes in the direction of the wind for 1892 is complete.

The mean temperature of the year 1892 was 48°·1, being 1°·4 below the average of the 50 years, 1841–1890. The highest air temperature in the shade was 85°·9 on June 10, and the lowest 17°·6 on December 27. The mean monthly temperature in 1892 was below the average in all months excepting May, August, and November. In March it was below the average by 4°·4, in October by 4°·6, and in December by 3°·0.

The mean daily motion of the air in 1892 was 265 miles, being 17 miles below the average of the preceding 25 years. The greatest daily motion was 687 miles on January 29, and the least, 48 miles on December 28. The greatest pressure registered was 11·8 lbs. on the square foot on October 9.

Bright sunshine was recorded on 1277 hours during the year, this being 7 hours below the average of the preceding 15 years. The sun being above the horizon for 4465 hours, the mean proportion of sunshine for the year was 0·286, constant sunshine being represented by unity.

The rainfall amounted to 22·3 inches in 1892, this being 2·2 inches below the average of the fifty years 1841-1890.

In the determination of the longitude of Paris, four observers, two French and two English, took part in the work, as in 1888; three of them were the same as before (Colonel Bassot, Commandant Defforges, and Mr. Turner), but Mr. Hollis replaced Mr. Lewis, whose special attention was required in the Time department. The plan of operations adopted in 1888 was only modified in the following particulars: two clocks were used instead of one, at each end of the line, and all the clocks were placed in rooms kept at nearly constant temperature. The Sidereal Standard was used by the English observer at Greenwich throughout. The English observers used the small chronographs procured for the Montreal longitude, with one pen only, thus avoiding the troublesome correction for parallax of pens.

In the Astronomer Royal's general remarks, he mentions that "the work of the Observatory during the past year has been carried on under circumstances of exceptional difficulty. In the first place the operations for the determination of the longitudes of Paris and Montreal involved the absence of the Chief Assistant and of another assistant for protracted periods during last summer and autumn. Secondly, for six months the Observatory was left entirely without the services of a clerk, and the appointment of a permanent officer to undertake cash and other clerical duties has not yet been made; thus the scientific work of the Observatory has seriously suffered in consequence. It has not been possible for me, while harassed with constant interruptions on matters of administrative detail, to carry out the scientific investigations connected with the Observatory, which properly fall within the province of the Astronomer Royal. Thus, during the past year, I have had repeatedly to lay aside the important subject of the measurement of the plates of the astrographic chart in order to deal with details of cash accounts and other similar matters, which properly pertain to the functions of a clerk. In this connection I may mention that some years ago I proposed a photographic corrector, which, at a comparatively small cost, would render an ordinary astronomical refracting telescope available for photography; but, though a trial instrument has been made, and though I have partly worked out the details of a more complete form, I have never been able to command sufficient leisure, tolerably free from interruptions, to enable me to complete the rather troublesome optical calculations. Such a corrector could be usefully applied to the new 28-inch telescope as well as to other large instruments; but under present conditions I fear that there is little prospect of my being in a position to work out the idea."

"The growth of the Observatory buildings, involving the introduction of large masses of iron, raises the question of the possible disturbing effect on the magnets in their present position. Though the masses of iron would be at such a distance that they could not sensibly affect the registers of magnetic changes, which are purely differential, it is possible that the aggregate effect on the absolute determinations of the magnetic elements might become appreciable. Under these circumstances it is desirable that an auxiliary magnetic station for determination of absolute values of the magnetic elements should be established in the immediate neighbourhood of the Observatory, at such a distance that there would be no suspicion of disturbance from the iron in the buildings."

W. J. S. L.

REV. CHARLES PRITCHARD, D.D., F.R.S.

ANOTHER and a familiar figure has passed from among us, diminishing the strength of the tie that links the present generation to the science of the past. Almost a contemporary of Airy and of Herschel at Cambridge, Prof. Pritchard has seen the school, which they may be said to have inaugurated, lose its members one after another, to be himself among the last. But in no sense can it be said that he outlived his reputation, or that he was not a worthy disciple and an admirable exponent of that school. Nor was he content to remain simply a disciple. His ambition was to stand in the front rank, and to contribute his quota to the further progress of science. And this is the more remarkable and the more praiseworthy when it is remembered that he was considerably advanced in life before he devoted himself to any special science.

For Prof. Pritchard's early life had been spent, and worthily spent, in an endeavour to exhibit an improved method of education in the then upper middle-class schools. Of the success that attended his efforts, one of his old pupils, the present Dean of Westminster, has recently given an appreciative account. Dean Bradley has contrasted the dull methods that prevailed generally some sixty years since, even in schools of repute, with the vigour and enthusiasm which characterised the newer teaching, whose importance Prof. Pritchard early recognised and enforced. For thirty years he led the life of an active schoolmaster, and that he was successful in his vocation is fully established by the long list of the names of his pupils, famous in every walk of life. For private and personal reasons he retired from this career, and then his ambition was to take active clerical duty in some country parish. But in this he was disappointed, for as he has told the writer of this notice more than once, that though he was a divine in mind and heart, he was made an astronomer by Providence. But his loyal attachment to the Church of England and his scientific training placed him frequently in a position to render services to both science and religion. This is shown by the thoughtful and eloquent sermons that he has frequently preached on the occasions of the meeting of the British Association, as well as by his Hulsean Lectures at Cambridge, or in the capacity of Select Preacher at Oxford.

In 1870 the Savilian Professorship of Astronomy in Oxford fell vacant through the decease of Prof. Donkin. At the urgent recommendation of Sir John Herschel, Lord Hatherley, who was at the time Lord Chancellor, was induced to exercise his influence among the trustees of the Savilian estates, and Prof. Pritchard was elected to the vacant chair. How worthily he filled this office is known to the readers of this journal. It is sufficient to recal that he induced the University, shortly after his appointment, to supply an astronomical observatory, for at this date there was no observatory under academical control, and not only was research impossible, but very inadequate provision was made for the teaching of his class. The modest establishment originally contemplated by the University was materially increased by the munificence of the late Dr. De la Rue, in a way which admirably supplemented the judicious expenditure of the University. In later time a lecture-room and library had to be provided, and Prof. Pritchard probably felt that in the possession of a small, but tolerably complete, observatory, he gained rather than lost, from the fact that it was called into existence in quite modern times. Here it was his good fortune early to recognise the important part that photography was destined to play in the new astronomy, and before the gelatine plate had thoroughly revolutionised the art, he was at work on bright objects like the moon, to which photographic methods could then be applied. His success justified his foresight, and though in his subsequent career he frequently turned aside to pursue other lines of inquiry, he always returned to his original plan of investigation by means of photography.

In one of these excursions into more varied inquiries he was tempted to investigate the magnitude of the brighter stars on a plan which had occurred to him while at Clapham, and was, I believe, the practical outcome of a suggestion of the Rev. W. R. Dawes. This was the process of extinction by means of a wedge of neutral-tinted glass, used differentially. The method was carried out practically with great success, and the results of his work, embodied in a *Uranometria Nova Oxoniensis* received the reward of the medal of the Royal Astronomical Society, and procured for him, what he valued quite as highly, an honorary fellowship from his old college of Saint John's, at Cambridge. To secure the necessary completeness in this inquiry, Prof. Pritchard undertook to visit Egypt to determine the amount of atmospheric absorption. It was a source of great gratification to him to know that the more protracted inquiry of Dr. Müller led to practically the same result, and confirmed his investigation in every material particular.

Another of his researches, but one which he always held to be incomplete, was an effort to determine the relative co-ordinates of the stars of the Pleiades with a view to ascertaining the mutual proper motions. This group of stars had for him a great fascination, and to within a few days of his death he was at work endeavouring to supplement this inquiry by photographic methods. His favourite motto was—

spem nos vetat inchoare longam
aetas,

but certainly he never acted by the implied caution. To undertake some fresh work as soon as, or before the last was finished was his constant aim, and his zeal was generally equalled by his success. He undertook very little from which he did not get some positive result, for his method was to work tentatively, and to relinquish the inquiry if it did not appear promising. In this way he took up what he regarded as the greatest work of his life, the determination of the parallax of stars of the second magnitude. In this investigation he showed the keenest interest, and much of the work was performed not only under his directions, but actually by himself, and the Royal Society, recognising the importance of this work, and also Prof. Pritchard's earnest and protracted devotion to astronomy, awarded him the Royal Medal last year. W. E. P.

NOTES.

THE annual meeting of the Royal Society for the election of Fellows was held in their apartments at Burlington House on Thursday last, when the following gentlemen were elected into the Society:—Prof. William Burnside, Prof. Wyndham R. Dunstan, William Ellis, Prof. J. Cossar Ewart, Prof. William Tennant Gairdner, Ernest William Hobson, Sir Henry Hoyle Howorth, Edwin Tulley Newton, Charles Scott Sherrington, Edward C. Stirling, John Isaac Thornycroft, Prof. James William H. Trail, Alfred Russel Wallace, Prof. Arthur Mason Worthington, Prof. Sydney Young.

AMONG Fellows of the Royal Society whose names appear in the list of birthday honours are Dr. B. W. Richardson, F.R.S., Capt. A. Noble, C.B., F.R.S., and Mr. Charles Todd, C.M.G., F.R.S. Dr. Richardson, who has been knighted, is well-known as a writer on hygienic and medical subjects, and Capt. Noble, who is created a Knight Commander of the Bath, is an authority on explosives. Mr. Todd has been promoted to Knight Commander of the Order of St. Michael and St. George. In the announcement of the honour that has been conferred upon him, he is described as Postmaster-General and Superintendent of Telegraphs of the colony of South Australia. It should be pointed out, however, that Mr. Todd is also the Government Astronomer at Adelaide and that he has published numerous contributions to meteorology and astronomy. It almost appears as if Mr. Todd's standing as an astronomer and man of science has been wilfully avoided, for we can hardly think that the Colonial Office is in blissful ignorance of his scientific work. The only scientific man in Government employ whose services have been recognised is Mr. David Morris, the assistant director of the Botanic Gardens at Kew, who has been made a Companion of the Order of St. Michael and St. George.

THE ladies' *conversazione* of the Royal Society was held last night in the Society's apartments at Burlington House.

THE President of the Society of Antiquaries has issued invitations for a *conversazione* at Burlington House, on the 14th instant.

IT is expected that, at the meeting of the Royal Astronomical Society to-morrow evening, Prof. Thorpe and Mr. Alfred Taylor will give an account of the expeditions to observe the recent total solar eclipse. Prof. E. E. Barnard, of the Lick Observatory, will also be present, and will address the meeting.

THE annual *conversazione* of the Society of Arts will take place at the Imperial Institute, South Kensington, on Friday, June 30, from 9 to 12 p.m.

ON June 26, 1793, died Gilbert White of Selborne, a man who has done perhaps more than any other of his countrymen to awaken a taste for natural history and encourage its pursuit. A writer in the June number of *The Zoologist* gives a sketch of the life of this naturalist, and points out that now is the time to erect some kind of monument to his memory. The sole memorial which at present exists is a marble tablet on the chancel wall of the church in which he officiated. This is not as it should be. A marble bust was erected to Richard Jefferies, in Winchester Cathedral, a few months after his death, while Gilbert White, also a Hampshire man, has remained unhonoured for a century. As to the claim of the author of the "Natural History of Selborne," to a memorial there can be no doubt, and it is to be hoped that a committee will be formed to take the matter in hand, and carry it to a successful termination. Unfortunately no portrait of Gilbert White is in existence, so there is a difficulty in designing a monument with a statue unless it be decided to allow the sculptor to carve the features from his imagination. Under these circumstances, the preferable plan would be to erect a monument emblematical of the avocation of a naturalist, such, for example, as the monument to the naturalist, John James Audubon, which was unveiled at New York on April 26 last. Whether the monument should be erected at the little village of Selborne, or in the borough-town of Petersfield, ought soon to be decided. We trust that when an appeal for funds is made, there will be a hearty response to it.

WE regret to have to record the death of Dr. Carl Semper, Professor of Zoology and Comparative Anatomy in the University of Würzburg, on May 29.

IT has been resolved by the Government of India that in the future two-thirds of the officers of the Geological Survey shall be primarily engaged in the explorations necessary for the completion of the geological map, and the remaining third on the investigation of mineral fields. According to the *Times*, the exploration in the latter case will be confined to such preliminary examination as may be necessary to supply general information regarding their character and extent to capitalists and promoters, upon whom will rest the responsibility for more detailed prospecting.

AN International Electrical Congress will be held in connection with the Columbian Exposition, at Chicago, in August. There will be three sections, one dealing with pure theory, another with theory and practice, and a third with practice only. Papers are solicited upon electrical subjects, and should be sent to Prof. T. C. Mendenhall, Washington, D.C., not later than August 1. Electrical standards and units will be considered by a body consisting of those specially designated as representative delegates from the various Governments.

THE second meeting of the International Maritime Congress is to be held in the rooms of the Institution of Civil Engineers next month. The chief object of the congress is the reading and discussion of papers on matters relating to the promotion and security of maritime traffic and commerce. After the meeting it is proposed to visit the docks along the Thames, and some of the provincial seaports.

THE annual general meeting of the Institution of Civil Engineers was held on May 30. Before proceeding to the ordinary business, H.R.H. the Duke of York was elected an honorary member. The ballot for Council resulted in the election of Mr. Alfred Giles as President; of Sir Robert Rawlinson, Sir B. Baker, Sir Jas. N. Douglass, and Mr. J. W. Barry, as Vice-Presidents; and of Dr. W. Anderson, Mr. A. R. Binnie, Sir Douglas Fox, Sir Chas. A. Hartley, Messrs. J. C. Hawkshaw, C. Hawksley, Alex. B. W. Kennedy, Sir Bradford Leslie, Mr. J. Mansergh, Sir Guilford Molesworth, Mr. W. H. Preece, Sir E. J. Reed, Messrs. W. Shelford, F. W. Webb, and W. H. White as other Members of Council.

THE weather during the latter part of last week continued particularly dry over the greater part of these islands, owing to an anticyclone which lay over the Atlantic embracing most part of the country, but shallow depressions ormed over Scandinavia and the Baltic, and under their influence some slight showers occurred in the extreme north and north-west. At the end of the week however the anticyclone temporarily shifted somewhat southwards and eastwards, thunderstorms became prevalent in the north, east, and south-east, and rain fell at most stations, amounting to over half an inch in the north-east of Scotland, but generally speaking the amounts were slight elsewhere; on Tuesday, the 6th inst., the anticyclone again embraced the whole of the southern portion of our islands. During the first part of the period frost occurred on the ground in many parts of England; and although the maximum temperatures have not been high generally, they have at times exceeded 70° in different parts of Great Britain, but in the extreme north the highest readings have generally been below 60°. The *Weekly Weather Report* of the 3rd inst. showed that the temperature was slightly below the average in some of the wheat-producing districts, and rather above it in the grazing districts. Rainfall was below the mean everywhere; the deficiency since the beginning of the year ranged from 2·3 inches in the north of Scotland to 6·0 inches in the west of Scotland. Bright sunshine was only above the average in the west of Scotland, the south-west of England, and the Channel Islands. In the latter district the duration was as high as 70 per cent. of the possible amount.

THE Meteorological Council have issued the fourth volume of Hourly Means of the readings obtained from the self-recording instruments at their observatories for the year 1890. The tables contain hourly means or totals for periods of five days, months, and for the year, and, with the exception of the wind observations, daily values are also given. Breaks in the hourly readings are rare, but occur at times from failure of photography, stoppage of clocks, and in the case of the wet-bulb thermometer, owing to frost; such cases, however, are carefully examined and the losses can usually be made good by interpolation, with a very near approach to accuracy.

SIR C. TODD has published the meteorological observations made at the Adelaide Observatory and other places in the colony during the year 1890. The maximum shade temperature at Adelaide was 105° on January 18, and the minimum 34°·2 on July 17; the greatest range in 24 hours was 38°·8 on January 4th, and the lowest temperature on grass was 25° on July 17. Throughout the colony generally very oppressive weather was experienced in January and February, with heavy tropical rains over northern areas, and the winter also was very wet. The extraordinary rainfall (especially in the first three months) was the chief feature of the year, which was the wettest on record, some stations having a fall of over 100 inches.

A CORRESPONDENT calls our attention to a peculiar phenomenon witnessed at Aboyne on the morning of May 26. "Stretching along the falls of Morven and Culblean, and slightly below the top of the former, was a magnificent ribbon, exhibiting the full spectrum of colours from red to violet—in fact, a perfect 'rainbow,' but without the slightest curve. The sun was shining brightly in the east, while it was raining on Morven, which, of course, accounts for the colours; but I am unable to account for the absence of the arch." The lowest part of the ribbon showed the least refrangible colours.

A NUMBER of experiments to determine the temperature of the steam arising from a boiling salt solution have been made from time to time, but the conclusions have frequently been of a conicting character. The difficulty of arriving at trustworthy results lies in the fact that the walls of the steam-chamber must be above 100° C., and yet below the temperature of the solution, and that, at the same time, a sufficient quantity of steam must escape from the solution to ensure that these walls shall have no material cooling effect upon the steam. These desiderata are all met by an arrangement employed by Prof. Sakurai, and described in the Journal of the College of Science, Imperial University, Japan, vol. vi., part i. From experiments on solutions of calcium chloride, sodium nitrate, and potassium nitrate, it appears that the temperature of the steam escaping from a boiling solution is exactly the same as that of the solution itself.

To measure the viscosity of liquids they are let flow, under given conditions of pressure and temperature, through a capillary tube, and the time of passage is determined. This is rather unsuitable for very viscous liquids, such as concentrated glycerine; and Herr Brodmann has devised a method (*Wied. Ann.*) for determining co-efficients of friction, where these exceed a thousand times that of water. The liquid flows by gravity through a vertical tube from a wide vessel above, filled to a certain height, into a small shallow vessel below, standing on one scale of a chemical balance, the other scale being weighted so that it is down. A time comes when this preponderance ceases. The moment of passage of a certain mark is noted, a weight is added to the weight-scale, and the process is repeated. The difference of time between two of these passages corresponds, after some corrections, to the direction of outflow of a quantity of liquid equal in mass to the added weight.

A NOTE in *Électricité* gives the substance of a letter to the Génie Civil, in which the correspondent shows that there is a difference of potential between the water and gas pipes in all houses, and that if one terminal of a telephone is joined, say, to the water-pipe, on lightly touching the gas-pipe with the other, a crackling sound is heard in the telephone indicating the passage of a current. By replacing the telephone by a galvanometer, it is found that the negative pole is formed by the gas-pipe, and that the galvanometer deflection is permanent and constant in amount during several months, though there is a slight diurnal variation. The author attributes these currents to a slow chemical change in the pipes, which thus form the plates of a battery. However, these observations suggested that the pipes must be fairly well insulated from each other, and might act as conductors for telephonic communication, and he has succeeded in carrying on a conversation, without any other connecting conductor between two houses at a distance of a hundred metres apart. In this experiment the microphone, without any induction coil, was joined to three bichromate cells. It is very easy to see if the experiment will succeed, as it is only necessary to set a small induction coil to work, joining its terminals to the water and gas-pipes, then in all neighbouring houses in which, on joining a telephone to the pipes, the sound of the coil is heard communication is good. Even if speech cannot be satisfactorily transmitted, it would be possible to communicate by the ordinary Morse signals.

A HIGHLY sensitive manometer, suitable for measuring small variations of high pressures, is described by M. Villard in No. 21 of the *Comptes Rendus*. It consists of a U-tube one or two mm. in diameter and about 20 cm. long, one end of which leads into a closed glass cylinder about 50 sq. mm. in section and 8 or 10 cm. long or longer, according to the degree of sensibility required. The other end opens into another wide tube ending in a narrower portion, which may be bent back. A narrow copper tube fixed inside this portion by about 3 cm. of marine glue forms a most efficient mouthpiece and offers an almost indefinitely large resistance to the passage of gaseous matter. Enough mercury is contained in the U-tube to fill one of its branches. The filling is to a great extent self-acting. The mouthpiece need only be connected to a compressed gas reservoir. The gas bubbles up through the narrow tube and fills the cylinder at the pressure required. A slight expansion subsequently enables the mercury to reenter the narrow tube, and the position of the thread of mercury is then read off on a scale. In one of the instruments constructed, which has a reservoir of 5 cc. capacity, a change of level of 1 mm. at 20 atmospheres corresponds to a change of pressure amounting to 1 in 2500, so that it may safely be said that at 50 atmospheres the same change of level indicates a change in pressure of one-fiftieth of an atmosphere. But this amount of sensitiveness may be increased by making the reservoir longer, and since it is possible to take readings to 0·1 mm., the instrument may be said to indicate differences as small as 1 in 25,000. The variation in height of the mercury must of course be allowed for, and the tube and reservoir accurately gauged before the instrument is set up. After use at a high pressure it can be opened to the air, when the compressed gas will escape in bubbles through the wide tube. It is found that the instrument is easily made strong enough to work with safety at 100 atmospheres.

A REPORT on "The Hawks and Owls of the United States," with special reference to the economic status of the various species, has been prepared by Dr. A. K. Fisher for the U.S. Department of Agriculture. Of the seventy-three species and sub-species described only six prove to be injurious, and three of those are extremely rare. The contents of about 2700 stomachs of hawks and owls were examined, and omitting the six species that feed largely on poultry and game, 56 per cent. contained mice and other small mammals, 27 per cent. insects, and only 3½ per cent. poultry or game birds. This result shows that a class of birds commonly looked upon as enemies to the farmer really rank among his best friends. The report contains twenty-five coloured plates.

AT a meeting of the Norfolk and Norwich Naturalists' Society, held on May 30, a resolution with regard to the Wild Birds Protection Bill now before the House of Lords was unanimously passed, and the president requested to forward the same to the Earl of Kimberley, one of the Vice-presidents, asking his cooperation with its objects. The result of the proposed amendments would be that the County Council should be empowered to order the protection of certain specified districts easily defined, rather than the eggs of specified species, which, in many instances, so closely resemble those of other species (as for instance, those of the Teal and Gargany Teal, and the Ruff and Redshank) that their identification would be so difficult to establish as to render a conviction practically impossible.

IN the fourth annual report of the Missouri Botanical Garden, which has just been published, Mr. W. Trelease gives the results of further studies of yuccas and their pollination. Mr. Albert S. Hitchcock also contributes a description of plants collected in the Bahamas, Jamaica, and Grand Cayman.

MESSRS. BLACKIE AND SON have added another to their already large number of science text-books. "Chemistry for All," by W. Jerome Harrison and R. J. Bailey, is a tersely-written account of the chemistry of common things, in which equations, formulæ, chemical symbols, and arithmetical calculations are eschewed. There is little new in the book, either in the text or illustrations.

MESSRS. MACMILLAN AND CO. have just published a fine work by Mr. G. W. Caldwell Hutchinson, entitled "Some Hints on Learning to Draw." A few excellent, though brief, remarks on elementary anatomy precede the description of drawing the human figure, but artists do not yet seem to realise the equal importance of knowing something about the elements of physical science before conceiving pictures of natural phenomena.

MESSRS. GAUTHIER-VILLARS have issued two small volumes by M. P. Minel on "L'Electricité Industrielle." One deals with potential lines of force and electro-magnetic units, and in the other, magnetic circuits and induction machines are considered. The object of the author has been to bring together the theoretical principles necessary to the proper understanding of dynamo-electric machinery and electric lighting.

A USEFUL little book by M. Henri Coupin on "L'Aquarium d'Eau Douce" has recently been published by Messrs. Baillière. It is well illustrated, and should be interesting to young naturalists. The author describes how to capture, preserve, and study some of the common types of plants and animals found in fresh water.

A TRANSLATION of Dr. Migula's "Introduction to Practical Bacteriology," by M. and H. J. Campbell, has just been published by Messrs. Swan Sonnenschein and Co. The German edition was reviewed in these columns on June 30, 1892.

THE Geological and Natural History Survey of Minnesota have issued their twentieth annual report. Among other papers contained in the report is one by Mr. N. H. Winchell on "The Crystalline Rocks, some preliminary considerations as to their Structure and Origin," and Dr. A. C. Lawson gives the results of a survey of the raised beaches of the north shore of Lake Superior.

A USEFUL syllabus of an elementary course of botany has been received from the author, J. Bentley Philip. It is published by James G. Bisset, of Aberdeen.

PROF. HERDMAN writes to us:—"During the Whitsuntide vacation the Liverpool Marine Biology Committee spent two days in dredging from Port Erin, and the rest of the time in work on the shore and in the Biological station. On one day the weather was sufficiently fine to allow of the steamer working on the seventy fathom depression which lies to the west of the Isle of Man, half way to the Irish coast. The bottom there is a fine stiff grey-blue mud or clay, which, it has been suggested, may be of glacial origin. We searched very carefully through dredgefuls of this unpleasantly tenacious cold mud in the hope of finding some stones or shells which might settle the matter, but in vain. The animals on this ground include the Crustaceans *Calocaris macandreweæ* and *Pasiphæa sivado*, a Polynoid (*Panthalis oerstedi*) in enormous muddy tubes and *Lipobranchius jeffreysii*, Echinoderms *Amphiura chiajii* and *Brissopsis lyrifera* (in quantity), *Virgularia mirabilis*, and the Molluscs *Isocardia cor* and *Rissoa abyssicola*. On a previous trip, shortly before this, one of our party obtained fifteen living specimens of *Isocardia cor* on this ground. The rest of the dredging on the two days was carried on nearer Port Erin, along the west side of the Isle of Man, at depths of twelve to forty-six fathoms. Among the more noteworthy forms obtained were the Echinoderms *Thyone raphanus* and *Echinocardium flavescens*, a calcareous sponge *Ute glabra* (found before at Guernsey), the Ascidians *Eugyra glutinans*, *Polycarpa comata*, and a considerable number of the rare *Forbesella tessellata* (which present such variations in shape, general appearance, colour and texture, along with identity in anatomical characters, as to enable me to say that Forbes's *Cynthia tessellata* and *C. limacina* are undoubtedly one and the same species), and the mollusca *Oscanius membranaceus*, *Coryphella landsburgi*, and *Cyclostrema millepunctatum*, Friele, which is new to British seas. One of our reporters on Mollusca (Dr. Chaster) tells me that Canon Norman, who has seen our specimens of the *Cyclostrema*, and compared them with one of Herr Friele's type specimens in his collection, writes that the species has only been taken by the Norwegian North-Atlantic Expedition at Stat. 192 (Lat. 69°46′ N., Long. 16° 15′ E.), off the northern part of Norway, at a depth of 649 fathoms. *Anomalocera pattersonii* was very conspicuous in the surface nettings, and additional specimens of the new *Lichomolgus* (L.

maximus, Thomps.) inhabiting *Pecten* were obtained, along with many other Copepoda which have not yet been examined."

Two further papers upon his researches with the electric furnace are contributed by M. Moissan to the current number of the *Comptes Rendus*. In the first it is shown that crystals of quartz and zircon are almost instantly fused at the high temperature of a powerful electric arc, the liquids brought to vigorous ebullition in a few moments and actually distilled, passing over into the receiver in the form of a dense fume. M. Moissan further demonstrates how easy it is at this high temperature to obtain pure zirconium and pure silicon by reduction of the liquefied oxides with carbon. The current employed was one of 360 ampères. When fragments of rock crystal were placed in the crucible of the furnace and subjected to the arc they rapidly melted, and in seven minutes the liquid boiled vigorously; the vapour of silicon dioxide which escaped condensed in the cooler portion of the furnace to a bluish-white fume, which deposited in the receiver in the form of small opalescent spheres, visible to the unaided eye. These spheres of silica were solid throughout, and usually exhibited a depression at some portion of the surface, indicating contraction upon passing from the liquid to the solid state. They were readily soluble in hydrofluoric acid. It is of interest that M. Moissan has discovered similar opalescent spheres of silica upon glass globes which have been employed in electric lighting to diffuse the light from arc lamps, indicating that slow volatilisation of the silica of the glass had occurred. It is doubtless to this cause that the opalescence which usually occurs after such globes have been in use for some time is due. The specific gravity of the spheres is 2·4, slightly less than that of quartz. At the temperature of the arc given by 360 ampères liquid silica is very readily reduced by carbon, a crystalline regulus of silicon being obtained containing more or less carbon.

WHEN zircons or any other form of zirconia are submitted to the high temperature of the same arc they likewise fuse, and in about ten minutes the liquid boils vigorously, and zirconium oxide passes over as a white fume into the receiver, where it condenses in the form of a white powder. Any liquid remaining in the crucible after switching off the current solidifies to a crystalline mass, and scattered about the walls of the furnace numerous perfect little artificial zircons are observed, identical n colour, lustre, and other properties with natural zircons. Both these and the powder condensed in the receiver readily scratch glass. Liquid zirconia, like silica, is readily reduced by carbon. If the oxide is fused by the arc in a carbon crucible, a button of metallic zirconium is found at the close of the operation beneath the residual solidified zirconia. If zirconia is mixed with powdered carbon a metal is obtained containing 4–5 per cent. of carbon. This carbide can be refined by re-melting with more zirconia when the pure metal is obtained. Zirconium is a very hard metal, readily scratching glass and ruby. Its density is 4·25.

THE second paper of M. Moissan describes the preparation of metallic tungsten, molybdenum, and vanadium. Tungsten is readily obtained in the form of powder by reduction of heated tungstic acid in a current of hydrogen, but the powder thus obtained has been hitherto found to be practically infusible. M. Moissan now shows that tungsten may be readily prepared in solid ingots in the electric furnace. A mixture of tungstic acid and carbon is placed in the crucible, and after ten minutes' subjection to an arc of the tension above stated a button of over a hundred grams of the metal is produced. If care has been taken to ensure excess of tungstic acid, pure tungsten is obtained in the one operation. Otherwise a carbide is obtained which requires refining by re-melting with a further quantity of tungstic acid. The tungsten thus obtained is a very brilliant metal of specific gravity 18·7. M. Moissan has further observed that if a much more powerful arc is employed, the percentage of carbon in the carbide of tungsten first obtained is very largely increased. Thus when a current of 1000 ampères was employed the percentage of carbon rose to 18, indicating an attempt to form a true binary compound. Metallic molybdenum has likewise been obtained by M. Moissan by the reduction of its oxide with powdered charcoal at the temperature of the arc afforded by a current of 360 ampères. The metal is not, however, quite free from carbon, and requires refining.

THE preparation of metallic vanadium has presented considerable difficulty. It will be remembered that Sir Henry Roscoe found it impracticable to reduce vanadic acid by carbon, and eventually isolated the pure metal by reduction of the dichloride in a stream of hydrogen. M. Moissan finds that even after twenty minutes' action of the arc from the 360 ampères current, only a trace of reduction is apparent at the surface of the mixture of oxide and charcoal. Upon increasing the tension of the arc by employing a current of a thousand ampères complete reduction occurs, but the metal produced combines, as in the case of tungsten, with a large quantity of carbon. It would appear, therefore, that at this high temperature these refractory metals combine with carbon to form definite binary compounds.

NOTES from the Marine Biological Station, Plymouth.—Last week's captures include the Actinians *Sagartia miniata* and *venusta*, the Nemertines *Amphiporus hastatus* and *Malacobdella grossa*, the Polychæte *Myrianida maculata* (with a posteriorly proliferated chain of buds), and the Schizopods *Siriella frontalis* and *jaltensis*, the latter species in considerable numbers. Floating Cœlenterates have been particularly plentiful. Medusæ of *Aurelia aurita* (now 4 to 7 ins. in diameter) have frequently been noticed. The Anthomedusæ have been represented by *Sarsia tubulosa*, *Bougainvillea ramosa*, and, more plentifully, by *Amphinema Titania*; the Leptomedusæ by countless numbers of *Phialidium variabile*, together with a smaller proportion of *Thaumantias Thompsoni* (Forbes) and *Laodice cruciata*, Ag. (= *T. pilosella*, Forbes). A few young *Clytia* medusæ have been occasionally taken, but *Obelia* medusæ have been very scarce. The Ctenophore *Hormiphora plumosa*, in various stages of growth, is now abundant. Several specimens of the parasitic larva of the Actinian *Halcampa chrysanthellum* have been taken. The beautiful veliger *Echinospira diaphana* has once been noticed; larvæ of the Crustacean *Porcellana* are plentiful. The following animals are now breeding:—The Hydroid *Clava cornea*, the Mollusca *Murex erinaceus* and *Aplysia punctata*, the Schizopoda *Macromysis inermis* and *Siriella jaltensis*, the Decapod *Palæmonetes vulgaris*, and the Echinoderm *Asterina gibbosa*.

THE additions to the Zoological Society's Gardens during the past week include a Barbary Ape (*Macacus inuus*, ♀) from North Africa, presented by Mr. A. G. F. Dashwood; a Suricate (*Suricata tetradactyla*) from South Africa, presented by Mr. L. V. Harcourt; three Chinese Quails (*Coturnix chinensis*, ♂ ♀ ♀) from China, presented by Mr. W. J. Ingram; two Kingfishers (*Alcedo ispida*) British, presented by Mr. A. K. Dixon; a Harlequin Snake (*Elaps fulvius*) from Florida, presented by Mr. C. Ernest Brewerton; a Horned Lizard (*Phrynosoma cornutum*) from Texas, presented by Mr. J. Harland Coates; a Sykes's Monkey (*Cercopithecus albigularis*, ♀) from East Africa, a Leucoryx (*Oryx leucoryx*, ♀) from North Africa, a Mexican Deer (*Cariacus mexicanus*, ♂) from Mexico, a Malayan Tapir (*Tapirus indicus*, ♂) from Malacca, two Common Cassowaries (*Casuarius galeatus*, jr.) from Ceram, a Leopard Tortoise (*Testudo pardalis*), two Derbian Zonures (*Zonurus derbianus*) from South Africa, deposited; two Brazilian Cariamas (*Cariama cristata*) from Brazil, four Black-tailed Godwits

(*Limosa ægocephala*) four Flamingoes (*Phœnicopterus antiquorum*) European, purchased; a Barbary Wild Sheep (*Ovis tragelaphus*, ♂), an Angora Goat (*Capra hircus*, ♀ var.), a Japanese Deer (*Cervus sika*, ♀), a Great Kangaroo (*Macropus giganteus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE TOTAL SOLAR ECLIPSE (April, 1893).—M. N. Coculesco, in the current number of the *Comptes Rendus* (No. 22) gives a brief account of his observations made during the last total solar eclipse. The station he occupied was at Fundium. The instruments which he took with him consisted of a telescope of 0·16 m. aperture, with a wooden mounting, a fine comet seeker, a mean time chronometer, and a thermometer. An ordinary photographic camera fixed to the telescope was also employed, five fine negatives of the corona being obtained with it. The plates employed were the ordinary dry plates of gelatine-bromide of silver, and the developer that of ferrous-oxlate. The exposures were of 2, 4, 6, 7, and 5 seconds duration, but the second plate seems to have given the most details. The observation of contacts gave the following results:—

Observation.	Paris M. T. h.	m.	s.
1st contact	2	20	21
2nd ,, ...	3	42	51
3rd ,, ...	3	47	2
4th ,, ...	5	3	36

thus giving 4m. 11s. as the duration of totality. The thermometrical observations showed that on the day of the eclipse the temperature was + 28° C., at the commencement of totality 26°·6, middle of totality 24°·0, and at the end of the eclipse 26°·5. A fall of from 3½° to 4° was thus noticed from the commencement of the eclipse to the middle of totality.

METEOR OBSERVATIONS.—Mr. Denning, in the *Observatory* for June, has a note on the large meteor of April 15, 1893, and also notes on observations of fireballs. With reference to the latter he points out those observations are made by a number of casual observers, and are commonly found to be conflicting and incomplete, the accounts being based on "rough hurried impressions often vitiated by serious errors." In attempting to reduce such observations it is generally found impossible to accommodate the descriptions unless we assume that the several large meteors appeared simultaneously in different paths. These bodies, he says, deserve closer attention than is usually given to them, and accurate observations should be made with regard to their positions, directions, and durations of their flights among the stars. That meteoric astronomy would advance by rapid strides, and that many "moot points in the visible behaviour of meteor-streams would soon receive settlement" cannot for a moment be doubted.

The study of brilliant meteors is one that requires no instrument but simply a good star atlas, and we hope that many of our readers may take Mr. Denning's words to heart and try to elevate this important branch of astronomy so that it can no longer be said that "they come and go, and their transient glories serve no more important end than that of affording startling spectacles to those who are fortunate enough to witness them."

WASHBURN OBSERVATIONS.—In vol. vi. part 3 of the Publications of the Washburn Observatory are the results of the observations made by Mr. Sidney Dean Townley of telescopic variable stars of long period. The method employed was to select two stars for comparison, one slightly brighter and the other slightly fainter than the one to be measured, the difference between these two comparison stars in brightness being less than a magnitude. By this means a very accurate estimation can be made of the brightness of the star in tenths of the interval between those taken for comparison. In estimating the magnitudes of the comparison stars he has employed the limit of visibility of the finder and large telescope (apertures 8·9 cm. and 39·5 cm. respectively), commencing with the former, and going down the numerical scale. The method of recording the values obtained is similar to the notation used by Argelander and Herschel Thus of two comparison stars *a* and *b*, *a* 1 *b* shows that the star observed is very nearly as bright as *a*, while *a* 9 *b* shows that it is very nearly equal in brightness to *b*, the number 1 representing one-tenth of the difference of brightness between the two comparison stars. In the tables, the number of the stars, together with their R.A.'s and declinations, are taken from Chandler's "Catalogue of Variable Stars." About 36 variables are included in this work, the observations extending over the period 1889-1892.

FINLAY'S COMET (1886 VII.).—Comet Finlay is described as circular, 1′ in diameter, 11th magnitude, very diffuse, and with no tail. As it rises just before the morning twilight in this country, it is by no means in a good position for observation. The following ephemeris is taken from a continuation of M. Schulhof's computations, made by M. Coniel, the difference between the computed and observed places being approximately—1m. 43s. in R.A. and + 12′ N.P.D.

M.T. Paris.

1893.	R.A. app. h.	m.	s.	Decl. app. °	′
June 8 ...	1	12	56 ...	+4	40·6
9 ...		17	35 ...	5	9·9
10 ...		22	15 ...	5	39·1
11 ...		26	56 ...	6	8·2
12 ...		31	38 ...	6	37·1
13 ...		36	20 ...	7	5·9
14 ...		41	3 ...	7	34·5
15 ...	1	45	47 ...	+8	2·9

GEOGRAPHICAL NOTES.

AT the last meeting of the Royal Geographical Society, Dr. Joseph A. Moloney, medical officer to Capt. Stairs' expedition to Katanga, read a paper descriptive of the journey. The expedition of over 300 men landed at Bagamoyo on June 27, 1891, and marched to Lake Tanganyika through the German territory, following the well-known caravan-track through Tabora. On the way proofs were not wanting that the slave-traders were kept well supplied with gunpowder, in spite of the strict regulations which are made much of in Europe. On October 9 they reached Lake Tanganyika near its southern end, and from conversations with the missionaries and natives obtained some interesting information as to the variations in the level of the water. It appears that the outlet of the lake by the Lukuga becomes periodically choked by sand and vegetation, thus forming a natural dam, which causes the level of the lake to rise. After a time the barrier is carried away and the river issues with great force, flowing strongly for a number of years. The extreme difference in level must be about 18 feet, and the rise and fall probably occupy about fifteen years. On October 31 the caravan started from the west side of the lake. The Kaomba country first passed through was found to abound in minerals, iron and copper being extensively worked by the natives who show much skill in the manufacture of weapons and implements. Bunkeia, the capital of Msiri's territory, was reached on December 14, the journey having been of extraordinary rapidity considering the route taken. Much of the country was swampy, and there were tracts of dense tropical forests reminding Captain Stairs of the Aruwimi basin. Near Bunkeia a famine was raging, and this, together with the tragedies consequent on the conquest of Msiri, brought the expedition into a very bad state. All the Europeans except Dr. Moloney suffered severely, and Captain Stairs never fully recovered. On February 4, 1892, the survivors of the expedition set out on the return journey, and travelling by Lake Nyasa and the Shire reached the Chinde mouth of the Zambesi on June 4.

JUDGE DALY, President of the American Geographical Society, devoted his anniversary address, which has just been published, to a critical study of the portraits of Columbus. He believes that several of those popularly held to be authentic are really original paintings from the life, but the Lotto portrait which has been multiplied indefinitely by the United States Government on commemoration coins and postage stamps he looks on as of very doubtful value.

MR. CARL LUMHOLTZ publishes a letter from North Mexico in the last number of the *Bulletin* of the American Geographical Society, in which he gives some account of his studies of the Tarahumare Indians, who are cave-dwellers although not apparently connected with the ancient cave and cliff-dwellers of the United States. Mr. Lumholtz was engaged in taking down the language, and in making anthropometric measurements of this little-known tribe.

THE French weekly geographical paper, *La Géographie*, has, after five years in the ordinary garb of a newspaper, assumed a new form, each number consisting of eight quarto pages in a coloured wrapper.

MR. H. YULE OLDHAM, Lecturer on Geography in Owens College, Manchester, has been appointed to the lectureship on Geography in the University of Cambridge, formerly held by Mr. J. Y. Buchanan, F.R.S. Mr. Oldham has mainly studied the historical aspects of geography, and in his appointment the University of Cambridge obviously intends to associate its geographical teaching with the Historical rather than the Natural Science Board of Studies. It is to be hoped that the lectureship will receive more attention from the members of the University than has been given to it hitherto, and that the loss to scientific geography caused by Mr. Buchanan's retirement will be more than made up by increased interest in the less specialised aspects of the science.

MR. H. M. CADELL gives a remarkably interesting map of the site of Edinburgh in prehistoric times in the June number of the *Scottish Geographical Magazine*. The most noteworthy feature is the submergence of the 25 feet raised beach on which the greater part of Leith is now built, and the existence of seven comparatively large lakes of which the shrunken remnants only remain, or which have been entirely drained and reclaimed within the historic period. A summary of the evidence for the existence of these lakes is given in the form of a short article. It is noteworthy that the changes in the surface of the land due to cultivation and building operations have in some cases almost entirely concealed the original features. In the early human period the shores of the Firth of Forth must have been occupied by a succession of swampy lakes dominated by the steep cliffs of the volcanic hills.

SEISMOLOGY IN JAPAN.[1]

THE editor insists in a Wordsworthian manner on calling this the seventeenth volume although it is really vol. i. of the journal: he numbers it as a continuation of publications hitherto issued as the Transactions of the Seismological Society of Japan. The Society was founded in 1880 and for many years its meetings were frequent and well attended. It ceased to live in so far as subscriptions and meetings are concerned in 1892, many of its members having left the country. It may now be said to exist as much as ever it did, but without subscriptions. The transactions are in sixteen volumes of scientific papers to which a general index is published in this first number of the journal, and there can be no doubt of the great value of these papers, or of the ability and industry in experiment and speculation of the men who wrote them. During the twelve years' work of the Society much was accomplished; some order was evolved out of chaos; seismographs have been invented giving absolute measurements of earth motions, and a complete change has been effected in earthquake observation; a chair of seismology has been established in the Imperial University and there is now a bureau controlling a central observatory and some 700 outside stations, together with many seismological laboratories. This is some of the work which the Society has done.

The first paper in this journal "On the Mitigation of Earthquake Effects, and Certain Experiments on Earth Physics" by the editor, reads very strangely to any one unacquainted with the work done by Prof. Milne in the last fifteen years. For example, on the construction of buildings in earthquake countries, his experiments have led to such results that he can speak with certainty on things which used to be merely matters of vague speculation, such as the security given by depth of foundation and the great differences in the earth motions at places within a few hundred yards of one another.

Probably no one can speak with greater authority on photographic matters than Prof. Burton, who contributes an article "On the Application of Photography to Seismology and Volcanic Phenomena." The other papers are:—An abstract of "The Seismometrical Observations for the year 1890," by the editor; "An Account of Experiments on the Overturning and Fracturing of Brick and other Columns by Horizontally Applied Motion," by the editor and Prof. Omori; "On Earth Pulsations in relation to certain Natural Phenomena and Physical Investigations," by the editor; an abstract on observations by Dr. E. Von Rebeur-Paschwitz with horizontal pendulums; a note on old Chinese earthquakes, by Prof. Omori, and a note by the editor on the destructive earthquake of 1891. All these papers seem to me to be valuable and interesting; they ought to be studied by every young philosopher whose mathematical and other weapons are ready, but who is yet without mental employment. The subject is one of world-wide interest, although it may seem to be only interesting to people like the Japanese who are jogged into attention every week of their lives.

[1] *The Seismological Journal of Japan*, edited by John Milne, F.R.S. Vol. xvii. 1893.

The beautiful series of photographs published by Burton and Milne about a year ago are records that can never be branded as lies or exaggerations. Even Dr. Johnson, who to his dying day denied the fact that an earthquake had occurred at Lisbon, would have been convinced by records such as these. Without these photographs it would be difficult to believe in the actual compression in area of land over a large district or in vertical wave motion, travelling along a street as if the earth were water in a canal. The Japanese cannot neglect the study of the subject and other people ought not. Our time also may come, even in England, when in a five seconds interval, three fourths of all the houses in London may tumble into ruin and a quarter of a million sterling may be lost on every square mile of English ground. It is of no use to argue from the long histories of ancient cities. Earth shakes that had no evil effect on the more or less pyramidal architecture of Assyria and Egypt would lay the dwelling houses of London in long swathes upon the ground. One laughs at Alice's White Knight who was so well prepared for sharks, but we also laugh at Mrs. Aleslime whose specific in the real time of danger was "black stockings for sharks." Whatever our own safety may be we must remember that some of the most interesting parts of the world are vitally interested in this question, and the most artistic, most honest, most kindly, most generous and confiding clever people that the world has ever seen are demanding from us that we shall study this question to find out whatever means there may be for mitigating the effects of earthquakes, and more than all, taking away from them the dreadful everpresent feeling of danger, which seems in itself almost sufficient to arrest progress in civilisation.

We western people were till lately represented in Japan on this question by the Seismological Society. What one earnest worker and a few of his friends can do is being done, but in spite of earnestness and devotion, I am afraid that in one respect there must be a lessened result. The existence of the Society was of some weight in maintaining the interest of the Japanese Government on what must seem to non-scientific people a rather hopeless search for information. Even the small and exceedingly intermittent assistance of the British Association grant is of enormous moral value to Prof. Milne; and I think that if the council at Edinburgh had yielded to the representations of section A and granted the modest request of Prof. Milne for £25, they would have done more good than they can do with any equal sum in their present list. We have here a man who is untiring in experimental work, who has the power of keeping enthusiasm alive in other people to a remarkable degree, who is not a wealthy man and who yet spends some hundreds of pounds a year of his own, in making and using apparatus and in publishing a journal which has about seventeen subscribers. And all the work is good; it is thankless work as all work on the beginning of a science must be.

If every reader of NATURE who is interested in the matter and who can afford it, would only send to Prof. Milne a subscription (one pound a year) to this journal, his losses would be confined to his experimental work; the Japanese Government would more certainly continue to interest its officials in making observations, and the subscribers would glow in the consciousness of having done their duty. JOHN PERRY.

ON LIGHT AND OTHER HIGH FREQUENCY PHENOMENA.[1]

BRILLIANTLY worded, comprehensive, and strikingly illustrated was a lecture delivered by Mr. Nikola Tesla, of which a report has just reached us. In his own words:—

[1] A lecture delivered before the Franklin Institute, at Philadelphia, Feb. 24, 1893, and before the National Electric Light Association, at St. Louis, Mo., March 1, 1893.

"In presenting these insignificant results I have not attempted to arrange and co-ordinate them as would be proper in a strictly scientific investigation in which every succeeding result should be a logical sequence of the preceding, so that it might be guessed in advance by the careful reader or attentive listener. I have preferred to concentrate my energies chiefly upon advancing novel facts or ideas which might serve as suggestions to others, and this may serve as an excuse for the lack of harmony. The explanations of the phenomena have been given in good faith, and in the spirit of a student prepared to find that they admit of a better interpretation. There can be no great harm in a student taking an erroneous view, but when great minds err, the world must dearly pay for their mistakes."

The following extracts will serve to show the character of the discourse :—

The Action of the Eye.

It can be taken as a fact, which the theory of the action of the eye implies, that for each external impression, that is, for each image produced upon the retina, the ends of the visual nerves concerned in the conveyance of the impression to the mind, must be under a peculiar stress or in a vibratory state. It now does not seem improbable that, when by the power of thought an image is evoked, a distinct reflex action, no matter how weak, is exerted upon certain ends of the visual nerves, and therefore upon the retina. Will it ever be within human power to analyse the condition of the retina when disturbed by thought or reflex action, by the help of some optical or other means of such sensitiveness, that a clear idea of its state might be gained at any time? If this were possible, then the problem of reading one's thoughts with precision, like the characters of an open book, might be much easier to solve than many problems belonging to the domain of positive physical science, in the solution of which many, if not the majority, of scientific men implicitly believe. Helmholtz has shown that the fundi of the eyes are themselves luminous, and he was able to *see*, in total darkness, the movement of his arm by the light of his own eyes. This is one of the most remarkable experiments recorded in the history of science, and probably only a few men could satisfactorily repeat it, for it is very likely that the luminosity of the eyes is associated with uncommon activity of the brain and great imaginative power. It is fluorescence of brain action, as it were.

Another fact having a bearing on this subject which has probably been noted by many, since it is stated in popular expressions, but which I cannot recollect to have found chronicled as a positive result of observation is, that at times, when a sudden idea or image presents itself to the intellect, there is a distinct and sometimes painful sensation of luminosity produced in the eye, observable even in broad daylight.

Two facts about the eye must forcibly impress the mind of the physicist, notwithstanding he may think or say that it is an imperfect optical instrument, forgetting that the very conception of that which is perfect or seems so to him, has been gained through this same instrument. Firstly, the eye is, as far as our positive knowledge goes, the only organ which is *directly* affected by that subtile medium, which, as science teaches us, must fill all space; secondly, it is the most sensitive of our organs, incomparably more sensitive to external impressions than any other.

This divine organ of sight, this indispensable instrument for thought and all intellectual enjoyment, which lays open to us the marvels of this universe, through which we have acquired what knowledge we possess, and which prompts us to, and controls, all our physical and mental activity. By what is it affected? By light! What is light?

It is beyond the scope of my lecture to dwell upon the subject of light in general, my object being merely to bring presently to your notice a certain class of light effects and a number of phenomena observed in pursuing the study of these effects. But to be consistent in my remarks it is necessary to state that according to that idea, now accepted by the majority of scientific men as a positive result of theoretical and experimental investigation, the various forms of manifestations of energy which were generally designated as "electric" or more precisely "electromagnetic" are energy manifestations of the same nature as those of radiant heat and light. Therefore the phenomena of light and heat, and others besides these, may be called electrical phenomena. Thus electrical science has become the mother science of all and its study has become all-important. The day when we shall know exactly what "electricity" is, will chronicle an event probably greater, more important than any other recorded in the history of the human race.

Transformation of Currents.

Mr. Tesla then went on to describe the apparatus employed, and the method of obtaining the high potentials and high frequency currents which are made use of in his experiments. In order to explain the transformation of currents he used the following analogy :—

Imagine a tank with a wide opening at the bottom, which is kept closed by spring pressure, but so that it snaps off *suddenly* when the liquid in the tank has reached a certain height. Let the fluid be supplied to the tank by means of a pipe feeding at a certain rate. When the critical height of the liquid is reached, the spring gives way and the bottom of the tank drops out. Instantly the liquid falls through the wide opening, and the spring, reasserting itself, closes the bottom again. The tank is now filled, and after a certain time interval the same process is repeated. It is clear that if the pipe feeds the fluid quicker than the bottom outlet is capable of letting it pass through, the bottom will remain off and the tank will still overflow. If the rates of supply are exactly equal, then the bottom lid will remain partially open, and no vibration of the same and of the liquid column will generally occur, though it might, if started by some means. But if the inlet pipe does not feed the fluid fast enough for the outlet, then there will be always vibration. Again, in such case, each time the bottom flaps up or down, the spring and the liquid column, if the pliability of the spring and the inertia of the moving parts are properly chosen, will perform independent vibrations. In this analogue the fluid may be likened to electricity or electrical energy, the tank to the condenser, the spring to the dielectric, and the pipe to the conductor through which electricity is supplied to the condenser. To make this analogy quite complete it is necessary to make the assumption, that the bottom, each time it gives way, is knocked violently against a non-elastic stop, this impact involving some loss of energy, and that, besides, some dissipation of energy results, due to frictional losses. In the preceding analogue the liquid is supposed to be under a steady pressure. If the pressure of the fluid be assumed to vary rhythmically, this may be taken as corresponding to the case of an alternating current. The process is then not quite as simple to consider, but the action is the same in principle.

Electrostatic Force.

After showing that the human body could be traversed by a powerful electric current vibrating at about the rate of one million times per second, Mr. Tesla said :—

The amount of energy which may thus be passed into the body of a person depends on the frequency and potential of the currents, and by making both of these very great, a vast amount of energy may be passed into the body without causing any discomfort except perhaps in the arm, which is traversed by a true conduction current. The reason why no pain in the body is felt, and no injurious effect noted, is that everywhere, if a current be imagined to flow through the body, the direction of its flow would be at right angles to the surface; hence the body of the experimenter offers an enormous section to the current, and the density is very small, with the exception of the arm perhaps, where the density may be considerable. But if only a small fraction of that energy would be applied in such a way that a current would traverse the body in the same manner as a low frequency current, a shock would be received which might be fatal. A direct or low-frequency alternating current is fatal I think, principally because its distribution through the body is not uniform, as it must divide itself in minute streamlets of great density, whereby some organs are vitally injured. That such a process occurs I have not the least doubt, though no evidence might apparently exist or be found upon examination. The surest to injure and destroy life is a continuous current, but the most painful is an alternating current of very low frequency. The expression of these views, which are the result of long-continued experiment and observation, both with steady and varying currents, is elicited by the interest which is at present taken in this subject and by the manifestly erroneous ideas which are daily propounded in journals on this subject.

The electrostatic attractions and repulsions between bodies of measurable dimensions are, of all the manifestations of this force, the first so-called *electrical* phenomena noted. But though they have been known to us for many centuries, the precise nature of the mechanism concerned in these actions is still unknown to us, and has not been even quite satisfactorily explained. What kind of mechanism must that be? We cannot help wondering when we observe two magnets attracting and repelling each other with a force of hundreds of pounds with apparently nothing between them. We have in our commercial dynamos magnets capable of sustaining in mid-air tons of weight. But what are even these forces acting between magnets when compared with the tremendous attractions and repulsions produced by electrostatic force, to which there is apparently no limit as to intensity. In lightning discharges bodies are often charged to so high a potential that they are thrown away with inconceivable force and torn asunder or shattered into fragments. Still even such effects cannot compare with the attractions and repulsions which exist between charged molecules or atoms, and which are sufficient to project them with speeds of many kilometres a second so that under their violent impact bodies are rendered highly incandescent and are volatilized. It is of special interest for the thinker who inquires into the nature of these forces to note, that whereas the actions between individual molecules or atoms occur seemingly under any condition, the attractions and repulsions of bodies of measurable dimensions imply a medium possessing insulating properties. So, if air, either by being rarefied or heated, is rendered more or less conducting, these actions between two electrified bodies practically cease, while the actions between the individual atoms continue to manifest themselves.

Single-wire Transmission.

It has been for a long time customary, owing to the limited experience with vibratory currents, to consider an electric current as something circulating in a closed conducting path. It was astonishing at first to realise that a current may flow through the conducting path even if the latter be interrupted, and it was still more surprising to learn, that sometimes it may be even easier to make a current flow under such conditions than through a closed path. But that old idea is gradually disappearing, even among practical men, and will soon be entirely forgotten.

It is thought useful to devote here a few remarks to the subject of operating devices of all kinds by means of only one leading wire. It is quite obvious, that when high-frequency currents are made use of, ground connections are — at least, when the E.M.F. of the currents is great—better than a return wire. Such ground connections are objectionable with steady or low frequency currents on account of destructive chemical actions of the former and disturbing influences exerted by both on the neighbouring circuits; but with high frequencies these actions practically do not exist. Still, even ground connections become superfluous when the E.M.F. is very high, for soon a condition is reached when the current may be passed more economically through open, than through closed conductors. Remote as might seem an industrial application of such single wire transmission of energy to one not experienced in such lines of experiment, it will not seem so to any one who for some time has carried on investigations of such nature. Indeed I cannot see why such a plan should not be practicable. Nor should it be thought that for carrying at such a plan currents of very high frequency are implicitly required, for just as soon as potentials of say 30,000 volts are used, the single wire transmission may be effected with low frequencies, and experiments have been made by me from which these inferences are made.

Electrical Resonance.

Some remarks and experiments were then made with regard to electrical resonance. Continuing, Mr. Tesla said:—

In connection with resonance effects and the problem of transmission of energy over a single conductor which was previously considered, I would say a few words on a subject which constantly fills my thoughts and which concerns the welfare of all. I mean the transmission of intelligible signals or perhaps even power to any distance without the use of wires. I am becoming daily more convinced of the practicability of the scheme, and though I know full well that the great majority of scientific men will not believe that such results can be practically and immediately realised, yet I think that all consider the developments in recent years by a number of workers to have been such as to encourage thought and experiment in this direction. My conviction has grown so strong that I no longer look upon this plan of energy or intelligence transmission as a mere theoretical possibility, but as a serious problem in electrical engineering, which must be carried out some day. The idea of transmitting intelligence without wires is the natural outcome of the most recent results of electrical investigations. Some enthusiasts have expressed their belief that telephony to any distance by induction through the air is possible. I cannot stretch my imagination so far, but I do firmly believe that it is practicable to disturb by means of powerful machines the electrostatic condition of the earth, and thus transmit intelligible signals and perhaps power. In fact, what is there against the carrying out of such a scheme? We now know that electric vibration may be transmitted through a single conductor. Why then not try to avail ourselves of the earth for this purpose? We need not be frightened by the idea of distance. To the weary wanderer counting the mile-posts the earth may appear very large, but to that happiest of all men, the astronomer, who gazes at the heavens and by their standard judges the magnitude of our globe, it appears very small. And so, I think, it must seem to the electrician, for when he considers the speed with which an electric disturbance is propagated through the earth all his ideas of distance must completely vanish.

A point of great importance would be first to know what is the capacity of the earth? and what charge does it contain if electrified? Though we have no positive evidence of a charged body existing in space without other oppositely electrified bodies being near, there is a fair probability that the earth is such a body, for by whatever process it was separated from other bodies—and this is the accepted view of its origin—it must have retained a charge, as occurs in all processes of mechanical separation. If it be a charged body insulated in space its capacity should be extremely small, less than one-thousandth of a farad. But the upper strata of the air are conducting, and so, perhaps, is the medium in free space beyond the atmosphere, and these may contain an opposite charge. Then the capacity might be incomparably greater. In any case it is of the greatest importance to get an idea of what quantity of electricity the earth contains. It is difficult to say whether we shall ever acquire this necessary knowledge, but there is hope that we may, and that is by means of electrical resonance. If ever we can ascertain at what period the earth's charge, when disturbed, oscillates with respect to an oppositely electrified system or known circuit, we shall know a fact possibly of the greatest importance to the welfare of the human race. I propose to seek for the period by means of an electrical oscillator, or a source of alternating electric currents. One of the terminals of the source would be connected to earth, as, for instance, to the city water mains, the other to an insulated body of large surface. It is possible that the outer conducting air strata or free space contains an opposite charge and that, together with the earth, they form a condenser of very large capacity. In such case the period of vibration may be very low and an alternating dynamo machine might serve for the purpose of the experiment. I would then transform the current to a potential as high as it would be found possible and connect the ends of the high tension secondary to the ground and to the insulated body. By varying the frequency of the currents and carefully observing the potential of the insulated body and watching for the disturbance at various neighbouring points of the earth's surface resonance might be detected. Should, as the majority of scientific men in all probability believe, the period be extremely small, then a dynamo machine would not do and a proper electrical oscillator would have to be produced and perhaps it might not be possible to obtain such rapid vibrations. But whether this be possible or not, and whether the earth contains a charge or not, and whatever may be its period of vibration, it certainly is possible—for of this we have daily evidence—to produce some electrical disturbance sufficiently powerful to be perceptible by suitable instruments at any point of the earth's surface.

Production of Light.

The light effects which it has been the chief object to investigate can be divided into four classes: (1) Incandescence of a solid. (2) Phosphorescence. (3) Incandescence or phosphorescence of a rarefied gas, and (4) Luminosity produced in a gas at ordinary pressure. The first question is, How are these luminous effects produced? In order to answer this question as satisfactorily as I am able to do in the light of accepted views and with the experience acquired, and to add some interest to this demonstration, I shall dwell here upon a feature which I consider of great importance, inasmuch as it promises, besides, to throw a better light upon the nature of most of the phenomena produced by high frequency electric currents. I have on other occasions pointed out the great importance of the presence of the rarefied gas, or atomic medium in general, around the conductor through which alternate currents of high frequency are passed, as regards the heating of the conductor by the currents. My experiments described some time ago have shown that the higher the frequency and potential difference of the currents, the more important becomes the rarefied gas in which the conductor is immersed, as a factor of the heating. The potential difference, however, is, as I then pointed out, a more important element than the frequency. When both of these are sufficiently high, the heating may be almost entirely due to the presence of the rarefied gas. [Experiments were performed showing the importance of the rarefied gas, or generally of gas at ordinary or other pressure as regards the incandescence or other luminous effects produced by currents of this kind.]

Incandescent Lamps.

Disregarding now the modifying effect of convection, there are two distinct causes which determine the incandescence of a wire or filament with varying currents, that is, conduction current and bombardment. With steady currents we have to deal only with the former of these two causes, and the heating effect is a minimum, since the resistance is least to steady flow. When the current is a varying one the resistance is greater, and hence the heating effect is increased. Thus if the rate of change of the current is very great, the resistance may increase to such an extent that the filament is brought to incandescence with inappreciable currents, and we are able to take a short and thick block of carbon or other material and bring it to bright incandescence with a current incomparably smaller than that required to bring to the same degree of incandescence an ordinary thin lamp filament with a steady or low frequency current. This result is important, and illustrates how rapidly our views on these subjects are changing, and how quickly our field of knowledge is extending. In the art of incandescent lighting, to view this result in one aspect only, it has been commonly considered as an essential requirement for practical success, that the lamp filament should should be thin and of high resistance. But now we know that the resistance to the steady flow of the filament does not mean anything; the filament might as well be short and thick; for if it be immersed in rarefied gas it will become incandescent by the passage of a small current. It all depends on the frequency and potential of the currents. We may conclude from this, that it would be of advantage, so far as the lamp is considered, to employ high frequencies for lighting, as they allow the use of short and thick filaments and smaller currents.

If a wire or filament be immersed in a homogeneous medium, all the heating is due to true conduction current, but if it be enclosed in an exhausted vessel the conditions are entirely different. Here the gas begins to act and the heating effect of the conduction current, as is shown in many experiments, may be very small compared with that of the bombardment. This is especially the case if the circuit is not closed and the potentials of course very high. Suppose a fine filament enclosed in an exhausted vessel be connected with one of its ends to the terminal of a high tension coil and with its other end to a large insulated plate. Though the circuit is not closed, the filament, as I have before shown, is brought to incandescence. If the frequency and potential be comparatively low, the filament is heated by the current passing *through* it. If the frequency and potential, and principally the latter, be increased, the insulated plate need be but very small, or may be done away with entirely; still the filament will become incandescent, practically all the heating being then due to the bombardment. . . . It should not be thought that only rarefied gas is an important factor in the heating of a conductor by varying currents, but gas at ordinary pressure may become important, if the potential difference and frequency of the currents is excessive. On this subject I have already stated, that when a conductor is fused by a stroke of lightning, the current through it may be exceedingly small, not even sufficient to heat the conductor perceptibly, were the latter immersed in a homogeneous medium.

From the preceding it is clear that when a conductor of high resistance is connected to the terminals of a source of high frequency currents of high potential, there may occur considerable dissipation of energy, principally on the ends of the conductor, in consequence of the action of the gas surrounding the conductor. Owing to this, the current through a section of the conductor at a point midway between its ends may be much smaller than through a section near the ends. Furthermore, the current passes principally through the outer portions of the conductor, but this effect is to be distinguished from the skin effect as ordinarily interpreted, for the latter would or should occur also in a continuous incompressible medium. If a great many incandescent lamps are connected in series to a source of such currents, the lamps at the ends may burn brightly, whereas those in the middle may remain entirely dark. This is due principally to bombardment, as before stated. But even if the currents be steady, provided the difference of potential is very great, the lamps at the ends may burn more brightly than those in the middle. In such case there is no rhythmical bombardment, and the result is produced entirely by leakage. This leakage or dissipation into space, when the tension is high, is considerable when incandescent lamps are used, and still more considerable with arcs, for the latter act like flames. Generally, of course, the dissipation is much smaller with steady than with varying currents.

Incandescence of Gases.

Coming now to the incandescence or phosphorescence of gases at low pressures or at the ordinary pressure of the atmosphere, we must seek the explanation of these phenomena in shocks or impacts of the atoms. Just as molecules or atoms beating upon a solid body excite phosphorescence in the same or render it incandescent, so when colliding among themselves they produce similar phenomena. But this is a very insufficient explanation, and concerns only the crude mechanism. Light is produced by vibrations which go on at a rate almost inconceivable. If we compute, from the energy contained in the form of known radiations in a definite space the force which is necessary to set up such rapid vibrations, we find, that though the density of the ether be incomparably smaller than that of any body we know, even hydrogen, the force is something surpassing comprehension. What is this force, which in mechanical measure, may amount to thousands of tons per square inch? It is electrostatic force in the light of modern views. It is impossible to conceive how a bod of measurable dimensions could be charged to so high a potential that the force would be sufficient to produce these vibrations. Long before any such charge could be imparted to the body it would be shattered into atoms. The sun emits light and heat, and so does an ordinary flame or incandescent filament, but in neither of these can the force be accounted for if it be assumed that it is associated with the body as a whole. Only in one way may we account for it, namely, by identifying it with the atom. An atom is so small, that if it be charged by coming in contact with an electrified body and the charge be assumed to follow the same law as in the case of bodies of measurable dimensions, it must retain a quantity of electricity which is fully capable of accounting for these forces and tremendous rates of vibration. But the atom behaves singularly in this respect, it always takes the same "charge."

It is very likely that resonant vibration plays a most important part in all manifestations of energy in nature. Throughout space all matter is vibrating, and all rates of vibration are represented, from the lowest musical note to the highest pitch of the chemical rays, hence an atom, or complex of atoms, no matter what its period, must find vibration with which it is in resonance. When we consider the enormous rapidity of the light vibrations, we realise the impossibility of producing such vibrations directly with any apparatus of measurable dimensions and we are driven to the only possible means of attaining the object of setting up waves of light by electrical means and economically, that is, to affect the molecules or atoms of a gas, to cause them to collide and vibrate.

Much would remain to be said about the luminous effects produced in gases at low or ordinary pressures. With the present experiences before us we cannot say that the essential nature of these charming phenomena is sufficiently known. But investigations in this direction are being pushed with exceptional ardour. Every line of scientific pursuit has its fascinations, but electrical investigation appears to possess a peculiar attraction, for there is no experiment or observation of any kind in the domain of this wonderful science which would not forcibly appeal to us. Some beautiful experiments with a vacuum tube concluded the lecture.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Observatory Syndicate have prepared a report with respect to the future work of the Cambridge Observatory.

They are of opinion that in the present condition of Astronomy provision must be made for photographic work, so that their inquiries have been directed to the discovery of the best scheme for rendering the Northumberland Equatorial available in connection with the project for a photographic establishment. The primary question as to the respective merits of reflectors and refractors for the photographic instrument had of course to be considered. On this issue there is considerable difference of opinion. For producing representations of astronomical objects, where great detail is required, reflectors are the most suitable. But where accurate measurement of the photographic plates is the object in view the balance of opinion seems clearly to show that the refractor is better adapted than the reflector. As it seems obvious that the work undertaken at the Cambridge Observatory should be based on accurate measurement the Syndicate have come to the conclusion that the refractor is the photographic telescope that should be employed. They think it right, however, to draw the attention of the University to the kindness of Mr. Common who offered to make and present to the Observatory a suitable silvered glass mirror if it were decided to employ the reflecting instrument.

It may be well to add that the Newall Telescope is devoted in the main to spectroscopic work and further that this instrument having been made for visual observation is not adapted to the special photographic work to which it is now proposed to direct the energies of the Observatory.

The scheme which the Syndicate suggest is that a new objective of eighteen inches aperture corrected for the photographic rays be provided ; that the focal length of this should be about the same as that of the Northumberland objective, for which a new tube will be required ; and that the two objectives, united as a pair like the present instruments at Greenwich and Oxford, should be erected on a new mounting, under a new dome, in the building at present occupied by the Northumberland Equatorial.

It will be observed that, by this scheme, the Northumberland objective will still be useful for every purpose for which it has been hitherto employed, with the great additional advantages of an excellent mounting and a good clock work. For example, such observations of comets as have been previously made here can be conducted under circumstances of much greater convenience than before. As to the special work to be undertaken by photography, it appears to the Syndicate that for the present under the particular conditions in which work here can be conducted there is no subject so promising as stellar parallax. The Director of the Observatory desires to undertake a systematic search with the aid of photography for stars which have measurable parallax, and of course so complete an apparatus as is now proposed would be available for many other researches besides that just suggested.

A preliminary estimate for the new telescope and mounting complete makes the cost £2450. To this must be added £500 for the new dome, and £150 for the measuring apparatus. If £100 be added for extras this makes a total of £3200. There is now a sum of about £1500 in the Special Sheepshanks Fund available for the purchase of instruments. In view of future contingencies, to exhaust the Sheepshanks Fund would be unadvisable and indeed it would not suffice for the purchase of an 18-inch equatorial. As such an instrument would contribute largely to the astronomical services of the Observatory the Syndicate think that an appeal to the public for subscriptions would probably be successful and such an appeal they are prepared to make.

It is therefore recommended that they be authorised to obtain estimates and plans for a new instrument as above described.

Dr. Hill, Master of Downing College, has been appointed a representative of the University at the International Medical Congress to be held at Rome next September.

SCIENTIFIC SERIALS.

American Meteorological Journal, May.—The following are the principal meteorological articles :—Meteorology as the physics of the atmosphere, by Prof. W. v. Bezold. This is a translation by Prof. C. Abbe of the first part of an important paper from *Himmel und Erde*. It describes the problems which at present are the subject of theoretical investigation, and points out what new problems have grown from looking at observational meteorology from a theoretical point of view. During the last decade attention has been chiefly devoted to the development of the so-called convection theory, which is principally based on observations at the earth's surface, but which, at higher elevations, is found to have defects. It has therefore become necessary to try and connect this theory with that of the old trade-wind theory, which for several decades has been entirely set aside. More attention is required to observations made in the higher regions of the atmosphere, together with the application to them of the principles of general mechanics, as well as of thermo-dynamics.—Charts of storm frequency, by Prof. Abbe. The author has plotted in a tabular form the number of storm centres that pass over each quadrangular degree between lat. 20° and 49° N., and long. 99° and 63° W., deduced from the tri-daily Signal Service charts, from March, 1871, to February, 1873. He states that the chart from which the table is prepared clearly shows that the storm tracks, which move from Alberta and Assinniboin south-eastward over the United States and then north-eastward towards the gulf of St. Lawrence, describe a system of parabolic curves whose tendency is to have a common point of intersection, and therefore a region of maximum storm frequency, in, or to the north-west of Nebraska.—Six and seven day weather periodicities, by H. H. Clayton. The author, who has studied the subjects of periodicities for several years, found a striking regularity between the intervals of many of the temperature maxima of the Blue Hill observations, and that almost all the maxima could be arranged in such a way that they followed each other at intervals of six or seven days. He thinks that, for a large part of the year, forecasts of temperature, on the assumption of regular rhythmic oscillations, and a knowledge of the time of their beginning and ending, may be made for a week or two in advance with nearly as much accuracy as they are now made by the Weather Bureau for thirty-six hours.

American Journal of Mathematics, vol. xv., No. 2. (Baltimore, April, 1893).—The opening memoir is one entitled "Hyperelliptische Schnittsysteme und Zusammenordnung der Algebraischen und Transcendentalen Thetacharacteristiken," by H. D. Thompson (pp. 91–123). There are numerous figures and an index of contents.—On the determination of groups whose order is a power of a prime, by J. W. A. Young (pp. 124–178), considers in some detail groups of the order specified in extension of the work on groups by Cayley (*Am. J. of Math.*, vol. i.), Kempe (*Phil. Trans.*, vol. clxxvii.), Netto (Substitutionentheorie, pp. 133–7), and Kronecker. The author's aim has been "to presuppose no knowledge of the theory of groups on the part of the reader."—The third paper, the projection of fourfold figures upon a three-flat, by T. P. Hall (pp. 179–189), is an interesting contribution to the literature of higher space, and the last page (190) contains a note on a geometrical theorem by C. N. Little. It gives a property of a Pascal line, and a Brianchon point of 6 gons formed in a specified manner.

Wiedemann's Annalen der Physik und Chemie, No. 5.—On electrical discharges : production of electrical oscillations and their relation to discharge tubes, by H. Ebert and E. Wiedemann. This portion of the work investigates the manner in which the properties of the conducting circuit determine the sensibility of the discharge-tube when placed in a given position with regard to the terminal condenser. Among the conditions thus studied were the distance between the plates of the primary condenser, the D.P. in the primary spark-gap, and the frequency of the sparks ; also the influence of bridges across the wire system, the D.P. required to make the tubes glow, and the effects of the presence of other glowing tubes in the field. As regards the last, it was found that if a glowing gas was present in a portion of the condenser field the distribution of energy was quite different from that in a homogeneous field ; the tubes of energy were attracted towards the gas and passed through it, showing that the gas in the state of glow has a greater permeability for the electric flux.—On the diffraction of light at the straight sharp edge of a screen, by Eugen Maey. This work was undertaken to test whether a certain diffraction phenomenon was explainable by the accepted theory of diffraction. The phenomenon in question, as described by W. Wien, consists in the fact that a finely-ground metallic edge, when illuminated by an intense white light, appears as a bright line from points deep in the geometrical shadow. A careful theoretical and experimental study of the phenomenon shows that the theory is competent to explain the fact within certain limits, but that the phenomenon is greatly influenced by small differences of excellence in the edges, a circumstance which has an important bearing upon the behaviour of gratings.—Absolute measurements on the discharge of electricity from points, by Julius Precht. In general, points may be charged highly before discharge begins. Lightning conductors require about 15,000 volts, and the finest points 2500. Ultra-violet illumination favours discharge, whereas dust and flame gases diminish it. A bundle of equal points requires a higher potential than a single one. A point discharging positive electricity wears away, whilst a point negatively electrified does not.—Also papers by O. Wiener, J. von Geitler, M. Levy, A. Kossel, and A. Raps.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 4.—"Further Experimental Note on the Correlation of Action of Antagonistic Muscles." By C. S. Sherrington, M.A., M.D.

In a previous communication (Proceedings of Royal Society, February 1, 1893) it was stated that physiological contraction, and even mere mechanical tension, of the *flexor muscles* of the knee exerts considerable physiological influence upon the activity of the antagonistic group of muscles, the *extensors*. For instance, the elicitation of the "jerk" from the extensors can be rendered difficult for a time by appropriate excitation of the flexors, and can on the other hand be much facilitated by flaccidity or paralysis of the latter.

In order to judge whether under these circumstances the briskness of the "knee-jerk" varies directly with the degree of tonus of the extensor muscles, the rapidity of onset of rigor mortis, has been chosen as a guide to the degree of tonus existing in them before death. The experiments of Brown-Séquard and Hermann have proved that section of the nerve supplying a muscle delays the time of onset of rigor mortis in the muscle, even if the section is performed only shortly before death. There was therefore examined the influence of section of the motor spinal roots on the time of onset of rigor mortis, and a delay of onset of rigor mortis was thus produced. The delay seemed as considerable as after section of the entire muscular nerve. The effect of section of the sensory roots was next examined, and found to be marked retardation of onset of rigor; the retardation was less if the spinal cord were previously severed in the region of the first lumbar segment. The effect of placing and keeping one hind limb in the pose most favourable for the elicitation of the "jerk" (knee flexed) and the other limb in the position in which the jerk is restrained (knee extended) was then investigated (always after previous severance of the spinal cord at the first lumbar segment). On the side on which the knee had been kept flexed the onset of rigor mortis was delayed in the extensor muscles, whereas on the opposite side, with the knee extended rigor was delayed in the flexors. It was inferred that the tonus of extensors is heightened by excitation of the antagonistic set, and conversely.

In regard to the mutual association of action of antagonistic muscles about other joints than the knee, it had been noticed in an earlier series of observations that during excitation of the cortical areas of the hemisphere, when isolated movements of the pollex and hallux are being initiated, the movement of response obtained is often reversed by section of the peripheral nerve or nerves supplying those muscles which predominate in the movement obtained. For example, flexion can by section of the flexor nerve be at once converted into extension. Sometimes, however, movement in the same sense, although diminished in force and extent persists even after cutting the nerve to the predominant group of the antagonistic muscles. This indicates that in some cases there occurs, together with contraction of one group of muscles, concomitant relaxation of the antagonist. This evidence of inhibition of one set of the synergetic muscular couple during co-ordinate action induced by cortical excitation is in the case of the digits of comparatively infrequent occurrence. In the case of the eye muscles it is, on the contrary, quite usual.

When, the external rectus muscle of one eye (*e.g.*, of the left eye) having been put out of action, the frontal cortex of the right hemisphere is excited, the eyeballs if previously directed to the right revert both of them to the left—*i.e.*, the excitation which evokes contraction of the right internal rectus evokes also relaxation of the left internal rectus. Again, when the internal rectus has been put out of action—*e.g.*, in the left eye—excitation of the left frontal cortex produces, if the eyes have been previously directed to the left, an immediate movement of both eyeballs to the right, the left eye frequently rotating beyond the median primary position. Here the same excitation of the cortex which induces contraction of right external rectus muscles induces synchronously a relaxation of the left internal rectus muscle. These interruptions of the tonus or of the contraction of one antagonist concurrently with augmentation of the contraction of its opponent are obtainable not only from the so-called "motor" region of the cortex, but even more strikingly by excitation of the "visual area" of occipital region of the cortex.

During voluntary movements similar phenomena occur, but appear less obvious than under experimental excitation of the cortex. Although inhibition of contraction or tonus is apparently so common a factor in the co-ordination of the antagonistic lateral straight muscles of the eyes, these muscles occasionally yield good indication of synergetic contraction as well as co-ordinate relaxation. The mutual association of the two oblique muscles seems usually of the nature of concomitant contraction, not of contraction coupled with relaxation. On the other hand, the muscles which close and open the palpebral fissure appear to work altogether independently one of the other. In their case section of the particular peripheral nerve concerned in either movement is at once followed by total disappearance of the movement, and that without reversal.

Although the cerebral cortex exercises inhibition so readily in the field of innervation of the third nerve, the dilatation of the pupil evoked by excitation of that portion of the cortex appeared whenever tested to be due to impulses discharged *viâ* the cervical sympathetic, and not to inhibition of the constriction exercised *viâ* the third nerve.

May 18.—"An Experimental Investigation of the Nerve Roots which enter into the Formation of the Lumbo-Sacral Plexus of *Macacus rhesus*." By J. S. Risien Russell, M.B., M.R.C.P., Assistant Physician to the Metropolitan Hospital.

(From the Pathological Laboratory of University College, London.)

This formed the subject of a paper recently read before the Royal Society, in which the author described one chief type of plexus met with in *Macacus rhesus*, the main distinguishing features of which, as contrasted with the chief variation encountered, consisted in the fifth lumbar nerve root sending a branch to the sciatic nerve trunk, and the obturator nerve taking its origin from the fourth and fifth lumbar nerve roots alone, whereas of the variations met with that which occurred most frequently was one in which the fifth lumbar root did not send a branch to the sciatic nerve, and the obturator nerve received a branch from the sixth lumbar nerve root in addition to those received from the fourth and fifth lumbar roots. Between these two extremes all forms of variation were met with; but the upper limit of supply to the limb was always found to be the third lumbar root, and the lower limit the first sacral root.

Excitation Experiments.

The movement which results on excitation of any given nerve root with the Faradic current is a compound one made up of several simple movements; while excitation of any single small bundle of nerve fibres, many of which combine to form a nerve root, results in a single simple movement, and not all the movements of the compound root in lessened degree. These single simple movements bear an almost constant relation to the nerve roots, the same movements being as a rule found in any given root, and such movements always bear the same relation to the spinal level. Further, each bundle of nerve fibres representing a single simple movement in a nerve root remains distinct in its course to the muscle or muscles, producing such a movement without inosculating with other motor nerve fibres.

Muscles diametrically opposed in their action are represented in the same nerve root, but in different degrees, and when a certain group of muscles predominate in their action in one root they as a rule predominate in that root. In those instances in which the opposed movements are represented in three consecutive nerve roots the middle root of the series is that in which both movements are represented, while the root above contains the one movement, and that below contains the other.

The movements of flexion and extension are found to alternate in their representation from above down, flexion being at a higher level than extension in the highest segment of the limb, while extension is above flexion in the next, and so on.

A muscle is usually represented in two nerve roots, and to an unequal extent in these; and when variations occur, it is, as a rule, that one of the nerve roots in which the muscle is represented is different, rather than that it is represented in more nerve roots. When the same muscle is represented in two nerve roots the muscle fibres innervated by one root are not innervated by the other, so that only part of the muscle contracts when a single root is excited.

Ablation Experiments.

Division of any given nerve root produces paresis of the group of muscles supplied by it, which paresis is temporary, nearly all of it being recovered from. The amount of paresis or paralysis produced is proportional to the number of nerve roots divided; and this again varies according to whether the roots divided are consecutive or alternate ones, the effect being much greater in the former than in the latter case. Such division of one or more nerve roots does not result in incoordination of the remaining muscular combinations represented in other nerve roots; the remaining movements are merely more feeble.

Exclusion of a certain Root or Roots during an Epileptic Convulsion in the Limb.

Division of one or more nerve roots produces alteration of the position of a limb during an epileptic convulsion, which altered position depends on the muscular combinations that have been thus thrown out of action. And the effect is identical when the root or roots are divided at the time when the convulsions are evoked, and when they have been divided some weeks previously. No incoordination is produced in the remaining muscular combinations; and there is no evidence of overflow of the impulses which ought to travel down the divided root into other channels through the spinal centres, so as to reach the muscles by new paths.

"A Further Minute Analysis by Electric Stimulation of the so-called Motor Region (Facial Area) of the Cortex Cerebri in the Monkey (*Macacus sinicus*)." By Charles E. Beevor, M.D., F.R.C.P., and Victor Horsley, M.B., F.R.C.S., F.R.S. [1]

(From the Laboratory of the Brown Institution, and from the Pathological Department of University College, London.)

In the paper of which this is an abstract the authors have completed the minute analysis of the movements elicited by excitation of the excitable (so-called motor) region of the cortex cerebri in the Bonnet Monkey (*Macacus sinicus*). The portions hitherto examined having been those in which the movements of the limbs were represented, the facial area was chosen for the present research. After an historical introduction and a description of the anatomy of the region investigated, the method of notation and record of results is discussed.

Considering that in this part of the cortex cerebri there is well-defined representation of movements of both sides of the body, the question of bilaterality of representation is raised, and attention directed to its importance. The analysis of the results obtained show that there existed precise localisation for the movements of the individual portions of the face, even to that of half the lower lip.

The specialisation of the movements of the tongue was rendered easy of examination by employing the operative device of dividing the tongue in the middle line. This shed unexpected light on the representation of the movements of this organ.

Movements of the pharynx were made the subject of observation, and some degree of unilaterality was discovered in the movements of the soft palate.

Finally, attention is drawn to the fact that the marches of movements in succession are in this region very inconstant and difficult to arrange.

[1] The expenses of this research were defrayed principally by a grant from the Government Grant Fund of the Royal Society, and in part by a grant from the Scientific Grants Committee of the British Medical Association.

"On the presence of Urea in the Blood of Birds, and its bearing upon the Formation of Uric Acid in the Animal Body." By Sir Alfred Garrod, M.D., F.R.S.

The author gives in his paper a *résumé* of the opinions held with regard to the formation of uric acid in the animal economy during the last half century, and then announces his discovery of the presence of urea in the blood of birds in quantities practically the same as that which is present in the mammalian blood; by which discovery the views hitherto held as to the formation of uric acid are necessarily modified. Having afterwards shown that the kidneys have no power of removing uric acid from blood, and referred to other physiological points in connection with uric acid and urea, he sums up most of his views in the following propositions:—

First. That in mammalia and other urea-excreting animals the metabolism of the nitrogenised tissues results in the formation of urea as an ultimate product; that an appreciable and measurable amount of this substance is always found in their blood, and is constantly being excreted by the kidneys; and, further, that any cause leading to the decrease of this excretion produces an augmentation of the urea in the blood.

Second. That in birds, and other uric-acid-excreting animals, the metabolism of the nitrogenised tissues is exactly the same as in mammals, and that urea is the ultimate product of this metabolism; that urea is always present in their blood, in quantities not less than in mammalian blood, and that the urate of ammonium is a subsequent product of the union of urea with some other principle or principles, glycine probably being one of them. Consequently, it is not necessary that uric acid should be present in the blood of uric-acid-excreting animals: in health, in fact, it is not detectible. When it is present, its presence is a result of its having been absorbed after formation in the kidneys or elsewhere.

Geological Society, May 24.—W. H. Hudleston, F.R.S., President, in the chair.—The following communications were read:—Notes on Dartmoor, by Lieut.-General C. A. McMahon. The author alluded to a memoir on the British Culm Measures recently published by Mr. Ussher, in which the view is advanced that the granite of Dartmoor resulted from the metamorphism of pre-existing rocks which had in a rigid state offered obstruction to a long sustained N. and S. squeeze, and that their fusion and consequent consolidation were effected *in situ*. The author gave some of the results of a visit to the western borders of Dartmoor. He detailed some examples of eruptive granite-veins intruding into Culm beds in the immediate vicinity of the main mass of granite. The latter, in the locality described, is porphyritic down to its boundary, and the veins are also porphyritic. All the circumstances lead to the belief that these veins are real apophyses from the main mass, and that the view adopted by De la Beche regarding the origin of the Dartmoor granite is the true one. After alluding to some features in the Meldon granite-dyke not before noted, some detailed observations in the bed of the River Tavey were given, and an explanation offered of the way in which the fine-grained marginal variety of the granite, seen in that locality, has been produced. The improbability that a tremendous squeeze sufficient to fuse 225 square miles of a pre-Devonian rock into granite while the Culm Measures outside the zone of marginal contact-metamorphism are left almost untouched was commented upon, and finally, the author alluded to the often-observed pseudo-stratification of the Dartmoor granite, and urged that the cause of this is not the one suggested by De la Beche, but that it is due to sub-aerial agencies. The reading of the paper was followed by a discussion in which the President, Mr. Watts, Mr. Teall, Mr. Rutley, Prof. Bonney, and Prof. Hull took part. General McMahon briefly replied.—On some recent borings through the lower Cretaceous strata in East Lincolnshire, by A. J. Jukes-Browne. The borings described in this paper are at Alford, Willoughby and Skegness, and disclose the existence of an unsuspected anticlinal axis, bringing up Lower Cretaceous rocks beneath the

Drift. In the Willoughby boring, beneath the Drift, a brown sand was obtained, apparently the "Roach" division of the Lower Cretaceous, and below it the Tealby Clays (108 feet), oolitic ferruginous beds (18 feet), and sandstone and sand regarded as the Spilsby Sandstone. In the Alford boring the highest solid rock appears to belong to the basal beds of the Red Chalk, and below it is Carstone, and then clay. The axis of the anticlinal appears to pass between Alford and the border of the wolds, and is probably continued in a north-westerly direction beyond the village of Claythorpe. The result of the information now obtained makes it probable that the Chalk tract which lies to the south-east of the Calceby valley is completely isolated from the rest of the Chalk area. The President said that the lesson of the paper was that it was never safe to take anything for granted when one had to deal with Boulder Clay, and Mr. Strahan remarked that he agreed with Mr. Jukes-Browne's interpretation of the structure of the district.

Linnean Society, May 24.—Anniversary meeting.—Prof. Stewart, President, in the chair.—The treasurer presented the accounts duly audited, and the secretary having announced the elections and deaths during the past twelve months, the usual ballot took place for new members of Council, when the following were elected:—Messrs. J. G. Baker, A.C.L. Günther, G. R. Murray, R. C. A. Prior, and Howard Saunders. The President and officers were re-elected. The librarian's report having been read and certain formal business disposed of, the President delivered his annual address, taking for his subject "The various modes in which animal sounds are produced." On the motion of Dr. Braithwaite, seconded by Sir James Gibson Maitland, Bart., a unanimous vote of thanks was accorded to the President for his address, with a request that he would allow it to be printed. The Society's gold medal was then formally presented to Prof. Daniel Oliver, in recognition of the services rendered by him to botanical science, and having been acknowledged by Prof. Oliver, the proceedings terminated.

CAMBRIDGE.

Philosophical Society, May 15.—Prof. T. McK. Hughes, president, in the chair.—The following communications were made to the Society:—Exhibition of abnormal forms of *Spirifera lineata* (Martin) from the Carboniferous Limestone, by F. R. Cowper Reed. This species, as defined by Davidson, is normally subject to great variation of form and ornamentation, as it includes *Sp. imbricata* and *Sp. elliptica*. Specimens with intermediate characters are however common. The series of abnormal forms exhibited showed the gradual development of a sharp median groove both in the dorsal and ventral valves so as ultimately to produce a bilobed shell. From the nature of these grooves interruption of the shell-secreting action of the mantle seems to have occurred along a definite line: and the cause may have been disease, the presence of a parasite or foreign body, or pressure during life. Similar malformation is seen in some Terebratulas, &c. The normal and regular bilobation of some species of *Orthis*, *Terebratula*, &c., is comparable.—Exhibition of Post-Glacial Mammalian bones from Barrington recently acquired by the Museum of Zoology, by Mr. S. F. Harmer.—Exhibition of a specimen showing Karyokinetic division of the nuclei in a plasmodium of one of the *Mycetozoa*, by Mr. J. J. Lister.—Observations on the Flora of the Pollard Willows near Cambridge, by Mr. J. C. Willis and I. H. Burkill.—The plants occurring in the tops of willows near Cambridge have been recorded during the last few years, and amount to 80 species, occurring 3951 times altogether in about 4500 trees. Of these 80, only 18 form more than 1 per cent. of the total number of records. The rest have only a small number of records. As Loew has pointed out in a recent paper, these plants are of interest from the points of view of distribution of seeds and of epiphytism. Classifying them according to means of distribution, we find that 19 species have fleshy fruits; 1763 records (44·6 per cent.) of these occur. Three species with burrs have 651 records (16·4 per cent.); 34 species with winged or feathered fruit or seed have 996 records (25·1 per cent.); 7 with very light seeds have 421 (10·6 per cent.); and finally of plants whose means of distribution is poor or somewhat doubtful, we have 17 species with 120 records (2·9 per cent.). It is thus shown very strikingly how the various distribution mechanisms succeed, only the better ones showing in the list any numbers. The bird-distributed plants figure much higher here than in such cases as *e.g.* the flora of the churches of Poitiers (Richard), because birds visit the trees to such an extent. The observations show clearly the fact that a seed is only carried a short distance by its distribution mechanism. Plants were always found upon the soil, within 250 yards at most, of those found in the trees. An analysis was taken as far as possible of the birds' nests found in the trees, and pieces, often with ripe fruits, of many plants in the list were discovered in them, so that probably this means of distribution is of some importance. With regard to epiphytism, Loew considers these plants as exhibiting a commencement of this mode of life, and this seems probably enough. Like the regular epiphytes, they possess good methods of seed distribution. Their position does not call for any special means of supporting themselves, and the supply of humus is plentiful. *Mycorhiza*, which Loew found on many, was not observed in the few examined. The size of many of the shrubs, *e.g.* Elder, *Ribes*, Roses, &c., was very remarkable; some elders were three inches thick or more, and as much as 12 feet high. Experiments are in progress upon the growth of plants in willow humus.—Note on the plants distributed by the Cambridge dust-carts, by I. H. Burkill.—The street-sweepings of Cambridge have of late been spread on Coe Fen for the purpose of raising the level. From this material spring the plants whose seeds have been scattered in the dust of the roads. Of these, 99 species and one variety have been collected. No less than 39 per cent. are species whose dissemination has been effected directly or indirectly by Man, being either used for food or maintained in the gardens. The other species are almost all such as seed freely on roadsides, and have for the most part very light seeds.

DUBLIN.

Royal Dublin Society, May 17.—Prof. G. F. Fitzgerald, F.R.S., in the chair.—Dr. G. Johnstone Stoney, F.R.S., read a paper on the cause of sun-spots. In this communication the author recalled attention to the explanation of sun-spots which he had offered in 1867, in a paper on the physical constitution of the sun and stars, published in the Proceedings of the Royal Society, No. 105, 1868. He pointed out that the discoveries since made through the spectroscope, and the details of the photosphere revealed to us in the photographs taken by Prof. Janssen at Meudon, have brought to light striking confirmations of this explanation. The photosphere, according to the author's view, consists of incandescent sooty clouds, and the cloudy regions constitute the bright patches seen in Prof. Janssen's photographs, each of which is in general some hundreds of miles broad and several hundreds of miles long. Inasmuch as the greater part of the radiation emanates from them, they must form a stratum of minimum temperature. In the interstices between the patches and in those larger openings which are known as sun-spots, a less luminous background is brought into view. This is either a second layer of cloud which is of transparent material like terrestrial clouds, or it is a position in which both the density suddenly becomes greater and at which there is a sudden transition from transparent atmosphere above to opacity beneath. This would present the appearance of the reflecting surface of a molten ocean. Now, by the "Law of Exchanges," such an ocean as is supposed by the second hypothesis, being capable of reflecting incident light abundantly, or such a cloud of transparent material as is supposed by the first hypothesis, being capable of scattering incident light abundantly, would either of them radiate much less abundantly than the sooty clouds which constitute the photosphere, and would therefore appear black in comparison, whether at the same temperature, or at higher temperatures up to a certain limit. One or other of these, then, appears to be that dark background seen in sun-spots and in the intervals between the patches of photosphere. The appearance of penumbra seen in most sun-spots and in many of the intervals between the patches of photosphere would be presented wherever the sooty clouds are thin, and not sending down the abundant showers which seem elsewhere to prevail, and which in faculæ are continuous over immense spaces.—Mr. Thomas Preston attracted the attention of the Society to a simple, direct, and perfectly general method of expressing the efficiency of a reversible engine in terms of the temperatures of the source and refrigerator. He also mentioned that the cycle originally described by Carnot requires no correction, and depends on no theory of heat. Carnot begins with an adiabatic transformation, and his cycle consequently possesses all the advantages of the "corrected" cycle proposed by Maxwell.

The commonly accepted version of Carnot's method is therefore an injustice to the celebrated author of "The Motive Power of Heat."

PARIS.

Academy of Sciences, May 29.—M. de Lacaze-Duthiers in the chair.—Studies on diffraction gratings; focal anomalies, by M. A. Cornu. Gratings, although trustworthy enough to be used for determining wave-lengths of light, yet present various anomalies which might cast some doubt upon the rigour of the optical principles upon which their construction is based. In order to study these perturbations in detail and to eliminate the attendant errors, M. Cornu constructed a machine for the automatic ruling of lines spaced according to fixed laws, so as to produce and exaggerate at will the anomalies whose origin was to be verified. Thus the systematic error in the position of the focus of spectrum images was reduced to two distinct and purely geometrical causes: In plane gratings, to the existence of a feeble curvature of the ruled surface; in a plain or curved grating, to the existence of a regular variation in the distance apart of the lines. In most cases these two causes co-exist, which makes the laws of the optical phenomenon highly complex.—On the volatilisation of silica and zirconia, and the reduction of these compounds by carbon, by M. Henri Moissan (see Notes).—Preparation in the electric furnace of some refractory metals: tungsten, molybdenum, vanadium, by M. Henri Moissan (see Notes).—On the preparation of zirconium and thorium, by M. L. Troost. An intimate mixture of zirconia and finely comminuted sugar charcoal, the former being in excess, is strongly compressed into small discs and placed in a carbon retort. It is then subjected to the action of the voltaic arc supplied by a current of 35 ampères and 70 volts, the retort being placed in a closed chamber traversed by a slow current of carbonic acid, so as to prevent the air from burning and retransforming the metal into zirconia. The reduction is immediate, and gives rise to small metallic masses which are not pure zirconium, but a true carburet of zirconium, corresponding to the formula ZrC_2. If the carbon retort is lined with zirconia the ingot is gradually freed from carbon, and leaves the pure metal behind. This has a steel-grey colour and is extremely hard. It scratches glass deeply, and is untouched by the best files. In air it is unaltered at ordinary temperatures. At a red heat it oxidises at the surface if containing little carbon, but burns brightly if containing much. It is not attacked by acids except by hydrofluoric acid, which acts even if greatly diluted. Thorium is prepared in an exactly similar way from the chloride. The reduction takes place more readily, giving rise to a carburet, ThC_2. The metal is very brittle, and less hard than zirconium. It decomposes water in the cold, evolving hydrogen and a hydrocarbon of pungent odour. In contact with air it gradually swells up and forms a powder which burns with greater rapidity and brightness than zirconium.—Observations on the volatilisation of silica, *à propos* of M. Moissan's communication.—On the phenacite of Saint-Christophe en Oisans, by MM. A. Des Cloizeaux and A. Lacroix.—On ordinary differential equations which possess fundamental systems of integrals, by M. Sophus Lie.—The total solar eclipse observed at Fundium (Senegal) on April 16, 1893, by M. N. Coculesco.—On geometrical properties which only depend upon spherical representation, by M. C. Guichard.—On surfaces with lines of curvature plane in both systems and isothermals, by M. Th. Caronnet.—Theorems relating to analytical functions of n dimensions, by M. G. Scheffers.—On a general property of fields admitting of a potential, by M. Vaschy.—On the densities of some gases and the composition of water, by M. A. Leduc.—On the rigidity of liquids, by M. J. Colin.—Action of acetic anhydride upon linalol; transformation into geraniol, by M. G. Bouchardat.—A general method for the analysis of butters, by M. Raoul Brullé.—On the physiology of the crayfish, by M. L. Cuénot.—Mechanism of the hyperplasic process in epithelial tumours; applications, by M. Fabre-Domergue.—Researches on the modifications of the excretion of urea in the course of certain surgical maladies, and especially after great operations; consequences from the point of view of therapeutics and treatment after operations, by M. Just Championnière.

BERLIN.

Physical Society, May 12.—Presidents, at first Prof. Kundt, and later Prof. du Bois Reymond.—Dr. E. Pringsheim gave an account of his further researches on the cause of the emission of light by heated gases. By the method already employed for sodium (see NATURE, vol. xlv., p. 312) he had recently tested the vapours of lithium, thallium, and potassium. At the highest temperature, at which nickel was fused, the vapours of these metals similarly gave an emission-spectrum following on the absorption spectrum as long as reduction processes were excluded. They at once showed their characteristic spectral lines as soon as the salt used, or the silicate formed from the metal in contact with the surface of the porcelain tube, was reduced either by hydrogen, by the metal itself, or by iron. The experiment of Dewar and Liveing, in which, by heating lithium with potassium and sodium in an atmosphere of hydrogen in an iron tube, they obtained the lithium-line, was explained by the speaker as due to the above-named cause, viz., a compound is formed of iron and lithium, which is then reduced and exhibits both emission and absorption. Dr. Pringsheim concluded from his experiments in support of his views that the four elements—lithium, sodium, thallium, and potassium—are not luminous when simply heated above the temperature of the flame in which they ordinarily exhibit their characteristic spectra. He believed rather that they only show emission and absorption spectra when they are in the nascent state resulting from processes of chemical reduction.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—A Treatise on Elementary Dynamics, 2nd edition: S. L. Loney (Cambridge University Press).—An Introduction to Practical Bacteriology: Dr. W. Migula, translated by M. Campbell (Sonnenschein).—Some Hints on Learning to Draw: G. W. C. Hutchinson (Macmillan).—The Hawks and Owls of the United States in their Relation to Agriculture (Washington).—The Geological and Natural History Survey of Minnesota, 20th Annual Report (Minn.).—Missouri Botanical Garden, Fourth Annual Report (St. Louis, Mo.).—Modern Microscopy: M. I. Cross and M. J. Cole (Baillière).—Geological and Solar Climates: M. Manson (Dulau).—British Forest Trees: J. Nisbet (Macmillan).—Darwin and Hegel: D. G. Ritchie (Sonnenschein).—Lectures on Sanitary Law: A. W. Blyth (Macmillan).—Fragments of Earth Lore: Prof. J. Geikie (Edinburgh, Bartholomew).—The Lepidoptera of the British Islands, vol. 1, Rhopalocera: C. J. Barrett (L. Reeve).—Hypnotism, Mesmerism, and the New Witchcraft: E. Hart (Smith, Elder).

PAMPHLETS.—Die Klimate der Geologischen Vergangenheit: E. Dubois (Nijmegen, Thieme).—Notes on the Gasteropoda of the Trenton Limestone of Manitoba, with a Description of One New Species: J. F. Whiteaves.—Sulla Dissipazione di Energia in un Campo Elletrico Rotante e Sulla Isteresi Elettrostatica: R. Arnò (Roma).

SERIALS.—Brain, Parts 61 and 62 (Macmillan).—Engineering Magazine, June (New York).

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