THURSDAY, NOVEMBER 17, 1887.

## POLITICS AND THE PRESIDENCY OF THE ROYAL SOCIETY.

THE combination of vigorous intellect, profound knowledge, and scrupulous integrity, is not so common among our legislators, that a good citizen, whatever his political convictions, can have any feeling but one of satisfaction at the entrance into the House of Commons of the new member designate for the University of Cambridge. Prof. Stokes's foes (if indeed he have any foes), no less than his friends, will concur in attributing these qualifications to him. No man in the scientific world is, or deserves to be, more respected or more popular.

In that world many will doubtless find an additional source of congratulation in this public recognition of the merits of their colleague by the dominant political party in the University of Cambridge. And many will probably entertain the hope that the addition of another man of science to the three or four, who already occupy seats in the House of Commons, may do something towards the enlightenment and guidance of the House and of the Government, when scientific questions come under discussion.

In the minds of thoughtful men, more or less familiar with the realities of political and official life, however, it is probable that reflections of a less satisfactory nature may arise. They may regret that faculties which are so eminently fitted to serve science should inevitably be devoted to the interests of a party. Inevitably, because, with whatever high resolves the nominee of the Conservatives of Cambridge enters Parliament, he will find, before he has been there a week, that he is expected to do what the Whips bid him to do. And again such persons may think, not unreasonably, that Science is every day becoming more and more able to look after her own interests; and that, for her own honour and dignity, it is better that they should be neglected than that they should be promoted by back-stairs agencies. Moreover, experience may suggest that the deliberate judgment of the majority of scientific men, upon any question in which State intervention is called for, may be widely different from the view taken by this or that member of their body who happens to have a seat in Parliament; and that it is extremely undesirable that less legitimate methods of influencing a Minister should be substituted for the present fair and open mode of placing a case before him by responsible and authorized deputations.

But, whatever doubts may be entertained as to the service which has been, or can be, rendered to science by scientific members of Parliament, it is obviously within the right of every man to judge for himself whether he will become one or not. So far as Prof. Stokes is simply a very distinguished mathematician and physicist, it is for him, and for him alone, to decide between the claims of science, on the one hand, and those of political and ecclesiastical conviction on the other.

At the present moment, however, Prof. Stokes is something more than an eminent investigator and teacher: he is President of the Royal Society; and, as such, he enjoys all the prestige which is given by the fact that, in the eye of the public, he has the oldest, the strongest, and the most widely representative body of men of science in the country at his back. The President is the organ and mouth-piece of the Council of the Royal Society—a body which has frequent and important relations with the Government; and, as such, it may often be his business to represent to the Government the conclusions at which the Council arrives. It is therefore highly important that the freedom of the President's intercourse with Ministers should be in no way trammelled by his political relations.

It may be quite safely affirmed that Prof. Stokes's political and ecclesiastical views were not taken into consideration by those who placed him in the chair of the Royal Society. The last half-dozen of his predecessors, to go no further back, have sedulously abstained, during their occupancy of the chair, from holding office in any other Society, no less than taking part in any public, and especially political, action about which the opinions of the Fellows could be divided. Prof. Stokes has not followed this prudent example. Some little time ago he accepted the Presidency of a body of pronounced theological tendencies; and he now accepts the nomination of a no less pronounced political party, and, since our note upon his candidature appeared, he has issued an address in which he promises to devote himself to certain party objects.

It does not appear that Prof. Stokes has obtained, or, indeed, sought, the sanction of the Council or of the Society, at large, for this departure from precedent. For such it is, in spite of the fact that Sir Isaac Newton was a member of Parliament during his Presidency, and that many peers have occupied the chair. But it is obvious that a peer need not be a party politician; and, as regards the precedent of Sir Isaac Newton, it is enough to point out that the House of Commons of the end of the nineteenth century is a very different body from the House of Commons of the beginning of the eighteenth century. The position of an independent member has become impossible; and those who refer to Prof. Stokes's address will see that, whatever his first feelings may have been, he, now at any rate, does not propose to be anything but a staunch Conservative.

No doubt there are many staunch Conservatives in the Royal Society, but no doubt also there are many equally staunch Liberals and Radicals; and if it had entered into the imagination of the latter that Prof. Stokes would carry the prestige of the Presidency into the service of their political opponents, it may be doubted whether they would have voted for him. The same argument would apply with equal force if Prof. Stokes happened to be a Liberal. The question before us is one not of party, but of principle.

We are in the midst of a great political struggle, and it may be safely predicted that the force of party feeling will increase rather than diminish for years to come. If it is permissible that the President of the Royal Society may be a political personage, the minds of the Fellows on St. Andrew's Day will be divided between two sets of considerations. Not only will each ask, "Is A.B. the best man for the Presidency in the interests of science and of the Society?" which is the only question he ought to put; but he will ask, "Is A.B. of my politics, or the opposite?"

It is eminently true of political passion that a "little leaven leaveneth the whole lump"; once inoculate the Royal Society with that virus, and the poison will spread through the whole organism. The Council practically chooses the President: it will therefore be necessary to look to the politics of the Councillors. The Fellows elect the Council: have a care, therefore, to the politics of the new Fellows. We may yet see a politico-scientific caucus. Some years ago a most sagacious and experienced man of affairs in the United States was asked why, in drawing up the constitution of a new University, he had not given such persons as the Governor and Chief Justice of the State an *ex-officio* position on the governing body. "Ah," said he, with a shrewd smile, "if you only knew the trouble my colleagues and I have taken to render it impossible for any political person to have anything whatever to do with the administration of the University! We know to our cost that wherever politics enters corruption follows."

The records of the Royal Society tell us of more than two centuries of scientific life, fertile in good work and unstained by anything worse than an occasional outbreak of prejudice or jealousy. The only occasion on which it ever manifested a political bias was in the case of Priestley; and it has no reason to be proud of that episode.

The Society is now at the parting of the ways. Either it will continue its beneficent work for untold ages to come, untroubled by the transitory political and social storms raging around it; or, headed by politicians pledged to serve their party, it will gradually be dragged down into that miserable slough in which no capacity seems proof against the temptation to sophistical special pleading and no character strong enough to refuse degrading subserviency to party exigencies.

The occasion is grave and demands action. It is for the President, by the course which he may think fit to adopt, to determine what that action shall be.

## THE STORAGE OF ELECTRICAL ENERGY.

*The Storage of Electrical Energy.* By Gaston Planté. (London: Whittaker, 1887.)

TO the author of this book we owe the use of lead plates instead of platinum plates in voltameters. His experiments showed that, after repeated charging and discharging of lead-plate voltameters, accumulators of energy were producible which might be employed in a great variety of useful ways. He showed that his accumulators might be charged in parallel by a few Bunsen or Daniell cells, and discharged in series. As his accumulators had small internal resistances, he was able to give to circuits either of small or great resistance very considerable supplies of electric power for short times, and as an experimenter he availed himself of this novel power in heating wires, melting beads of metal, and generally of observing effects produced by strong currents.

Many of the phenomena observed by him were new, and well worthy of being recorded, as they were recorded, in the proceedings of scientific Societies; and the present book, in addition to a fine portrait of the author, and many other engravings, and a dedication to the Emperor of Brazil, seems to be merely a collection of these papers of M. Planté, published between the years 1859 and 1879. In the first chapter of the book and part of the second we find an interesting account of experiments with various electrodes in voltameters, which led the author to use lead instead of platinum, and of the forms which the author gave to his cells, with directions for their formation, and speculations as to the chemical actions involved. The remaining twelve and a half chapters may be regarded as almost solely devoted to the "effects created by currents combining quantity with high tension"—to use the old-fashioned phraseology which Mr. Elwell, the translator, has thought fit to use upon the title-page—and to the author's speculations upon things in general.

The infancy of the electric accumulator lasted to 1879, its boyhood to 1883, and we may now be said to know it in its manhood. The advance since 1879, not only in our knowledge of the chemical and electrical actions going on in the accumulator, but also in our methods of applying this knowledge, has been quite as wonderful as the advance made in any other part of applied physics. Batteries of accumulators capable of driving boats 80 feet long, of driving numbers of tram-cars, of maintaining large installations of electric lights, are now in actual use. Plates of lead are now used as in 1879, but the salts of lead in contact with the metallic plates are attached mechanically, hundreds of devices having been tried and rejected or adopted in the last eight years for the purpose of obtaining great capacity and longevity. Of these great changes, the results of numerous, most costly, and carefully conducted experiments, made by scientific men, M. Planté tells us nothing. He was in charge of the accumulator in its infancy; it was taken away from him in 1879, and its subsequent history seems to be as unknown to him as the boyhood and early manhood of Harry Bertram were to Dominie Sampson.

The dominie looked upon his pupil, now grown to be a man, as if he were still a boy who was about to resume his childish studies, and in the same way it is probable that M. Planté regards the accumulator of 1887 as in no respect different from the laboratory toy with which he obtained such remarkable effects prior to 1879. M. Planté gives in this book what may be regarded as the history of the infancy of the electric accumulator; and it is obvious that if he had written it as charmingly as Mrs. Molesworth herself could have written it for the nursery, yet, with the misleading title which it possesses, he has given occasion to the ordinary reader to feel greatly disappointed. We are here assuming that M. Planté shares with Mr. Elwell the responsibility of publication, and also of change in the name of the book from that of the first edition—"Recherches sur l'Électricité"—published in 1879, which is the only French edition with which we are acquainted.

The technical terms used by the translator are not now so familiar to students as they used to be in the good old times when *strength*, *intensity*, *quantity*, and *power* of a current were synonymous with each other or with electromotive force.

It was this freedom in "the older electricity" which enabled statements like "The E.M.F. was thus found equal to 1·41, the current from the Bunsen cell being 1" (p. 17) to be enjoyed by readers. Other statements like this: "We have found that the resistance of secondary cells of the various dimensions which we have used varied from 2 to 5 metres of a copper wire 1 millimetre in diameter" (p. 64), show that M. Planté sought for greater exactness in his measurements than many of his contemporaries during the infancy of the electric accumulator.

It was to be expected that in suggesting yet untried applications of secondary batteries the author should make statements which any student now knows to be erroneous. An example is to be found at p. 105, where it is suggested that, by using a secondary battery, two ordinary Bunsen cells might be enabled to work a continuous voltaic arc. As was also to be expected in such a republication of papers as this, many of which read like the contents of an inedited laboratory note-book, there are repetitions of the same facts and sentiments.

Unfortunately there is another resemblance to laboratory notes in much of the matter of this book which cannot be so readily forgiven. One often confides to one's note-book a speculation which is based on a very far-fetched resemblance between two phenomena. And it is quite possible to find in a note-book such a note as this (p. 198): "The experiment described above (158) in which a cloud of metallic oxide, torn from an electrode by the current, takes a spiral motion in the body of a liquid under the influence of a magnet, seemed of a nature to explain, in particular, the remarkable form of spiral nebulæ." Then follows a description of the nebulæ observed by "Lord Ross," and the further remarkable note: "In view of so striking a similarity, may it not be reasonably supposed that the nucleus of these nebulæ may be formed by a veritable electrical furnace; that their spiral form is probably caused by the presence of celestial bodies powerfully magnetized, and that the direction of the curve of the turns in the spiral must depend upon the nature of the magnetic pole turned towards the nebula."

This sort of thing may be found in the note-book of almost any laboratory worker, but it is astonishing to find that M. Planté has not only published it in the proceedings of a scientific Society, but actually publishes it again after he has had many years of leisure for reflection and for verification. These speculations occupy many chapters of the book. M. Planté describes some natural phenomenon, such as globular lightning, the formation of hail, water-spouts, cyclones, the aurora, atmospheric electricity, spiral nebulæ, or solar spots; he then begins to write on the vague analogy existing between this natural phenomenon and some isolated phenomenon observed by him in the laboratory, and after he has written some pages, the analogy becomes very indistinct; but he continues to write in the hope that if he writes long enough he may obtain clearer ideas. Of the same kind are his "views" of the nature of electricity. He finds that when successive intense currents are sent through fine wires, which are, of course, greatly heated, the wires lose their straightness in curious ways. It is very interesting to read about the observed phenomena, but unfortunately we have the author's speculations as well. He says (p. 247):—"The phenomena we have just described (313–20) are of a nature to throw some light on the mode of propagation of electricity. The molecular vibrations revealed by knots formed in a metallic wire, by the curious noise, and by a notable change in its cohesion under the influence of the passage of the dynamo-static current which we have just studied, must be produced in a lesser degree in conducting substances traversed by electric currents of very low tension. This vibration may be too feeble to be perceptible, but it is not the less real. We are then able to conclude that the electric movement must diffuse itself in substances after the manner of a purely mechanical motion, by a series of very rapid vibrations of the more or less elastic matter through which it passes."

He then goes on in his last chapter, without a thought of the possibility that very rapid heating of a not perfectly homogeneous conductor might explain his phenomena, to build up a theory of electricity from these isolated facts with the help of a few far-fetched analogies, and he publishes his theory without further verification. In spite of our great obligations to M. Planté, we feel that he has set the very worst example possible to the probable readers of his book, in publishing these vague speculations of his.

JOHN PERRY.

## FRITSCH'S CRUSTACEAN FAUNA OF THE CHALK OF BOHEMIA.

*Die Crustaceen der Böhmischen Kreideformation.* Von Prof. Dr. Anton Fritsch und Jos. Kafka. Pp. 55. (Prague: Selbstverlag, in Commission von Fr. Řivnáč, 1887.)

THERE is probably no sedimentary deposit in the whole series of the stratified rocks with which one is more familiar than the Chalk. This is doubtless due to its peculiar whiteness, and to the fact of its occupying so large an area in our eastern and south-eastern counties, and its prominence in the coast-sections of Yorkshire, Kent, and Sussex, and the opposite coast of France; forming at Dover those white cliffs which gave to our shores their ancient name of Albion.

In the Cretaceous formation, however, we include a set of other beds, very dissimilar from the Chalk in appearance and composition, but which, on stratigraphical and palæontological grounds, seem to form a natural rock-system. These are known as the Upper Greensand, the Gault Clay, the Lower Greensand, and the Wealden Beds, comprising marls, sands, clays, and even fresh-water limestones. Without entering into details as regards the minor divisions, we may say that the major proportion of these deposits are marine, as shown by the organic remains contained in them. The Chalk itself, from its general purity, must have been formed in a deep and open sea; indeed, the researches which have been carried on in the North Atlantic Ocean show that the materials for a continuous bed of limestone with flint-nodules are now being deposited at depths of from 400 to 2000 fathoms, while many forms of life met with there are analogous to those of the Chalk.

That this old Cretaceous sea must have been of very wide extent is proved by the enormous area over which its sediments have been traced, as shown on our geological maps; whilst outliers and vast beds of flint-gravel derived from the Chalk give evidence of a still wider region once covered by its waters, but whose deposits have since been removed by denudation.

The *white* Chalk, whence the name "Cretaceous" was taken, is almost wholly confined to the Anglo-Parisian area, where the system was first studied, but the formation, varying in lithological characters, may be followed from England into France, Belgium, Holland (Maestricht), Denmark (Faxoe), south of Sweden, Hanover, Brunswick, Saxony, Bavaria, Bohemia, Moravia, Switzerland, Austria, and the chain of the Alps, the Mediterranean Basin, including parts of Spain, south of France, Italy, Greece, Asia Minor, Sicily, and North Africa. This latter is the well-known "Hippurite Limestone" of the South of Europe, which stretches away to Persia and the Himalayas, and extends over the greater part of the continent of India. Cretaceous fossils have also been traced as far south in Africa as Natal.

The vastness of the Cretaceous system in North America far exceeds even our largest computation of its aggregate mass in the European area, being from 11,000 to 13,000 feet in thickness; whilst in our own hemisphere it probably does not exceed 7000 feet as a whole. It extends across the breadth of the North American continent, and over wide regions in South America, marked by many of the characteristic fossils of the Cretaceous rocks of Europe. But the evidence of contiguity to land in North America demonstrated by plant and animal remains far surpasses our own very limited records of shore and shallow-water conditions in Cretaceous times in Europe. Nevertheless we do possess at Aix-la-Chapelle, and in Saxony and Bohemia, Upper Cretaceous beds containing plant remains, such as leaves of *Acer*, *Alnus*, *Credneria*, *Cunninghamites*, and *Salix*, with Conifers akin to *Sequoia* and *Pandanus*, South African, and Cape *Proteaceæ*, and many Cryptogams, chiefly ferns, such as *Gleichenia*, *Lygodium*, *Asplenium*, &c. These have been dealt with elsewhere, as have also the Cephalopoda ("Cephalopoden der Böhmischen Kreideformation," von Dr. Anton Fritsch; Prague, 1872).

The present monograph presents us with descriptions and figures of seventy-two species of Crustacea obtained from eight localities and well-marked beds in the Cretaceous formation of Bohemia. These are divisible into Cirripedia (twenty-one species), Bivalved Entomostraca, Ostracoda (twenty-one species), Decapoda-Macroura (eighteen species), Decapoda-Brachyura (twelve species). The Cirripedia, with one exception, all belong to the stalked division (Lepadidæ), or "barnacles," eleven species being common to our own Chalk and Gault. In these are included two varieties of that most aberrant genus *Loricula*, first described by Sowerby from the English Chalk, and afterwards more fully by Charles Darwin. This pedunculated genus, by a retrograde development, no longer stands supported on its stalk, but lies prone, attached by one side to the surface of some shell, or other foreign body, its five rows of peduncular imbricating scales (over 100 in number) serving to form a dermal covering to the soft parts of the animal, which must have been distorted in its mode of growth somewhat as the flat-fishes (Pleuronectidæ) are modified as the result of their recumbent habits.

A *Balanus*, referred to a new genus (*Balanula* ?), is supposed to represent a sessile form of Cirripede. Such a form, *Pyrgoma cretacea*, was described from the Upper Chalk of Norfolk by H. Woodward in 1868 (see *Geol. Mag.*, vol. v. p. 258, pl. xiv. figs. 1-3), but the "acorn-shells," Sessile Cirripedes, mostly belong to the Tertiary and Recent periods, in which they attain a large development all over the globe.

The Ostracoda have been determined by Herr Joseph Kafka, Dr. Fritsch's assistant, in the Museum at Prague. Of the twenty species here treated of, five have been previously figured and described as new by Herr Kafka in the *Sitzungsb. K. böhm. Gesell. Wiss.*, Prag, 1885. The figures and woodcuts of the old species have been mostly taken from Prof. von Reuss's memoir on the Microzoa in Geinitz's "Elbithalgebirge," and the new species are here also figured in woodcuts, some of which leave much to be desired as to "finish" of characteristic features. Figs. 24 and 25 appear to belong to *Macrocypris*, and not to *Bairdia*. Fig. 26 has no relation to *Bairdia*, but may be a *Cytherella*. The representation of *Cythere reticulata*, Kf. (Fig. 32, *a*, *b*, *c*), has some peculiarities which better figures perhaps would clear up. Though not mentioned by Herr Kafka, ten of the species are found also in the English Chalk, and the others (excepting Fig. 32) have near allies in that formation in Western Europe. It is stated that in Bohemia the Ostracoda are mostly found in the Senonian stage. Only *Cytheridea perforata*, and four other species, come from the Turonian beds of Weissenberg.

Turning to the higher forms of Crustacea, the Decapoda (crabs and lobsters), only a single species, *Enoploclytia leachii*, Mantell, is recognized as being identical with our Chalk Crustacean fauna; but the genera *Hoploparia*, *Callianassa*, *Palæocorystes*, *Necrocarcinus*, *Etyus*, and *Astacus* are represented by corresponding species in the two areas. *Callianassa* is said to be represented by six species. This is a burrowing form, of which only the great chelate appendages are usually found fossil, or are brought up in the dredge from deep water, and it is extremely doubtful, judging from the author's figures, whether more than about three out of six of Fritsch's species can be maintained. One Greensand species occurs in Ireland, and the well-known *Callianassa faujasii* described eighty-eight years ago from the Uppermost Chalk of Maestricht. We have also a Tertiary form described from the upper marine series, Hempstead, Isle of Wight. All these species are very nearly related to each other.

Perhaps one of the most interesting forms described by Dr. Fritsch is his *Stenocheles esocinus*, the long slender-toothed chelæ of which agree closely with those of *Astacus* (?) *zaleucus*, W. Schm., a Crustacean dredged up in 1000 fathoms during the *Challenger* Expedition near St. Thomas in the West Indies.

The present work is illustrated by ten chromolithographic plates and seventy-two text figures.

This series of fine memoirs, which is being issued by Dr. Fritsch from the Royal Bohemian Museum, Prague, will certainly maintain the merit, and serve to enhance the reputation, of that great institution, which has, quite recently, been so well endowed by the magnificent bequest of the late Dr. Joachim Barrande, the historian and palæontologist of the Silurian system of Bohemia.

## *OUR BOOK SHELF.*

*Manual of Mineralogy and Petrography, containing the Elements of the Science of Minerals and Rocks.* By James D. Dana. Fourth Edition, Revised and Enlarged. Illustrated by numerous Woodcuts. (New York: Wiley and Sons; London: Trübner and Co., 1887.)

THAT a new edition of this important and admirable manual has been issued will be good news to all interested in mineralogy, and especially to the teacher and student. The book, which now consists of 517 pages, is well arranged throughout, and contains, as all such books should do, a full index. The whole body of mineralogical science is here brought to focus, and the present edition, in that part of it relating to the description of minerals, is brought down to the year 1886, many new species described during the past six years being included. The chapter on rocks has been re-written, re-arranged, and enlarged, and many illustrations are new. We would suggest to the learned author that in the next edition a chapter on meteorites and their mineralogy would form an appropriate and much-valued addition.

## *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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

### "A Conspiracy of Silence."

THE article which I contributed to the September number of the *Nineteenth Century*, on the Coral Islands of the Pacific, has done what I intended it to do. It has called wide attention to the influence of mere authority in establishing erroneous theories and in retarding the progress of scientific truth. The vehement assault made upon it in the current number of the same review by Prof. Huxley, and the article by Prof. Bonney in this journal, are to me gratifying evidences of success. But both of these writers are entirely wrong in the interpretation they put on a few expressions in my paper. They interpret these expressions as conveying imputations on the probity and honour of scientific men in the habitual and wilful suppression or discouragement of what they know to be truth. But there is nothing to justify this interpretation. I have made no such accusation, and if any one else were to make it I should join the two indignant Professors in repudiating it. Scientific men are not only as good as other men in this way, but generally a great deal better. Prof. Huxley has been irritated by some "anonymous sermon," which I have not seen and for which I am not responsible. He admits that it is in this anonymous production that the "slanders" against scientific men have taken the peculiarly offensive form; but he maintains that this unknown writer has been "inspired" by my article on Coral Islands. On the strength of this assumption—which may be true for aught I know—he goes on through some seven pages to dissect certain parts of my paper, and to read into it a great deal that is due to his own excitement and to nothing else.

I have no difficulty in expressing clearly and without any circumlocution exactly what I do mean, and what I have intended to say. Prof. Bonney interprets it very fairly, in abstract, when he says that the moral of my paper is, "Beware of idolatry." Some theory, hypothesis, or doctrine, is propounded by a great man. It becomes established, partly perhaps by certain inherent elements of strength, or at all events of attractiveness. But soon it stands unassailable, and unassailed, upon the vast foundations of general acceptance and admitted authority. It becomes what Prof. Huxley on a celebrated occasion, and with at least a momentary insight, called "a creed." The effect of such a position is tremendous. Some men who see cause to doubt are daunted. They keep silence. Others are prevented from even thinking on the subject. A few who do think, and who do doubt, and who do venture to express their doubts, are discouraged and discountenanced. A great many others take refuge in a suspended judgment, even after the production of evidence which, in the absence of a "creed" and of authority, would have been deemed conclusive. In all this there may be, and in general there is, nothing worse than timidity on the part of those who are the laggards, or the opponents, in some great advance. It is more difficult for some men than for others to face a prevalent opinion or an accepted doctrine. It is all very well to say, as Prof. Bonney says, that "to the man of science truth is a pearl of great price, to buy which he is ready to part with everything previously obtained." But scientific men are human. They are, I admit, immensely superior to the politicians, especially just now. But they have their failings, and everyone who knows the history of science must be able to call to mind not one instance only, but many instances, in which the progress of knowledge has been delayed for long periods of time by the powerful and repressive influences of authority, exerted in one or other of many ways.

My contention is that Darwin's theory on the origin of the Coral Islands is a case in point. I believed in it or accepted it, for many years, as others did. Prof. Bonney admits that I have described it not only fairly, but as forcibly as if I were still its advocate. This is exactly what I tried to do. I now hold that it has been disproved, and has been replaced by another theory quite as grand, and more in harmony with other natural laws which are of universal operation, but have been only lately recognized. I affirm, farther, that this new theory or explanation has been received with the timidity, the discouragement, the discountenance, and the obstruction which are characteristic in such cases. That Dr. Geikie has supported it, is most creditable to him. But his voice is not enough to disprove the truth of my contention. That Prof. Huxley and Prof. Bonney should be unable to make up their minds upon such evidence as has been before us now for several years is, in my opinion, a strong confirmation of the law which is operating upon them. There are some discoveries in science—some explanations of curious phenomena—which are self-luminous. They shine with their own light. The moment they are suggested, with a few cardinal and certain facts to illustrate them, they are their own proof. Everything that turns up speaks in support of them. My conviction is that such is the character of Mr. Murray's theory of the coral island formations in the Pacific.

Prof. Huxley challenges me to re-affirm with better proof the fact I allege—that Mr. Murray has met with discouragement. I respond at once to that challenge. I have seen the letter from Sir Wyville Thomson in which that naturalist urged and almost insisted that Mr. Murray should withdraw the reading of his papers on the subject from the Royal Society of Edinburgh. This was in February 1877. No special reason was assigned, but the terms of the letter indicate clearly that Sir Wyville dreaded some injury to the scientific reputation of the body of naturalists of whom he was the chief, and for whom, as connected with the *Challenger* Expedition, he was in some degree responsible. He had not himself at that time, I believe, fully accepted the new doctrine. But that would have been no sufficient reason for discouraging free discussion, if it were indeed as free as it ought to be. In my article I understated the delay which was thus occasioned. Three years, not two, elapsed before Mr. Murray was at perfect liberty to advocate his views in the proper place, before a scientific body.

But the challenge of Prof. Huxley has brought to my knowledge a new bit of circumstantial evidence to the same effect, which is highly significant. Among the investigators of the Pacific corals no man has done better work than Dr. Guppy, Surgeon of H.M.S. *Lark*. Since my article was written, his volumes on the Solomon Group of islands have been published. The geological volume is an admirable memoir. It is the record of observations as patient, detailed, and conscientious as have ever been made on the great geological problem which is at issue. After his return home he was advised by Mr. Murray to offer a paper on his researches to the Geological Society of London. He did so in the spring of 1885. But his paper was refused—much to Dr. Guppy's disappointment. It was not orthodox. His facts effectually removed some difficulties in the way of Mr. Murray's theory—facts which in more than a corresponding degree were adverse to the theory of Darwin. As a consequence the Royal Society of Edinburgh has had the honour of receiving and publishing Dr. Guppy's most interesting memoir. As a Scotchman I am proud of this contrast. I make no accusation of wilful unfairness against the authorities of the Geological Society of London, of which my critic Prof. Bonney was, I believe, at that time the President. They did not consciously discourage truth. On the contrary, they probably smelt heresy. But if their minds had been free from this prepossession—if they had been alive to the breadth and sweep of the questions at issue, and open to receive with welcome the crucial evidence bearing upon them which is contained in Dr. Guppy's paper—the rejection of it would have been impossible.

As regards Darwin's own state of mind upon the subject, I can only say that my information was as good as that in the possession of Prof. Huxley. I am not struck by the perfect candour of his reference to Darwin's letter to Prof. Semper in October 1879. If he had quoted the very next sentence to that which he does quote, a very different impression would have been left on the reader's mind. But I attach no importance to this point. I prefer to believe that Darwin's mind was open to conviction, and to hope that others will follow his example.

ARGYLL.

### The Theories of the Origin of Coral Reefs and Islands.

I WAS pleased to see Prof. Bonney's article on the Duke of Argyll's strictures on scientific men ("A Conspiracy of Silence," NATURE, November 10, p. 25). It is to be hoped that the rhetoric and methods of Parliamentary debate will not become common in scientific controversy. The Duke is, however, not the first who has tried to show "that if Darwin had lived he would with his well-known candour have been the first to admit the truth of Murray's theory," &c., &c. This I submit is a species of rhetoric which is out of place in scientific discussion.

It so happens that shortly after the appearance of Mr. Murray's paper "On the Structure and Origin of Coral Reefs and Islands," in NATURE, August 12, 1880 (p. 351), I had occasion to write to Dr. Darwin, and in my letter the following passage occurs, which I only quote to make Darwin's answer intelligible :—

"*September* 21, 1880.

"I think the theory Mr. Murray sets forth—that the cones or peaks, on which he considers atolls have been formed, have been levelled up by pelagic deposits, and thus brought within the limits of reef-building coral growth—a very far-fetched idea."

To which Darwin with his usual acumen replies :—

"*Beckenham, September* 22, 1880.

"I am not a fair judge, but I agree with you exactly that Murray's view is far-fetched. It is astonishing that there should be rapid dissolution of carbonate of lime at great depths and near the surface, but not at intermediate depths where he places his mountain peaks.

"Dear Sir, yours faithfully,
"CH. DARWIN."

As so far there appears to have been no *written* expression of Darwin's views published, this quotation may be of value.

T. MELLARD READE.

Park Corner, Blundellsands, November 11.

### Earthquake at the Bahamas.

I AM instructed by the Meteorological Council to inclose copies of reports from the Resident Justice and Light-keepers of Inagua, Bahamas, relating to an earthquake on September 23 last, which you may think worthy of a place in NATURE.

ROBERT H. SCOTT,
Meteorological Office, *Secretary*.
116 Victoria Street, London, S.W.
November 11.

*The Resident Justice at Inagua to the Colonial Secretary, Nassau. In re Earthquake at Inagua.*

*Resident Justice's Office, Inagua, September* 27, 1887.

I HAVE to report that this island was visited by a severe shock of earthquake at 7 a.m. of the 23rd instant ; the effect on the light tower, the keeper reports, was terrific, two nuts on the iron stauncheon of the smoke-stack were broken, and several cylinders. A portion of the stone wall around the Residency, and other private property, were thrown down in Mathew Town.

At 8.10 p.m. another shock was felt, no damage at the township ; at the light station the cylinder on the lamp was broken, and the keepers were compelled to extinguish the light to prevent conflagration. A new cylinder having been placed in position, the light was again lit in about six or eight minutes after the accident.

At midnight another shock was felt, and the light-keeper reported next morning several cracks in mortar inside of the light tower ; the light continued good.

Since the 23rd instant several light shocks have been felt, which keeps the people in a state of alarm.

We have had no arrival from Hayti and neighbouring islands, and it is feared that some of them have greatly suffered.

(Signed) G. R. McGREGOR,
*Resident Justice.*

The Hon. Robt. Butler, Acting Colonial Secretary.

*Principal and Assistant Light-keepers, Inagua, to the Inspector of Lighthouses, Nassau.*

*Inagua Light Station, September* 29, 1887.

SIR,—I beg most respectfully to report for your information that this station and island was visited by several severe shocks of earthquakes on the 23rd, 24th, 25th, and 26th instants. The shock on the former date was felt at 7 a.m., which shook the tower and dwelling severely. Two nuts forming a part of fastening of iron rods in the upper part of lantern supporting upper barrel and smoke-pipe were wrenched off and smashed several cylinders.

The second shock, at 8.10 p.m., shook the tower very much, and smashed the cylinder on lamp. The light was then extinguished to prevent fire, which last about eight minutes [*sic*], when the light was again exhibited and kept burning bright and clear until daylight. There was another shock felt during the night, but not so severe. I noticed several cracks on the walls in the tower, which may be the mortar only. The latest shock was on the morning of the 26th at 1.3.

I am glad to say that the lamp and machinery are in good working order, but there will be slight repairs required.

The latest shock felt was at midnight of the 27th.

I also inclose the head of nut, the length of which is seven-eighths of an inch on inside.

I have, &c.,
(Signed) BYRON N. JONES,
*Principal;*
CORNELIUS S. E. LOTMAN,
*Assistant.*

The Inspector of Lighthouses.

## *RESEARCHES ON METEORITES.*

### I.

On October 4 I communicated to the Royal Society a preliminary note embodying some results I had obtained in observations on meteorites, undertaken with a view of obtaining additional information on some parts of the spectrum of the sun.

Some years ago I commenced a research on the spectra of carbon in connection with certain lines I had detected in my photographs (1874) of the solar spectrum. I have been going on with this work at intervals ever since; and certain conclusions to which it leads, emphasizing the vast difference between the chemical constitution of the sun and of some stars, recently suggested the desirability of obtaining observations of the spectra of meteorites and of the metallic elements at as low a temperature as possible.

I have latterly, therefore, been engaged on the last-named inquiries. The work already done, read in conjunction with the work on carbon, seems to afford evidence which amounts to demonstration on several important points.

The researches are still very far from complete, and the results must be given with great reserve, as the astronomical observations with which I have had to compare my laboratory work have been frequently made under conditions of very great difficulty.

A full report on the work, so far as it has gone, made to the Solar Physics Committee, which I have also communicated to the Royal Society, was read to-day, and I have received permission to publish part of it in this week's NATURE.

The general conclusions at which I have so far arrived may be stated as follows:—

I. All self-luminous bodies in the celestial spaces are composed of meteorites, or masses of meteoritic vapour produced by heat brought about by condensation of meteor-swarms due to gravity.

II. The spectra of all bodies depend upon the heat of the meteorites, produced by collisions, and the average space between the meteorites in the swarm, or in the case of consolidated swarms upon the time which has elapsed since complete vaporization.

III. The temperature of the vapours produced by collisions in nebulæ, stars without C and F but with other bright lines, and in comets away from perihelion, is about that of the bunsen burner.

IV. The temperature of the vapours produced by collisions in α Orionis and similar stars is about that of the Bessemer flame.

V. The line of increase of temperatures of the swarms of meteorites, and of subsequent cooling of the mass of vapour produced, and the accompanying phenomena, may be provisionally stated as follows:—

SEQUENCES OF SPACING AND TEMPERATURES (PROVISIONAL).

*From Cold to Hot = Sparse to Dense Swarms.*

| | Spectrum of interspace. H. | Spectrum of interspace. C. | Spectrum of vapour of meteorite. *Radiation.* | Spectrum of vapour of meteorite. *Absorption.* | Spectrum of meteorite. *Radiation.* |
|---|---|---|---|---|---|
| Nebulæ (without F) ... ... ... | Nil | Nil | Mg (500) ± 495 | Nil? | Dimly continuous. |
| Comets 1866 and 1867 ... .. | Nil | Nil | Mg (500) .. ... | | |
| Nova Cygni after collision ... | Nil | Nil | Mg (500)... ... | | |
| Stars with bright lines (without F) | Nil | Nil | Fe, Mn ... ... | Broad band 475 ... ... | |
| Nebulæ (with F) ... ... ... | H | Nil | Mg (500) ± 495 | Nil? | Continuous. |
| Stars with bright lines (with F). | H | Nil | Fe, Mn ... ... | D and *b* and other lines and bands ... ... ... | |
| Comets under mean conditions of collision ... ... ... ... | Nil | C | Mg(*b*) ... ... | Nil. | Continuous. |
| Comets at perihelion... ... ... | Nil | C | Meteorite lines. | (?) | |
| Stars, Class III.*a* ... ... ... | Nil | C | | Meteorite flutings and lines | Vividly continuous. |
| Mixed swarms— | | | | | |
| R Geminorum ... ... ... | H | C | Meteorite lines. | Meteorite lines | |
| Nova Orionis at maximum. | H | C | | Meteorite flutings and lines | |
| *Condensation.* | | | | | |
| Stars, Classes I. and II. ... ... ... ... ... | | | Continuous ... | High-temperature lines of substances present in meteorites ... ... ... | The radiation from individual meteorites now gives place to radiation from the interior vaporous and subsequently consolidated mass of the condensed swarm. |
| *Subsequent Cooling.* | | | | | |
| Stars { Class II. some stars, including sun ... | | | Continuous ... | K in excess ... ... ... | |
| Stars { Class III.*b* ... ... ... ... ... ... | | | | Flutings of carbon ... | |

VI. The brilliancy of these aggregations, at each (increasing) temperature, depends on the number of meteorites in the swarm —*i.e.* the difference depends upon the quantity, not the intensity, of the light.

VII. The existing distinction between stars, comets, and nebulæ rests on no physical basis.

VIII. The main factor in the various spectra produced is the ratio of the interspaces between the meteorites to their incandescent surface.

IX. When the interspace is very great, the tenuity of the gases given off by collisions will be so great that no luminous spectrum will be produced ("nebulæ" and "stars" without F bright). When the interspace is less, the tenuity of the gas will be reduced, and the vapours occupying the interspaces will give us bright lines or flutings ("nebulæ" and "stars" with F bright). When the interspace is relatively small, and the temperature of the individual meteorites therefore higher, the preponderance of the bright lines or flutings in the spectrum of the interspaces will diminish, and the incandescent vapour surrounding each meteorite will indicate its presence by absorbing the continuous-spectrum-giving light of the meteorites themselves.

X. The brighter lines in spiral nebulæ, and in those in which a rotation has been set up, are in all probability due to streams of meteorites with irregular motions out of the main streams, in which the collisions would be almost *nil*. It has already been suggested by Prof. G. Darwin[1] —using the gaseous hypothesis—that in such nebulæ "the great mass of the gas is non-luminous, the luminosity being an evidence of condensation along lines of low velocity according to a well-known hydrodynamical law. From this point of view the visible nebula may be regarded as a luminous diagram of its own stream-lines."

XI. New stars, whether seen in connection with nebulæ or not, are produced by the clash of meteor-swarms, the bright lines seen being low-temperature lines of elements the spectra of which are most brilliant at a low stage of heat.

XII. Most of the variable stars which have been observed belong to those classes of bodies which I now suggest are uncondensed meteor-swarms, or stars in which a central more or less solid condensed mass exists. In some of those having regular periods the variation would seem to be partly due to

[1] NATURE, vol. xxxi. p. 25.

swarms of meteorites moving around a bright or dark body, the maximum light occurring at periastron.

XIII. The spectrum of hydrogen seen in the case of the nebulæ seems to be due to low electrical excitation, as happens with the spectrum of carbon in the case of comets. Sudden changes from one spectrum to the other are seen in the glow of meteorites in vacuum tubes when a current is passing, and the change from H to C can always be brought about by increased heating of the meteorite.

XIV. Meteorites are formed by the condensation of vapours thrown off by collisions. The small particles increase by fusion brought about again by collisions, and this increase may go on until the meteorites may be large enough to be smashed by collisions, when the heat of impact is not sufficient to produce volatilization of the whole mass.

XV. Beginning with meteorites of average composition, the extreme forms, iron and stony, would in time be produced as a result of collisions.

XVI. In recorded time there has been no such thing as a "world on fire" or the collision of masses of matter as large as the earth, to say nothing of masses of matter as large as the sun; but the known distribution of meteorites throughout space indicates that such collisions may form an integral part of the economy of Nature. The number of bodies, however, subject to such collision is small, and must, it would appear, form but a small percentage of the celestial bodies, seeing that they must be consolidated.

XVII. *Special solar applications.*

α. The solar spectrum can be very fairly reproduced (in some parts of the spectrum almost line for line) by taking a composite photograph of the arc spectrum of several stony meteorites, chosen at random, between iron meteoric poles.

β. The carbon which originally formed part of the swarm the condensation of which produced the sun has been dissociated by the high temperature brought about by that condensation.

γ. The indications of carbon which I discovered in 1874 (Proc. R.S., vol. xxvii. p. 308) will go on increasing in intensity slowly until a stage is reached when, owing to the reduction of temperature of the most effective absorbing layer, the chief absorption will be that of carbon—a stage in which we now find the stars of Class III.*b* of Vogel's classification.

δ. At the present time it seems probable that among the chief changes going on in the solar spectrum are the widening of K and the thinning of the hydrogen lines.

### Experiments upon which the Foregoing Conclusions depend.

*A.* Experiments upon carbon.

The main conclusions which may be stated here are that there are two systems of flutings which depend upon temperature only.

At low temperatures all compounds of carbon give a set of simple flutings, the brightest of which are at wave-lengths 4510, 4830, 5185, and 5610. At higher temperatures there is a series of compound flutings, the brightest edges of which are at wave-lengths 4380, 4738, 5165, and 5640. In the case of compounds of carbon with hydrogen there is an additional fluting at wave-length 4310, and this is the only criterion for the presence of hydrocarbon among the flutings shown on the map. (See Map 3.)

*B.* Experiments upon the luminous phenomena of the various metals volatilized in the bunsen burner and the oxy-coal-gas blow-pipe flame as compared with the phenomena seen at higher temperatures.

The main conclusions are that certain lines, bands, and flutings are seen in the bunsen burner, that a larger number is seen in the flame, and that the total number seen in the burner and flame is small.

The order of visibility in the bunsen is, roughly—

| | |
|---|---|
| Lines ... | Mg |
| | Na |
| | Li |
| | Tl |
| | Sr |
| | Ba |
| | Ca |
| | K |
| | Mn |
| | Bi |
| Bands | Ca |
| | Sr |
| | Ba |
| Flutings | Mg |
| | Mn |

All the observations both of bunsen and oxyhydrogen flame may be condensed as follows:—

| | |
|---|---|
| In metals of the alkalies ... ... | Na |
| | K |
| | Li |
| ,, ,, alkaline earths ... | Ca |
| | Sr |
| | Ba |
| In magnesian metals .. ... ... | Mg |
| | Zn |
| | Cd |
| In iron metals ... ... ... ... | Fe |
| | Ni |
| | Co |
| | Mn |
| | Cr |
| In metals which yield acids ... ... | Bi |
| | Ti |
| | W |
| In copper metals ... ... ... | Cu |
| | Tl |
| In noble metals ... ... ... | Ag |
| | Hg |
| In earthy metals ... ... ... | Ce |

The following table shows the positions of the principal lines, bands, and flutings seen in the spectrum of each of the metals examined, arranged roughly in the order of their intensities.

It should here be stated that as some of the researches have had to deal with feeble illumination small dispersion has been of necessity employed, and to make the observations along the several lines comparable a one-prism spectroscope has been so far used throughout. Hence the wave-lengths given are in all cases only approximate. With this proviso the lines observed have been as follows:—

| | | |
|---|---|---|
| Lines | *In bunsen—* | |
| | Mg | 5183, 5172, 5167, 4586, 5201. |
| | Na | 5889, 5895. |
| | Li | 6705. |
| | Tl | 5349. |
| | Sr | 4607. |
| | Ba | 5534. |
| | Ca | 4226. |
| | Mn | 5395. |
| | K | 6950. |
| | Bi | 4722. |
| | *Seen on passing from the temperature of the bunsen to that of the oxy-coal-gas flame—* | |
| | Fe | 5268, 5327, 5371, 4383, 5790, 6024. |
| | Cu | 5105, 5781, 5700. |
| | Cr | 5202, 5203, 5207, 5410. |
| | Zn | 4810, 4911. |
| | Cd | 5085. |
| | Ni | 5476. |
| | Ti | 5128, 5338. |
| | W | 5490, 5511. |
| | Ag | 5208, 5464. |
| | Hg | 5460. |
| | Ce | 5273, 5160. |
| Bands | *In bunsen—* | |
| | Ca | 5535, 6250, 6500, 6000. |
| | Sr | 6050. |
| | Ba | 5150, 5250, 5330, 4860. |
| | *Seen on passing from the temperature of the bunsen to that of the oxy-coal-gas flame—* | |
| | Co | 4710, 4920, 5170, 5460. |

Flutings
*In bunsen—*

| | |
|---|---|
| Mg | 5000 |
| Mn | 5580, 5860, 6145, 5340 |

*Seen on passing from the temperature of the bunsen to that of the oxy-coal-gas flame—*

| | |
|---|---|
| Ba | 6010, 6350, 6480 |
| Cr | 5360, 5570, 5800, 6040 |
| Fe | 6150 |
| Cu | 6050, 6130 |
| Zn | 5460, 5680, 4985, 5140, 5340 |

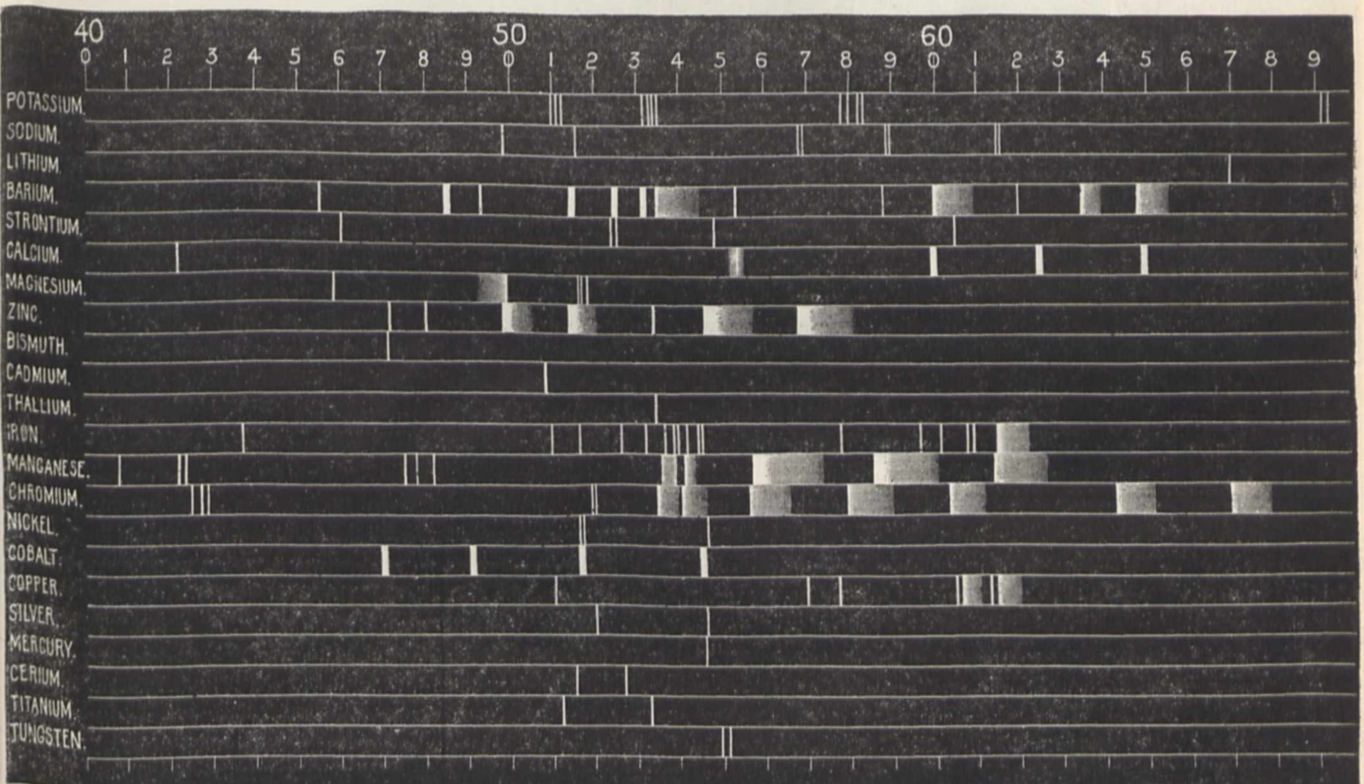
All the flutings, with the exception of magnesium, have their maxima towards the blue, and shade off towards the red end of the spectrum. (See Map 1.)

*C.* Experiments upon Mg at low temperatures.

I have again gone over the experiments already communicated to the Royal Society (Proceedings, vol. xxx. p. 27), and in addition have observed the spectrum of the metal burning in the centre of a large bunsen burner, in which case we get the line at 5201, and the fluting in the position of *b* without the fluting at 500. In the Bunsen as ordinarily employed the fluting at 500 far eclipses the other parts of the spectrum in brilliancy, and at this temperature, as already observed by Messrs. Liveing and Dewar (Proc. R.S. vol. xxxii. p. 202), the ultra-violet line visible is that at 373. Lecoq de Boisbaudran has observed the lines in the chloride at 4705 and 4483 ("Spectres Lumineux," p. 85).

*D.* Experiments upon the glow of Na and Mg in vacuum tubes.

A small piece of sodium, free from hydrocarbon, was placed in the lower limb of an end-on spectrum tube, and arrangements made for observing the spectrum of the gas evolved when the sodium was heated. Having first obtained as perfect a vacuum as possible, the sodium was gently heated, and the spectrum of the gas then gave nothing but the C and F lines of hydrogen. The pump being stopped and the sodium heated, a point was reached when C and F became very dim and were replaced by the structural spectrum of hydrogen.




MAP 1.—Spectra of metals at the temperature of the oxy-coal-gas blowpipe.

In another experiment the sodium was replaced by a piece of magnesium along the end-on tube. The same process being gone through, similar phenomena were observed, but in the latter case there was a line at 500, in addition to the lines seen in the case of sodium.

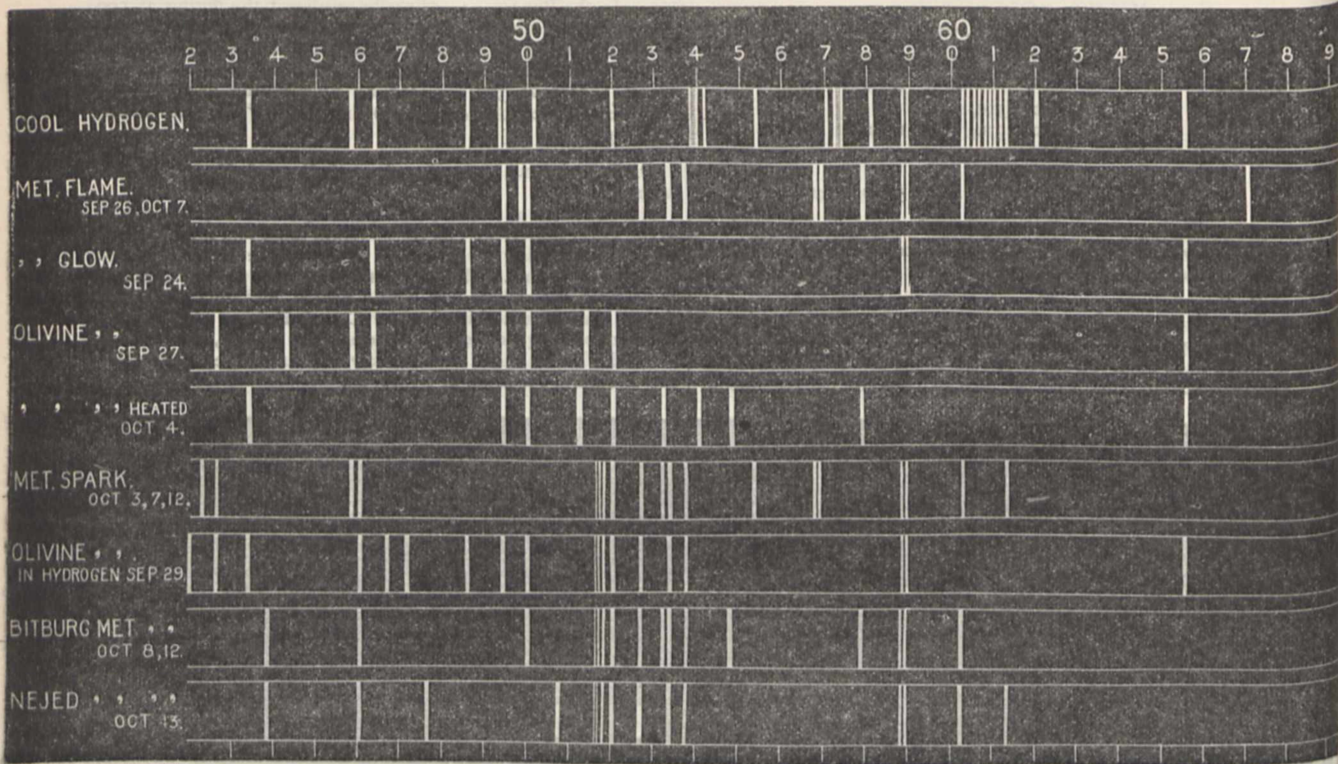
The important point, then, is the existence of a line at 500 in the spectrum when magnesium is heated, and the absence of such a line in the gas evolved from sodium under the conditions stated.

*E.* Experiments upon the conditions under which the C and F lines of hydrogen disappear from the spectrum.

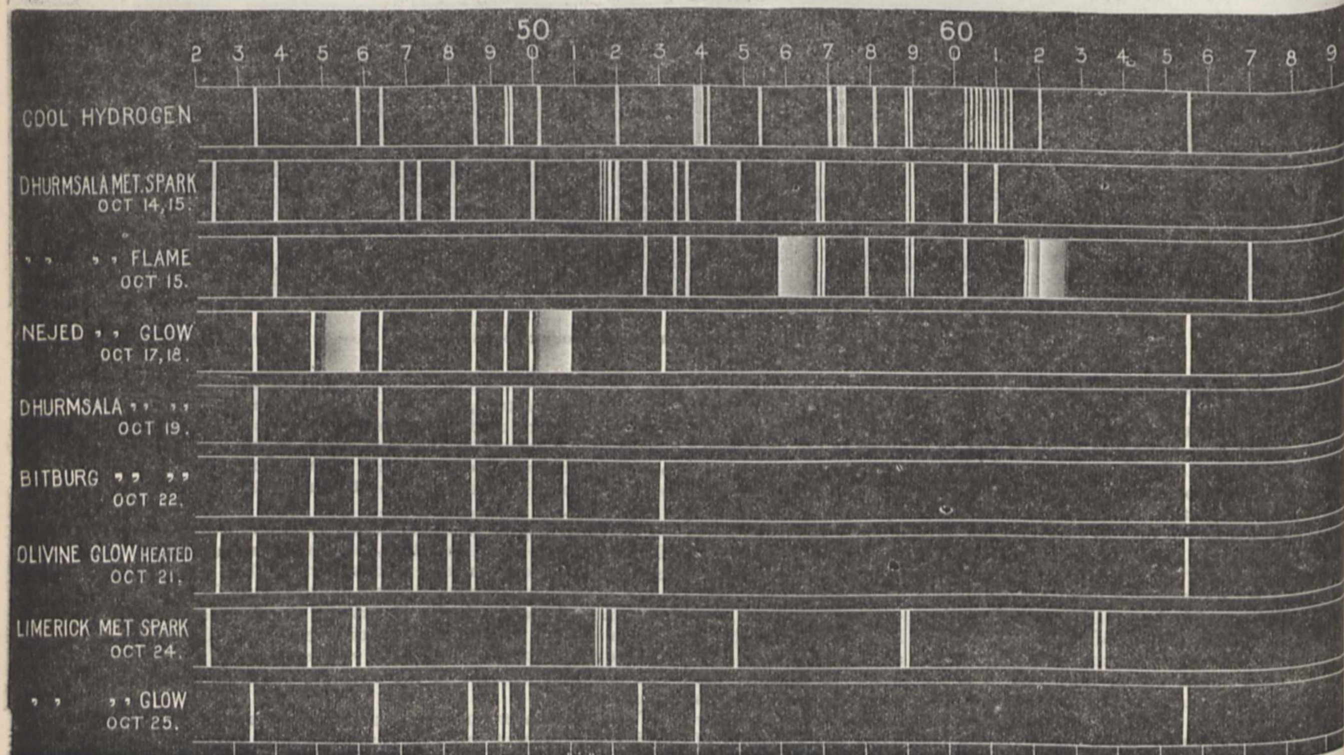
The association of the bright lines of hydrogen with nebulæ and many of the stars with bright lines and the so-called new stars points out at once that it is important to consider the various changes which hydrogen can undergo under various conditions of temperature and pressure. I pointed out many years ago that, when under certain conditions the spectrum of hydrogen is examined at the lowest possible temperature, the F line retains its brilliancy long after C disappears; and the fact that, after all the lines of hydrogen may be made to disappear from the spectral tube, the spectrum which remains visible, and is sometimes very brightly visible, is also due to hydrogen, has always been a matter of thorough belief in my mind, although so many observers, down even to M. Cornu not so very long ago, have been inclined to attribute it to the existence of "impurities."

I began to map the so-called structural spectrum at the College of Chemistry in 1869, but other matters supervened which prevented the accomplishment of this work. This, however, is a matter of small importance, because quite recently Dr. Hasselberg has communicated to the St. Petersburg Academy an admirable memoir on the subject, accompanied by a map (Mémoires de l'Académie Impériale, series vii. vol. xxx. No. 7, Hasselberg). The brightest portions of the structure spectrum are shown in Map 2.

The most convenient way of obtaining a supply of hydrogen for investigations of this kind is to use a little sodium which has never been in contact with hydrocarbon, or a piece of magnesium wire; to place them in the low end of a glass tube, one part of




Map 2.—Spectra of olivine and meteorites under various conditions.




Map 2A.—Spectra of olivine and meteorites under various conditions.

which can be used as an end-on tube, and then, after getting a vacuum so perfect that the spark will not pass, to slightly heat the metal. After a time the spectrum of hydrogen, sometimes accompanied by the low-temperature flutings of carbon, begins to be visible alike from the sodium and the magnesium.

If the vacuum has been very perfect to start with, the bright lines C and F will at first be visible without any trace of structure, and the hydrogen will be of a magnificent red colour. If now the action of the pump be stopped and the sodium be still more heated, a point will be reached at which the conductibility of the gas is at its maximum, and then, the jar not being in circuit, the structure-spectrum of the gas will be seen absolutely alone, without any trace of either C or F. The gradual disappearance of the F line is very striking, and when the bright line is out of the field the lines due to the structure seem to be enhanced in brilliancy.

The brightest part of the spectrum is then that near D; in the blue-green we have a line at 464 more refrangible than F, and then a doube line at 4930 and 4935; other less refrangible lines are seen. These are phenomena seen associated with sodium, but if we use the hydrogen produced from a piece of magnesium wire or from a crystal of olivine, under the same circumstances we find that so far as the lines of hydrogen go the phenomenon remains the same, but that there is then visible in the spectrum a line at 500, which has been recorded in the spectrum of magnesium under other conditions, not only by myself but by Dr. Copeland.[1]

*F.* Experiments upon the spectra of meteorites at low temperatures.

All the later observations recorded have been made on undoubted meteorites, fragments of which have been in the kindest manner placed at my disposal.

I. In the oxyhydrogen flame.

The observations gave in all only about ten or a dozen lines belonging to the metals magnesium, iron, sodium, lithium, and potassium, and two flutings, one of manganese, and one of iron.

II. With a quantity coil without jar.

The observations gave in all about twenty lines belonging to the metals magnesium, sodium, iron, strontium, barium, calcium, chromium, zinc, bismuth, and nickel, and four lines of unknown origin.

III. When heated in a vacuum tube when a current is passing along it.

A small piece of iron meteorite was inclosed in the middle of a horizontal tube, so that the spark might be made to pass through the tube and over the meteorite. After complete exhaustion has been obtained, the first spectrum observed when the tube, end on, is placed in front of the spectroscope, is a spectrum of hydrogen. The carbon flutings are only visible occasionally. If the meteorite then be very gently warmed by placing a Bunsen burner at some distance below the tube, the glow over the meteorite is seen to change its colour, and the line at 500 is constantly, and another line at 495, apparently exactly in the position of the second line of the spectrum of the nebulæ, is occasionally, seen. This line is more refrangible than the structure line of hydrogen in this region, which occupies the same position as the barium line. This, however, if the heating is continued, especially in the case of stony meteorites, is soon succeeded by a much more brilliant green glow, in which magnesium *b* and many other lines appear, now accompanied by the carbon flutings. The observations made under all the above conditions are shown in Maps 2 and 2A.

In these observations if a line in the meteorite spectrum were coincident with a metallic line, with the dispersion employed, in the absence of the brightest line of that metal, the line was regarded as originating from some other substance. Thus a line was sometimes seen at 5480, apparently coincident, with the dispersion employed, with the green lines of Sr and Ni; sometimes the brightest line of Sr at 4607 was absent, and it was then fair to assume that the presence of 5480 was due to Ni, but in the presence of 4607 it might be due to Sr.

[1] "To this table must be added 500·6 mmm. as the wave-length of the first line in the great band of magnesium as determined by M. Lecoq de Boisbaudran from the spark-spectrum of the chloride of that metal, which evidently agrees with the flame-spectrum, in this region at least. It is worthy of note that this line almost absolutely coincides with the brightest line in the spectra of planetary nebulæ" (Dr. Copeland, *Copernicus*, vol. ii. p. 109).

Comparisons of the Foregoing Observations among themselves and with those made on various Orders of Celestial Bodies.

The discussions have taken, in the first instance, the form of comparisons of the different phenomena observed, and for this purpose all recorded observations of flutings and bright lines and dark lines in stars, comets, nebulæ, &c., have been carefully mapped in addition, all records having, when necessary, been brought to a common scale. Having these maps, I could then compare the totality of celestial observations with the laboratory work to which reference has already been made.

The following are among the comparisons already dealt with:—

I. The spectra of meteorites observed under the various conditions, chiefly considering magnesium, iron, and manganese, with the bright lines observed at low temperatures.

The main conclusions are:—

(1) That only the lowest temperature lines of Mg, Na, Fe, Cr, Mn, Sr, Ca, Ba, K, Zn, Bi, and Ni are seen in the meteorites under the various conditions. They are not all seen in one meteorite or under one particular condition; the details of individual observations are fully recorded in Maps 2 and 2A.

(2) That in the case of Mg the line most frequently seen is the remnant of the fluting at 500, while in a photograph the main ultra-violet line recorded is the one at 373, previously recorded under these conditions by Messrs. Liveing and Dewar. In the quantity spark other lines are seen, notably $b_1$, $b_2$, $b_4$, and 5201. The line at 500 was considerably brightened when the number of cells was reduced, thus showing it to be due to some molecule which can exist best at a low temperature.

(3) That in the case of Mn the only line visible at the temperature of the bunsen burner, 5395, is the only line seen in the meteorites.

(4) That the lines of iron seen in the meteorites are those which are brightest when wire gauze is burned in the flame. The chief of these are 5268, 4383, 5790, and 6024; it is possible, however, that the two latter are due to some substance, not iron, common to the gauze and the meteorites.

II. The spectra of meteorites generally, with the bright lines and flutings seen in luminous meteors, comets, and some "stars."

*a.* Luminous meteors.

With regard to the records of luminous meteors, it may be remarked that the observations, so far as they have gone, have given decided indications of magnesium, sodium, lithium, potassium, and of the carbon flutings seen in comets. The following quotations from Konkoly and Prof. Herschel are among the authorities which may be cited for the above statement.

"On August 12, 13, and 14, I observed a number of meteors with the spectroscope; amongst others, on the 12th, a yellow fireball with a fine train, which came directly from the Perseid radiant. In the head of this meteor the lines of lithium were clearly seen by the side of the sodium line. On August 13, at 10h. 46m. 10s., I observed in the north-east a magnificent fireball of emerald-green colour, as bright as Jupiter, with a very slow motion. The nucleus at the first moment only showed a very bright continuous spectrum with the sodium line; but a second after I perceived the magnesium line, and I think I am not mistaken in saying those of copper also. Besides that, the spectrum showed two very faint red lines."[1]

"A few of the green 'Leonid' streaks were noticed in November (1866) to be, to all appearances, monochromatic, or quite undispersed by vision through the refracting prisms; from which we may at least very probably infer (by later discoveries with the meteor-spectroscope) that the prominent green line of magnesium forms the principal constituent element of their greenish light."[2]

Again, later on in the same letter, Prof. Herschel mentions Konkoly's observation of the bright *b* line of magnesium in addition to the yellow sodium line in a meteor on July 26, 1873.

I again quote from Prof. Herschel:—

"On the morning of October 13 in the same year, Herr von Konkoly again observed with Browning's meteor-spectroscope the long-enduring streak of a large fireball, which was visible to

[1] Konkoly, *Observatory*, vol. iii. p. 157.
[2] Herschel, letter to Nature, vol. xxiv. p. 507.

the north-east of O'Gyalla. It exhibited the yellow sodium line and the green line of magnesium very finely, besides other spectral lines in the red and green. Examining these latter lines closely with a star-spectroscope attached to an equatorial telescope, Herr von Konkoly succeeded in identifying them by direct comparison with the lines in an electric Geissler-tube of marsh-gas. They were visible in the star-spectroscope for eleven minutes, after which the sodium and magnesium lines still continued to be very brightly observable through the meteor-spectroscope."[1]

The green line "*b*" of magnesium occurring as a bright line in luminous meteors indicates that their temperature when passing through our atmosphere is higher than that of the bunsen, and we may add of comets as generally observed, although some exhibit the *b* lines of magnesium and those of iron when at perihelion, as shown later on.

The two lines which Konkoly supposes are probably due to copper will, I expect, be found to be iron lines when other observations are made of the spectra of meteors.

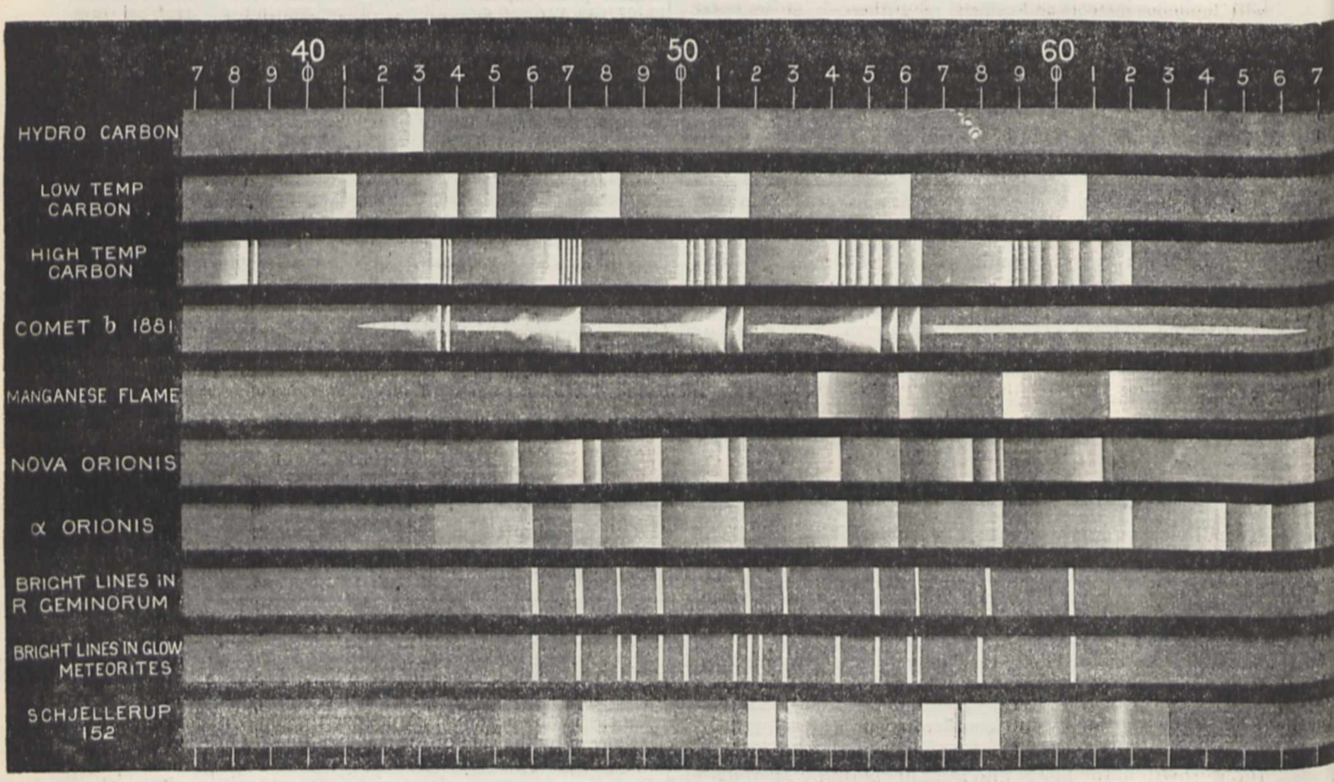
The main conclusions from this comparison are then: (1) that the temperature of luminous meteors is higher than that of the bunsen flame; (2) that the meteorites which produce the phenomena we are now discussing are hotter than those in the experimental glow taken generally; and (3) that in both cases flutings of carbon may be seen.

*β*. Comets.

When the meteorites are *strongly* heated in a glow-tube, the whole tube when the electric current is passing gives us the spectrum of carbon.

When a meteor-swarm approaches the sun, the whole region of space occupied by the meteorites, estimated by Prof. Newton in the case of Biela's comet to have been thirty miles apart, gives us the same spectrum, and further it is given by at all events part of the tail, which in the comet of 1680 was calculated to be 60,000,000 miles in length. The illumination therefore must be electrical, and possibly connected with the electric repulsion of the vapours away from the sun; hence it is not dependent wholly upon collisions.

Passing now from the flutings seen in cometary spectra, it is found that most of the lines which have been observed at perihelion are coincident with lines seen in experiments with meteorites,




MAP 3.—Comparison of flutings seen in the spectra of "stars" and comets with flutings of carbon, manganese, and zinc; and, in the case of R Geminorum, lines with remnants of flutings and lines seen in a meteorite glow. (The Zn fluting is at λ 544 in α Orionis.)

while the low temperature lines of Mg are absent. In the great comet of 1882, to which particular attention has been given on account of the complete record of its spectrum by Copeland,[2] the lines recorded were the D lines of sodium, the low-temperature iron lines at 5268, 5327, 5371, 5790, and 6024, the lines seen in the manganese spectrum at the temperature of the bunsen burner at 5395 and 5425, and a line near *b* which might be due to magnesium, or to a remnant of the carbon fluting. In addition to these there was a line at 5475, probably due to nickel, the absence of the blue strontium line indicating that it is not likely to be the green line of strontium. There were also four other lines less refrangible than D, the origin of which has not yet been determined. As the comet got further from perihelion the lines gradually died out, those which remained longest being the iron line at 5268 and the line near *b*. The absence of D before the disappearance of all the lines is probably to be accounted for partly by the greater brightness of the continuous spectrum in that region.

In the comets of 1866–67, when seen away from the sun, the only line seen was the one at 500.[1]

It is fair to myself to say that I was not aware of these observations when I began to write this paper. The fact of the line at 500 remaining alone in Nova Cygni made it clear that if my views were correct, the same thing should happen with comets. It now turns out that the crucial observation which I intended to make was made twenty years ago.

[1] Herschel, letter to NATURE, vol. xxiv. p. 507.
[2] *Copernicus*, vol. ii. p. 234.

[1] "In January 1866 I communicated to the Royal Society the result of an examination of a small comet visible in the beginning of that year (Proc. R.S. vol. xv. p. 5). I examined the spectrum of another small and faint comet in May 1867. The spectra of these objects, as far as their feeble light permitted them to be observed, appeared to be very similar. In the case of each of these comets the spectrum of the minute nucleus appeared to consist of a bright line between *b* and F, about the position of the double line of the spectrum of nitrogen, while the nebulosity surrounding the nucleus and forming the coma gave a spectrum which was apparently continuous" (Huggins, Proc. R.S. vol. xvi. p. 387).

In Comets *b*, 1881, and *c*, 1882, the only lines recorded were magnesium *b*; but, as before, the apparent absence of other lines might be due to continuous spectrum.

Of the five bands shown in Huggins's photograph of the spectrum of Comet Wells, taken with a wide slit, no less than three agree fairly in position with three lines seen in the spectra of meteorites. The wave-lengths of these are 4253, 4412, and 4769, and it is interesting to note that, so far, the origin of these lines is undetermined. The two remaining bands are at wave-lengths 4507 and 4634.

It is seen, then, that the spectra of comets—when their internal motions are relatively either slow or fast, and when therefore the number of collisions, and with them the heat of the stones in collision, will vary extremely—resemble the spectra of meteorites seen in glow tubes.

($\gamma$) "Stars" with flutings which have been observed in the laboratory and in luminous meteors and comets.

The most prominent bright flutings of carbon are not only observed in luminous meteors and comets, but in stars of Class III.*a*, and in some "Novas," notably Nova Orionis. So far, then, these bodies may in a certain measure be classed with luminous meteors and comets. But there is an important difference in the phenomena, for we have absorption as well as radiation. The discussion shows that the dark (or absorbing) flutings in these bodies are partly due to the absorption of light by the most prominent flutings of Mn and Zn, seen at low temperatures. This inquiry is being continued.

We have, then, in these bodies a spectrum integrating the *radiation* of carbon and the *absorption* of Mn and Zn vapour.

The law of parsimony compels us to ascribe the bright fluting of carbon in these stars to the same cause as that at work in comets, where we know it is produced by the vapours between the individual meteorites or repelled from them.

Hence we are led to conclude that the absorption phenomena are produced by the incandescent vapour surrounding the individual meteorites which have been rendered intensely hot by collisions.

These stars, therefore, are not masses of vapour like our sun, but clouds of incandescent stones.

We have here probably the first stage of meteoritic condensation. J. NORMAN LOCKYER.

(*To be continued.*)

## *FAIRY-RINGS.*

THE rains have come, and we have heard from all sides of the prolific crops of mushrooms and toadstools —paddock-stools, as they are termed in some northern districts—which have been springing up in the meadows and woods of England, Wales, and Scotland. Not only is surprise evinced at the marvellously rapid up-growth of these fungi, for the popular mind may well be amazed at that until a knowledge of the biology of these plants is more universal, but country people and dwellers in towns alike exclaim at certain other phenomena associated with their growth in the fields, and at none, perhaps, so much as what have been known from of old as "Fairy-rings" in England, *Hexenringe* and *Cercles de sorcières* on the Continent. Now fairy-rings, like very many other poetical objects, have of late years undergone the process of being explained away to an extent which, although it in no way removes the beauty from them, demands from us an admiration of a more stimulating and healthful character than the old awe which they inspired was capable of producing.

Disbelief prevails regarding Prospero and the beings that

> "By moonshine do the green sour ringlets make,
> Whereof the ewe not bites;"

and

> "whose pastime
> Is to make midnight mushrooms."

Fairy-rings are more or less regular and complete rings of grass, sharply distinguished from the ordinary grass surrounding them by means of their darker hue, more luxuriant growth, and other characters; in spring or autumn they are to be found with vigorous growths of mushrooms or toadstools springing from their outer margins, and the centre of the ring is often marked by a very poor crop of withered-looking herbage.

Before proceeding to give an account of the modern explanation of these remarkable objects, a few statements may be made as to their sizes, structure, and occurrence.

They are not always complete or regular rings, but may be parts of circles or ovals, or mere wavy strips. Nor are they always provided with the outer belt of fungi, though the rule is that a good season sees them so accompanied; if not, they do not remain long. In the typical cases, where the ring is annually provided with its fringe of fungi, it may go on increasing in size for years: records exist of rings which have been known to go on flourishing for forty or sixty years, and large rings on a hill-side could be seen from a considerable distance.

As to their sizes, they are known to commence as very small patches, but specimens have been measured as much as 60 feet and more in diameter. Indeed one observer refers to a fairy-ring which was nearly 100 feet across. While regarding these cases as rare extremes, it is well known that rings 12–20 feet in diameter have often been recorded, and, as we shall see, these must be several or many years old.

Although fairy-rings are usually noticed in meadows and on pasture lands, they are found on hills as well as in valleys, on dry soil as well as on wet, in woods and on heaths, and even in rocky places and situations near the sea. Perhaps the only generalization possible in this connexion is that they do not occur on highly-cultivated rich land.

On regarding carefully a typical fairy-ring, it may be found to present the following characters:—The central area, encompassed by the dark-green ring, consists of poor or even withered herbage—it may be of inferior grasses alone, or of these mixed with other plants. Then comes the band of luxuriant grass forming the ring proper: the grass composing this may be of more than one kind—*e.g.* *Lolium perenne* (the perennial rye-grass), *Dactylis glomerata* (the cock's-foot grass), and *Bromus mollis* (the soft brome) are common.

These grasses are rank, tall, and of a distinctly darker, bluer green hue than the rest; it is their coarseness, height, and especially the deeper colour, which render them so prominent. Fringing this ring, at the proper season, are found the spore-bearing heads of the Agarics *i.e.* the mushrooms or toadstools as the case may be; and if the observer digs carefully below the soil, he will find that these Agarics spring from a felted mass of root-like threads, the mycelium of the fungus. Then, outside all, comes the general herbage of the pasture, or whatever it may be: this is often scanty, indicating poor soil, and in any case is less luxuriant and lighter in colour than the rank herbage of the ring itself.

As with the herbage composing the rings, so the Agarics fringing them may be of different kinds. In the autumn the fairy-rings of this country and on the Continent commonly contain *Marasmius oreades*, Fr., a small pale mushroom with cream-coloured gills, and much esteemed as an esculent. It has a somewhat strong aromatic odour, and its mycelium is attached to the roots of the grasses among which it grows. It must not be confounded with certain acrid species allied to it.

The common mushroom (*Agaricus campestris*, L.) is also frequently found in large circles, fringing more or less complete fairy-rings. Among other forms may be mentioned the gray *Agaricus terreus*, Schoeff, not uncommon in beech- and fir-woods; the "parasol mushroom" (*Agaricus procerus*, Scop.), also not uncommon in fir-woods and pastures, and spoken of as one of the best of the esculent forms; also *Agaricus personatus*, Fr., with a lilac or purple stem. This is a late form, good to eat, and called the "Blewit." *Agaricus subpulverulentus*, Pers., is also not uncommon, and several others are known.

In the spring, fairy-rings have been found containing *Agaricus gambosus*, Fr., an edible mushroom known in England as the "St. George's mushroom," and much esteemed on the Continent.

There are also other forms, several of them poisonous, or at least inedible or dangerous; and even puff-balls are known to be associated with fairy-rings.

And now we come to the question, How do these fairy-rings arise and increase? It cannot be wondered at that the people of earlier days, wishing to explain a phenomenon which none could overlook, sought for satisfaction in their myths and folk-lore, and believed them to be "caused" by fairies and elves and other mystic beings of the woods and fields, dancing in circles beneath the moonlight, and enchanting the ground into a richness which it did not previously possess.

Then came the era of science, and people were dissatisfied with beliefs, and in course of time the followers of De Candolle at least tried to solve the problem according to what was known of Nature. It was at least necessary to explain (1) why the centre of the ring is so poor, (2) why the fungi are confined to the margin, and (3) why the ring goes on enlarging, as continued observation showed that it did.

The first theory of any merit was, that the "ring" takes its origin from a single mushroom, which sheds its spores from the gills down on to the ground around the thick stem: this necessarily produces a ring of spores, as the stem dies down in the centre. Now the physiologists of those days believed that a plant excretes into the soil at its base substances which are harmful to its further development, and so, they argued, the soil on the inside of the ring of spores is poisoned, as it were, and only the outer spores produce new plants. The new mushrooms come up in a ring, and in their turn shed spores in a ring of rings; but since the soil on the inside of all these rings is poisoned by the excreta, only the outer series can germinate and grow, and thus a new ring arises next season, and so on. But, it was thought, though the excreta are injurious to the growth of the same plant (the fungus in this case) in that particular soil, other plants can grow there (in the present instance, grasses), and so a ring of rank grass follows on, which in its turn spoils the soil for its own kind as it increases.

Now it has to be admitted that there was much ingenuity in this hypothesis, and it was maintained for some time; until, in fact, physiologists had to give up the excretion theory as not in accordance with observed facts.

Then followed the beginnings of the celebrated doctrine of the rotation of crops, and the facts accumulated about fairy-rings had to be looked at again. They had become too much for the excretion theory; how did they look when regarded from the new point of view? First, however, we may bear in mind the fact noticed by several observers. When two fairy-rings gradually extend so as to interfere, the green circles coalesce and form a single ring: evidently the conditions of the soil in the wake of the advancing ring are such that the grass of another advancing ring cannot go on luxuriating there. It is true this fact was as easily made use of by those who maintained the excretion theory as by those who advanced the theory we are now going to examine.

It gradually came to be recognized that the reason one species of plant cannot be continually grown on the same soil was not because the first crop poisons the soil by leaving injurious excreta behind it, but because it *takes away* certain mineral substances in such proportions that too little is left for the well-being of a second crop of the same species; in other words, it *exhausts* the soil of certain necessary ingredients. A crop of some other species may be raised on the partially exhausted soil, however, provided it is a plant which does not need the materials now deficient, in such large quantities as its predecessor. This is, roughly sketched, the *rationale* of the doctrine of the rotation of crops, and it was subsequently suggested that the "fairy-rings" we are considering are a natural illustration of this. The vegetable physiologists then came to the conclusion that the fungus causes the fairy-ring by exhausting the soil of certain substances which are necessary to its existence, and is only able to produce continued crops by extending centrifugally into soil which still yields these substances: the grass, however, does not need these substances in such large proportions, and so follows the fungus. But, as we have seen, the grass which immediately follows the fungus is particularly rank and luxuriant, and it was necessary to find an explanation for this fact. It was then suggested that the dying mycelium of the fungus acts as a manure for the grass to feed upon, and until this is exhausted the growth is peculiarly rich and rampant.

Before leaving this part of our subject, it should be pointed out that Dr. Wollaston, in an essay on fairy-rings published in the Philosophical Transactions of the Royal Society so long ago as 1809, ventured on the explanation that the fungi spread in rings, because the soil was, by their mycelium, progressively "exhausted of some peculiar pabulum necessary for their production. . . . An appearance of luxuriance of the grass would follow as a natural consequence, as the soil in the interior of a circle would always be enriched by the decayed roots of fungi of the preceding year's growth."

Meanwhile, the physiology of plants was passing into a more scientific phase of existence, and the beginnings of modern agricultural chemistry were made; and in 1846 an important contribution to our knowledge of fairy-rings was afforded by Way, who chemically analyzed the soil, the herbage, and the fungi of some of these curious formations. This chemist found that the fungi of his fairy-rings were remarkably rich in phosphoric acid and in potash; and that they also contained relatively large quantities of nitrogen. We know now that this is true of fungi generally, but these facts were by no means so well understood at that time. Way also analyzed the grasses composing the ring, and found that they also contained a larger proportion of phosphoric acid and potash than the herbage in the neighbourhood, but by no means so much as the fungi: the grass also contained considerable quantities of nitrogen.

The net result of these investigations was to explain fairy-rings as an illustration of the rotation of crops, but of course putting the explanation on much firmer grounds. Way also pointed out that as the rank green grass was cut or otherwise removed, valuable ingredients (phosphorus, potassium, alkalies, &c.), were removed with it, and so the crops of grass further inwards become poorer and poorer, accounting for the bare patches often found inside the dark ring.

Messrs. Lawes and Gilbert, whose magnificent experiments on the vegetation of agriculture will never be forgotten, supported the above view of the matter, and showed that the dark-green colour of the rank grass is due to the relatively large quantities of nitrogen. It was at this time (about 1850) customary to suppose that plants obtained their nitrogen from the atmosphere, a view now known to be erroneous from the brilliant researches of Boussingault, and of Lawes and Gilbert themselves. On this supposition the extraordinary accumulation of nitrogen (in the fungus and rank grass) was thought probably due to a power on the part of the fungus of taking nitrogen from the air. Subsequently the whole matter was again taken in hand by Messrs. Lawes and Gilbert, and the results published in the Journal of the Chemical Society, 1883.

The chief additional facts may be summarized as follows:—The fungi remove large quantities of carbon, nitrogen, and especially phosphoric acid and potash, from the soil. The soil inside the ring contains less nitrogen than that under the ring, and this again less than the soil outside the ring; a gradual exhaustion of nitrogen, then, is taking place as the fungus and rank grass extend the ring centrifugally, and this is promoted by the removal of the grass. These observers also demonstrated the spread of the mycelium: it is in greatest abundance just below the outer edge of the ring. They conclude that the fungus has powers of obtaining nitrogen from compounds in the soil which are not available to the roots of the green herbage, but after the decay of the fungus mycelium the grasses can avail themselves of part of the nitrogen. The grasses—being plants containing chlorophyll—of course obtain their carbon from the carbon dioxide of the atmosphere; but the fungus—equally of course, in the light of physiology—obtains its carbon from some organic substances in the soil. The accumulation of phosphoric acid and potash has already been accounted for.

We may now sum up, then, the rational explanation of these curious fairy-rings as follows.

A mushroom spore may be supposed to start its growth in or beneath the dung of cattle, or a bird, on poor soil; the first crop of mushrooms, produced from the mycelium to which the spore gave rise, exhausts the soil of available carbon, nitrogen, phosphorus, potash, and other substances, storing all it can get in its own substance. The mycelium extends centrifugally "into fresh fields and pastures new," and the next crop of mushrooms arises at a distance from the centre; and so the growth proceeds. The grasses, among the roots of which this extension is going on, now avail themselves of the rich manure afforded by the decomposition of the older mycelium, and a struggle for existence is set up which results in the victory of the coarsest and rankest-growing species. These in their turn exhaust the available supply, and if cut it is removed in their substance: no wonder, then, that the inner parts of the area are poor, and support little or no herbage.

Messrs. Lawes and Gilbert's researches also showed that if the growth of the herbage is promoted by means of manures containing much available nitrogen the fungi are found to suffer, and the "fairy-ring" may be brought to an end. Again, unfavourable seasons of drought may cause the death of the mycelium, and rings which have flourished for years be thus destroyed.

We have attempted in this article to give a complete explanation of the rise and progress of "fairy-rings," as afforded by modern science. That much is clear which was previously obscure will have to be conceded; but are all the facts covered by the explanation? There are some inquiring spirits who are never satisfied with an explanation, and we run the risk of being classed among these malcontents, but there are one or two curious little points which still obtrude themselves upon our attention.

There is, in the first place, some difficulty in realizing how the fungi manage to obtain their large supplies of carbon and nitrogen and other elements from poor shallow soil, in the absence of larger quantities of organic matter than may occur: there is, in fact, considerable difficulty about the whole question of the nutrition of the fungus. A second point is that we find the ultimate filaments into which the mycelium of the fungus breaks up becoming lost among the roots of the grasses; and if the latter are carefully washed and examined with the microscope, their fibrils and root-hairs can be seen to be infolded by delicate hyphæ, and in some cases the root-hairs are pierced by them. We do not know that this has been demonstrated before, but we find it the rule with *Marasmius*, and have already succeeded in detecting something of the kind in other forms.

Now this looks very like parasitism; and we are tempted to pause before accepting the last explanation of fairy-rings as conclusive, or covering all the facts. It may be, in fact, that the hyphæ of the fungus stimulate the roots of the grasses to increased activity: this would account for the rampant growth and the result of the struggle for existence. Subsequently the hyphæ kill the grass-roots—or at any rate those of some species—which accounts for the bare patches in some rings. It also easily explains the sources of the carbon and nitrogen, if the hyphæ absorb nutritive materials from the hard-working grass-roots. This being the case, fairy-rings become still more interesting, since they afford an illustration of symbiosis of a peculiar kind, at any rate during part of the time that the grass and the fungus are in contact; and it seems not improbable that the theory of the formation of fairy-rings will have to be modified somewhat as follows.

A fungus-spore starts its mycelium among the roots of the grasses, and the hyphæ obtain a hold on some root-hairs and fibrils; the mycelium thus parasitic on the roots reacts in a stimulating manner on the latter, and we have a symbiotic relationship established between the fungus and the host. The consequence is that both flourish, and become rampant. It may be that only some grasses are thus stimulated, or even attacked, and this will affect their struggle for existence, and result in the selection of a few coarse forms. In time the hyphæ or the roots get the upper hand, and this is expressed in the survival of the grass, or its decay; in some cases it is clear that hyphæ are living at the expense of dead and dying roots.

However, until the results of investigations at present going on are set forth more at length, it is impossible to say which of the above explanations is the true one; in any case, the attachment of fungus hyphæ to the living grass-roots needs explanation, and it must also be allowed that at present we have no satisfactory theory to account for the nutrition of these rampant mycelia. But this is not the place to do more than point out how interesting the subject is, and how promising a field for further research it offers.

## NOTES.

MR. W. BATESON, Fellow of St. John's College, Cambridge, who has just returned from a zoological expedition to Central Asia, and is well known for his researches on *Balanoglossus*, has been awarded the Balfour Memorial Studentship in Animal Morphology.

THE second meeting of the newly-formed Anatomical Society of Great Britain and Ireland will be held on Tuesday, November 22, at University College, Gower Street, at 5 p.m. The following papers will be read:—Prof. Sir William Turner, F.R.S., (1) "Variations in the Hippocampus Major and Eminentia Collateralis," by Robert Howden, and (2) "A Metallic Body in the Spinal Canal," by David Hepburn; (3) "Minute Anatomy of Clarke's Column in Spinal Cord of Man, the Monkey, and the Dog," by Dr. Mott; (4) "The Arteries at the Base of the Brain," by Prof. Bertram C. A. Windle; (5) "Note on the Functions of the Sinuses of Valsalva and Auricular Appendices, with some Remarks on the Mechanism of the Heart and Pulse," by Mayo Collier. A number of interesting exhibits are also announced.

ON Tuesday evening the second part of an important paper upon the causes of accidents in mines and the development of measures and applications for combating or avoiding them was read by Sir Frederick Abel at the Institution of Civil Engineers. The first part of the paper was read in May last, at the close of the session. Sir Frederick's ideas will be discussed at the meeting of the Institution next Tuesday.

WE are glad to hear that the Scottish University Extension Scheme is likely to prove successful. A brilliant start has been made in Perth, where Dr. H. R. Mill is giving a course of lectures on physiography to a class of over 240 students.

SOME time ago it was arranged that three lectures on "Heredity and Nurture" should be delivered at the South Kensington Museum, on behalf of the Anthropological Institute, by Mr. Francis Galton, President of the Institute. We are requested to state that these lectures have been postponed in consequence of Mr. Galton's indisposition.

PROF. J. MCK. CATTELL's paper on "The Psychological Laboratory at Leipzig," to be read before the Aristotelian Society on the 21st, will contain an account of the aim of experimental psychology, of the Leipzig Laboratory, and of the researches which have been carried on and are being carried on in it. The paper will be published in the January number of *Mind*.

THE borings in the Delta of the Nile carried on by the Royal Society have been brought to a standstill by the breaking of the pipe. The depth reached is over 324 feet, still without the solid rock being found. It is possible that the work may be recommenced upon a larger scale.

SEVERAL years ago three Russian "lady doctors" started at Tashkend a consulting hospital for Mussulman women. From the beginning the experiment proved a success, and the popularity of the hospital has been increasing ever since. During the last twelve months no fewer than 15,000 consultations have been given.

THE Russian Consul at Kashgar writes to the Russian Geographical Society that his endeavours to obtain from the Chinese authorities permission to erect a memorial to Adolf Schlagintweit on the very spot where Schlagintweit was killed have not been successful. The memorial will be erected in the Russian cemetery, where it will be at least protected from injuries.

THE money necessary for sending out M. Wilkitski to make pendulum observations in Novaya Zemlya has been granted by the Russian Geographical Society. He will be accompanied by a naturalist, M. A. Grigorieff.

THE Moscow Society of Naturalists invites those scientific bodies which would like to receive, in return for their own publications, the series of the Moscow *Bulletin*, to communicate with the Secretary of the Society.

REPORTS from Bergen, in Norway, seem to indicate that another great rush of herring under the west coast may be expected this winter, similar to those which have taken place periodically during the last two centuries through some unknown cause. The two greatest rushes on record were those of 1740 and 1807.

DURING a hailstorm at Mors, in Denmark, a few days ago, a flash of forked lightning—the only one occurring—struck a farm, and, having demolished the chimney-stack and made a wreck of the loft, descended into the living-rooms on the ground-floor below. Here its career appears to have been most extraordinary; all the plaster around doors and windows having been torn down, and the bed-curtains in the bed-rooms rent to pieces. An old Dutch clock was smashed into atoms, but a canary and cage hanging a few inches from it were quite uninjured. The lightning also broke sixty windows and all the mirrors in the house. On leaving the rooms it passed clean through the door into the yard, where it killed a cat, two fowls, and a pig, and then buried itself in the earth. In one of the rooms were two women, both of whom were struck to the ground, but neither was injured.

THE last two numbers of the *Folk-Lore Journal* (vol. v. Parts 3 and 4) exhibit very varied fare, and show how this interesting Society is gradually embracing the whole world. Side by side with Miss Courtney's Cornish folk-lore, we have Mr. Mitchell-Linne's birth, marriage, and death rites of the Chinese, followed by the indefatigable Mrs. Murray-Aynsley's account of secular and religious dances in Asia and Africa, which extends over both numbers, and in Part 3 is succeeded by Mr. Clouston's two Pacific folk-tales. Folk-lore amongst the Somali tribes follows that of British Guiana, and is succeeded by Cornish, Irish, Malay, and North Friesland tales. Dr. Gaster's paper, in the same part, on the modern origin of fairy-tales, is a very suggestive one. Its conclusion, after an examination of certain examples, which "can be infinitely multiplied," is "that the literature of romance and novel, be it a religious romance or one of chivalry, has passed nowadays to a great extent into the literature of fairy-tales, and that, far from being the basis, the fairy-tales are the top of the pyramid formed by the lore of the people. They are the outcome of a long *literary* influence, as well as an oral one, which was exercised upon the mind and soul of the people during centuries." What may be called the editorial matter—the notes, news, &c.—is of the usual varied and interesting character.

SIR D. SALOMON'S little work on accumulators, issued by Messrs. Whittaker and Co., has passed rapidly through two editions. A third and much improved edition, with many illustrations in the text, will be ready shortly.

WE have received the first instalment of what promises to be an important book, "Die Elektricität des Himmels und der Erde," by Dr. Alfred Ritter von Urbanitzky. The complete work will contain about 400 illustrations, including several coloured plates. The publisher is A. Hartleben, Vienna.

WE have received the first number of the *American Journal of Psychology*, edited by Prof. G. S. Hall. The object of this periodical, as the editor explains, is to record psychological work of a scientific, as distinct from a speculative, character. The present number contains, besides reviews and notes, articles on the following subjects: the variations of the normal knee-jerk and their relation to the activity of the central nervous system, by Dr. W. P. Lombard; dermal sensitiveness to gradual pressure-changes, by Prof. G. S. Hall and Mr. Y. Motoro; a method for the experimental determination of the horopter, by Christine Ladd-Franklin; and the psycho-physic law and star magnitudes, by Dr. J. Jastrow.

SIX Bulletins of the United States Geological Survey, Nos. 34–39, have been sent to us. The subjects are: on the relation of the Laramie Molluscan fauna to that of the succeeding fresh-water Eocene and other groups, by Dr. C. A. White; physical properties of the iron-carburets, by Mr. C. Barus and Mr. V. Strouhal; the subsidence of fine solid particles in liquids, by Mr. C. Barus; types of the Laramie flora, by Mr. L. F. Ward; peridotite of Elliott County, Kentucky, by Mr. J. S. Diller; and the upper beaches and deltas of the glacial Lake Agassiz, by Mr. W. Upham.

IN a paper which has just been reprinted from the Transactions of the New York Academy of Sciences, Mr. J. S. Newberry maintains that the decorative ideas expressed in the monuments of the ancient inhabitants of Central America have a close resemblance to the carvings executed by the Indians of the north-western coast of America, and by the people of the Pacific Islands. "Hence," says Mr. Newberry, "I am inclined to believe, as has been suggested by Baldwin, that the seeds of this ancient civilization were brought from the East Indian Archipelago from island to island across the Pacific, and that finally reaching our continent, and prevented by the great and continuous chain of the Cordilleras from further eastward migration, it slowly spread southward to Chili, and northward to our western territories."

FIVE years ago the increase of wolves in France had become so serious that the Government found it necessary to raise the awards for killing them. In 1882, 423 wolves were killed; in 1883, 1316; in 1884, 1035; in 1885, 900; and in 1886, 760. The awards are now 200 francs for the killing of a wolf which has attacked human beings; 150 francs for one in young; 100 francs for a male wolf, and 40 francs for a cub.

IN the current number (vol. i. No. 4) of the Journal of the Pekin Oriental Society, the well-known scholar Dr. Edkins writes on local value in Chinese arithmetical notation. The principle of local value is used in Chinese commerce, strokes being used instead of special symbols for 1, 2, 3, &c., the relation of the strokes to each other showing the value of the symbol. The abacus, with its upright strings and balls, is only a help to calculation, and does not contain any new principle. Dr. Edkins describes calculating slips which have been in use in China from the most ancient times. It is curious to notice that the principle of local value adopted by the Chinese was from left to right as with ourselves. The slips here mentioned, in which local value played an important part, had been in use fourteen centuries and probably more, when in the fourteenth century the abacus was introduced. Dr. Edkins assigns the origin of the principle of local value to the Babylonians, for several reasons. The first Chinese example known to us is dated B.C. 542, while in the sixteenth century B.C. the Babylonians could extract the cube and square roots of numbers: the Hindoos do not seem to have been proficients in mathematics at so early a date as B.C. 542; so that the probability is the principle of local value in arithmetical notation found its way to China through the Phœnician traders. The Chinese, in fact, acquired it where they acquired a knowledge of the clepsydra, the dial, astronomy, and astrology.

THE creation of provincial museums in Eastern Siberia is progressing very favourably. The example given by the Minusinsk Museum has been followed at Yeniseisk, and will be followed at several other towns. The Minusinsk Museum has now 4000 specimens of plants, 2000 of animals, and 1500 of minerals. The anthropological department has numerous models of huts and houses of the Russian and native population. The archæological collection is especially interesting; it contains 218 implements of the Stone Age, 1260 of the Bronze Age, and 1850 of the Iron Age. There is, moreover, a collection of implements used in, and produced by, local domestic trades. The whole is described in a good catalogue. Last year the Museum was visited by 8000 persons.

TWO bones which were found some time ago at Pitchery Creek, Central Queensland, attracted the attention of several persons interested in science. They were lately exhibited at a meeting of the Royal Society of New South Wales, and Mr. Etheridge explained that they were portions of the vertebral column of an extinct reptile, *Plesiosaurus*. From the transverse elongation of the portions preserved, the bones partook more of the facies of the Plesiosauri of the Cretaceous group than of those found in the Lower Mesozoic deposits.

DR. SCHWERIN, who was despatched last year by the Swedish Government to the Congo, in order to ascertain whether that place was suitable for the establishment of a Swedish colony, and to make scientific researches, has returned to Sweden with good results. He also reports having made an interesting discovery at the mouth of the river, viz. the marble pillar or *padro* erected here by Diego Cam in 1484, the first Portuguese traveller who reached the Congo. The Portuguese were in the habit of raising such *padroes*, bearing the arms of Portugal, in prominent places on the West Coast of Africa, when taking possession of territory, and it was known that one had been erected by Cam at the mouth of the Congo, but it was believed that it had been destroyed. However, Dr. Schwerin, having worked out a theory of his own, searched for this ancient monument some 6 miles further inland than the position indicated on English charts, viz. Point Padro, and here he found it. Dr. Schwerin is preparing an exhaustive account of his work on the Congo, at the expense of the Swedish Government.

AN electric railway for the dinner-table is one of the recent achievements of French ingenuity (*La Nature*, October 29). It makes the presence of servants unnecessary. The train, which runs on a line along either side of the table before the diners, consists of a platform pivoted on two bogies, one of which carries the motor, while the other is merely a supporting truck. The expenditure of electric energy is but slight, and the train is said to be thoroughly under control of the host.

THERE has been much speculation as to how the ancient Egyptians managed to erect their enormous monoliths, sometimes 100 feet in height and weighing hundreds of tons. An interesting recent article in the *Revue Scientifique*, by M. Arnaudeau, offers the explanation that water was employed. Round the obelisk, lying horizontally, with the base towards the pedestal, was raised a circular inclosure, of height equal to that of the monolith. This latter had pieces of wood, or other floats, fitted to it, especially at the upper part; so that when water was brought into the inclosure, the obelisk rose gradually to the vertical. The process may be simply imitated by introducing the end of a screw nail into a piece of cork, putting it in a basin, and then introducing water.

THE pulverizing of minerals for analysis often consumes much time, requiring, as it does, great care. A mill for the purpose, constructed on the model of the wet mill in porcelain work, has been recently brought before the Berlin Chemical Society by Herr Zulkowsky (*Berichte*, October 24). The grinding-surfaces are both agate, and the circular runner, on a vertical axis, has a sector cut out of it, and one edge of this rounded. The mill is driven by water-power, a pressure of two to three atmospheres being sufficient.

IN a paper on colour-blindness, contributed to vol. v. Part 2, of the Proceedings of the Bristol Naturalists' Society, Prof. W. Ramsay suggests that the particular defect which causes colour-blindness may lie in the brain, not in the eye. Certain persons, he points out, are incapable of judging which of two musical tones is the higher, even when they are more than an octave apart. Yet such persons hear either tone perfectly; the defect is not one of deafness. "It must be concluded," says Prof. Ramsay, "that in such a case the brain is the defaulter. And it may equally well be the case that the inability to perceive certain colours is not due to a defect in the instrument of sight—the eye, but to the power of interpreting the impressions conveyed to the brain by the optic nerve. If this is the case, the problem is no longer a physical one: it falls among those with which the mental physiologist has to deal."

A SUPPLEMENTARY mail has just arrived from Iceland, from which we learn that in spite of the ice which has blockaded the eastern and northern shores of the island there has been a good summer and autumn inland, and the harvest has been above the average. However, on the east coast the ice did not disappear till the middle of September, and on the north coast it has not remained so long as during this summer since 1846, and even then the ice-masses were far smaller than this year. In spite of this the weather has been unusually warm inland. Dr. Th. Thoroddsen, the well-known Iceland explorer, has been travelling in the north-western peninsula this year. The fisheries have entirely failed this autumn on the north and east coast, on account of the drift-ice, but they have been good on the south coast.

THE additions to the Zoological Society's Gardens during the past week include a Mongoz Lemur (*Lemur mongoz* ♂), an Olive-gray Lemur (*Hapalemur olivaceus*) from Madagascar, presented by Capt. J. Bonnerville; an Anubis Baboon (*Cynocephalus anubis*); an Angolan Vulture (*Gypohierax angolensis*) from West Africa, presented by Capt. Augustus Kent; a Peregrine Falcon (*Falco peregrinus*), European, presented by Mr. J. G. Keulemans; a —— Scops Owl (*Scops* ——) from Baltcitan, Himalayas, presented by Mr. John H. Leech, F.Z.S.; two Rough-scaled Zonures (*Zonurus cordylus*) from Robben Island, South Africa, presented by Mr. W. K. Sibley.

## *OUR ASTRONOMICAL COLUMN.*

THE ASTRONOMICAL SOCIETY OF FRANCE.—The science of astronomy has become so increasingly popular in France within the last few years, and Frenchmen have done so much to aid its progress that there is ground for wonder that hitherto there has been no Society in France explicitly devoted to its interests. Such a Society, on lines very similar to those of our own Royal Astronomical Society, has at length been founded, and its first meeting was held on October 12, M. Camille Flammarion, the President, being in the chair. MM. Paul and Prosper Henry, General Parmentier, and M. E. L. Trouvelot are the Vice-Presidents; and MM. Gérigny and Gunziger the Secretaries; whilst Dr. Lescarbault, M. G. Secretan, and M. Ch. Trépied are amongst the members of Council. At the first meeting, M. Trouvelot read a paper on a remarkable double shadow of the first satellite of Jupiter, observed by him in 1877 when at Cambridge, U.S.; and M. Ch. Mousette exhibited a fine photograph of a sunspot, and some large-scale photographs of portions of the solar spectrum.

THE LICK OBSERVATORY.—The *Sidereal Messenger* for the current month states that Mr. E. E. Barnard, of Nashville, Tenn., and Mr. J. M. Schaeberle, of the Ann Arbor Observatory, both well known for their cometary discoveries, have been appointed as astronomers at this Observatory.

## *ASTRONOMICAL PHENOMENA FOR THE WEEK* 1887 *NOVEMBER* 20-26.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

*At Greenwich on November* 20

Sun rises, 7h. 29m.; souths, 11h. 45m. 44·8s.; sets, 16h. 3m.: right asc. on meridian, 15h. 42·4m.; decl. 19° 42′ S. Sidereal Time at Sunset, 20h. 0m.

Moon (at First Quarter November 22, 11h.) rises, 12h. 15m.; souths, 16h. 43m.; sets, 21h. 18m.: right asc. on meridian, 20h. 41·0m.; decl. 17° 52′ S.

| Planet. | Rises. | Souths. | Sets. | Right asc. and declination on meridian. | |
|---|---|---|---|---|---|
| | h. m. | h. m. | h. m. | h. m. | ° ′ |
| Mercury.. | 6 48 ... | 11 22 .. | 15 56 ... | 15 18·5 ... | 16 56 S. |
| Venus ... | 3 1 ... | 8 48 ... | 14 35 ... | 12 44·5 ... | 3 22 S. |
| Mars ... | 1 6 ... | 7 35 ... | 14 4 ... | 11 30·9 ... | 5 1 N. |
| Jupiter ... | 6 34 ... | 11 10 ... | 15 46 ... | 15 6·7 ... | 16 36 S. |
| Saturn ... | 20 53* ... | 4 40 ... | 12 27 ... | 8 36·1 ... | 19 0 N. |
| Uranus ... | 3 27 ... | 9 2 ... | 14 37 ... | 12 58·2 ... | 5 31 S. |
| Neptune.. | 16 8 ... | 23 49 ... | 7 30* ... | 3 47·4 ... | 18 10 N. |

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

*Occultations of Stars by the Moon* (visible at Greenwich).

| Nov. | Star. | Mag. | Disap. | Reap. | Corresponding angles from vertex to right for inverted image. |
|---|---|---|---|---|---|
| | | | h. m. | h. m. | ° ° |
| 20 ... | B.A.C. 7202 ... | 6 ... | 16 46 ... | 18 2 ... | 124 279 |
| 20 ... | B.A.C. 7209 ... | 6½ ... | 17 35 ... | 18 32 ... | 159 259 |
| 20 ... | 19 Capricorni ... | 6 ... | 20 30 ... | 21 30 ... | 114 347 |

| Nov. | h. | |
|---|---|---|
| 21 ... | 1 ... | Mercury at least distance from the Sun. |
| 21 ... | 6 ... | Neptune in opposition to the Sun. |
| 24 ... | 10 ... | Venus in conjunction with and 1° 6′ north of Uranus. |
| 26 ... | 23 ... | Mercury stationary. |

*Variable Stars.*

| Star. | R.A. | Decl. | | |
|---|---|---|---|---|
| | h. m. | ° ′ | | h. m. |
| U Cephei ... ... | 0 52·3 ... | 81 16 N. ... | Nov. 22, | 1 48 *m* |
| R Arietis ... ... | 2 9·7 ... | 24 32 N. ... | ,, 25, | *m* |
| λ Tauri... ... .. | 3 54·4 ... | 12 10 N. ... | ,, 25, | 5 40 *m* |
| U Ophiuchi .. ... | 17 10·8 ... | 1 20 N. ... | ,, 22, | 5 27 *m* |
| | | and at intervals of | | 20 8 |
| β Lyræ... ... ... | 18 45·9 ... | 33 14 N. ... | Nov. 22, | 6 0 *m* |
| η Aquilæ ... ... | 19 46·7 ... | 0 43 N. ... | ,, 24, | 22 0 *M* |
| S Sagittæ ... ... | 19 50·9 ... | 16 20 N. ... | ,, 22, | 19 0 *m* |
| | | | ,, 25, | 19 0 *M* |
| δ Cephei ... ... | 22 25·0 ... | 57 50 N. ... | ,, 20, | 21 0 *M* |

*M* signifies maximum; *m* minimum.

*Meteor-Showers.*

| | R.A. | Decl. | |
|---|---|---|---|
| The Andromedes ... | 24° ... | 44° N. ... | Very slow; with trains. |
| Near μ Ursæ Majoris. | 155 ... | 40 N. ... | Swift; streaks. |

## *GEOGRAPHICAL NOTES.*

THE Owen Stanley Range of New Guinea, which has been so long known at a distance, has at last been ascended. Mr. E. H. Martin, of Queensland, in August last, reached the summit of the range, which he found to be 13,205 feet high. He reports the north side of the range to be a paradise with great tree-ferns, palms, and other magnificent tropical vegetation. Mr. W. R. Cuthbertson, the leader of the Australian Geographical Society's Expedition, started for Port Moresby on July 20 last, with Mr. G. Hunter as interpreter. Mr. Cuthbertson has not yet succeeded in ascending to the highest point of the Owen Stanley Range, as he intended, but ascended Mount O'Bree, 10,240 feet.

IN No. xi. of *Petermann's Mitteilungen*, Dr. Paulitschke describes Captain Stuart King's journey into the country of the Ejssa and Gadaburssi Somali, some 70 miles to the south of Zeyla, in 1886. The paper is accompanied by a map. Dr. von Jhering and P. Langhans conclude their long and elaborate memoir on the southern colonial region of Rio Grande do Sul. Dr. Hans Schinz, who has been so long in the Lake Ngami region, criticizes severely Mr. Farini's narrative of his journey to the Kalahari Desert, the conclusion being very adverse to the trustworthiness of Mr. Farini's narrative. Perhaps the most important contribution to this number is a beautiful map of the Russo Afghan frontier region, based upon the work of Colonel Holdich's Commission. It is remarkable that while Colonel Holdich's work is carefully locked up in the India Office as "confidential," so far as English geographers are concerned, it should be accessible to the geographers of other countries.

HERR KRAUSE has returned to the German settlement of Togo, on the Gold Coast, from his journey from Salaga through Dahomey. He has collected from 600 to 800 specimens of plants and seeds, a large number of insects, and numerous specimens of prehistoric articles found between Mosi and Timbuktu.

THE principal paper in the third part of this year's *Bulletin* of the Paris Geographical Society is an account of a journey made in 1881 by Count de Chavagnac, from Fez to Morocco, north-east to Mekenessa, and eastwards across the numerous wadis that run south into Wed Mellouja, and as far as Ajda. There is also a paper containing a good deal of useful information, and accompanied by an excellent map, on the ports of Tonquin, by M. J. Renaud. M. Datreuil de Rhins concludes his useful summary of our knowledge of Eastern Tibet.

THE session of the Royal Geographical Society began on Monday, with a paper on Siam, by Mr. J. McCarthy, Superintendent of Surveys in Siam. Mr. McCarthy has been at work for seven years on the survey of Siam, and some of the results he described in his paper, and embodied in the map by which it was illustrated. After indicating the position of Siam in the Malay Peninsula, the author went on to say that on the west is a chain of mountains which runs in an unbroken range to Singapore. the southernmost limit of the Malay Peninsula; some of its peaks between Burmah and Siam rise to a height of 7000 feet, while one peak in the Malay Peninsula reaches 8000 feet. On the east there is another range of mountains which forms the grand watershed of all the rivers that flow into the Gulf of Tonquin and Chinese Sea on the one hand, and the Meinam Kong on the other. There are peaks in this range that reach even 9000 feet above mean sea-level. Besides these ranges there is another which breaks away from the western range from a point north-east of Chingmai, and forms the watershed between the Meinam and Meinam Kong valleys. In this range, at the source of the eastern branch of the Meinam, are famous salt-wells. The salt is procured at depths varying from 35-45 feet—in these land-locked countries as valuable as money. The greater part of the valley of the Meinam Kong and the Meinam is flat, diversified by isolated hills, and broken and jagged ridges of limestone mountains. The most important river, though not the largest, is the Meinam Chau Phraya. It is the Nile of Siam, a good rice harvest very much depending on whether the river overflows its banks or not. The eastern branch of the river is specially known for the numerous crocodiles which yearly carry off some victims. Two other rivers converge towards the Meinam, the Mei Klong and Bang Pla-Kong. All these rivers are connected by canals, rendering communication easier in a country where roads are conspicuous by their absence. The Meinam Kong is the largest river, and flows through the northern and eastern parts of the kingdom, receiving the waters of many large affluents; but the channel of this mighty river is so blocked with large rocks and cataracts, that its navigation is very difficult, and in some parts impossible even for native craft. Mr. McCarthy then went on to describe some of his journeys in detail, especially the one to the north-east frontier, which led him through scenes of surpassing beauty, and during which he opened up much new ground.

THE Arctic land seen by Sannikof eighty years ago has been seen again by the Expedition of MM. Bunge and Toll from the northern extremity of the Kotelnyi Island. The Great and Small Liakhov Islands, the Thadeus Island, and New Siberia have also been visited by the Expedition, which has returned with rich zoological, botanical, and geological collections. Throughout the summer of 1886 the ice on the Siberian coast did not move from the shores, and the hunters said that the sea had not been clear from ice since the *Vega* Expedition.

## *METEOROLOGICAL NOTES.*

WE have lately been subjected to a series of storms which fortunately in the British Islands is not of very common occurrence. The storm of October 30, which was noticed in NATURE a few days after its occurrence, had scarcely left our shores before a fresh disturbance was approaching us from off the Atlantic, and by the evening of Monday, the 31st, another gale was blowing in Ireland, and during the night this storm extended to all parts of the British Islands. The central area of low barometer readings, which primarily occasioned the renewal of disturbed weather, kept to the westward of our coasts, but the Daily Weather Chart of November 1 shows that two secondary disturbances had been formed, one having its centre in the St. George's Channel, and the other over the Bay of Biscay. The very severe gale experienced in the south-west and west of England on November 1 was due to the former of these, the storm area passing during the day slowly up the Irish Sea. The fall of the barometer for this gale amounted to 1·02 in. at Pembroke in fourteen hours, from 6 p.m. 31st to 8 a.m. 1st; and at Lyme Regis the wind attained the velocity of 83 miles an hour between 7 and 8 o'clock in the morning. Another disturbance skirted to the westward of Ireland on the evening of the 2nd, and during the following day, causing southerly gales in many parts of the country, the barometer standing below 29 inches over the whole of the United Kingdom. On the evening of the 3rd another subsidiary was formed in the Irish Sea, and subsequently passed over the north of England, causing gales and disturbed weather in parts adjacent to its path. Before the expiration of the week a fresh disturbance was shown in the west, and on Saturday, the 5th, the barometer was again falling: the force of the wind, however, was not severe, although it blew a fresh gale in places. It will be seen from this notice that no fewer than five distinct storms were experienced in seven days, and in each case the wind was accompanied by heavy rain.

THE Meteorological Council have published Part I. of the "Hourly Readings" for 1885 (January to March) made at their self-recording observatories, together with the daily means, daily maxima and minima, and the daily range for pressure and temperature. Hourly values have now been issued in either lithographed or printed form since 1874, and afford valuable data for discussion in various ways, although the hourly means are not calculated. Corrections are given for reducing the barometric observations to mean sea-level. In connection with these observations it may be mentioned that the Meteorological Institute of the Netherlands lately published an interesting paper by M. Schokker on atmospheric disturbances studied by means of the hourly readings issued by the Meteorological Office and elsewhere; he traced on charts the positions of depressions for various hours, and showed that many phenomena which are clearly traceable from hourly observations are entirely lost sigh of on charts giving only one or two hours a day. He also quoted instances where timely warning of storms could have been given, which were not possible from the usual observations received by telegraph.

THE Hydrographic Office of the United States calls special attention to a new form for reports of storms, fog, ice, and derelicts, issued for the use of trans-Atlantic steamers. This form replaces those hitherto issued by that Office and the Signal Service, and the information thus collected is immediately utilized in preparing the telegrams sent daily to France by the United States Signal Service for the benefit of westward-bound vessels. Captains of trans-Atlantic steamships are requested, in the interest of navigation, to send in prompt and complete reports. No doubt British ship-owners will instruct their officers to co-operate in this enterprising experiment, as this country has at least equa interest with others in the safety of Atlantic navigation.

A DISCUSSION on the distribution of cloud over the eastern part of the North Atlantic, by Dr. W. Köppen, will be found in the *Annalen der Hydrographie und Maritimen Meteorologie* for October. The author points out that the cloud-conditions over the Atlantic are now fairly well known from the publications of the Meteorological Office (Captain Toynbee's great work for nine 10° squares), and the six 10° squares discussed by the Deutsche Seewarte. Dr. Köppen gives a table showing the mean monthly cloud from 20°-50° N. and from 10°-40° W., and the number of observations used, for every 5°, showing that, with regard to longitude, in the months January to April the cloud decreases north of 10° N. as we approach the shores of Africa and Europe, while in the other months this does not hold good. South of the equatorial calm-belt, May has the least cloud towards the east of the district, and in the months September to February the least cloud is towards the west. The differences of the amount of cloud with regard to latitude are much more decided, and these changes are shown on a map of equal lines of mean cloud, on the same plan as was adopted by the author in his discussion of the rainfall (NATURE, vol. xxxvi. p. 617). He also compares the cloud and rainfall curves for the yearly period, and draws attention to their marked difference in the zone of 15°-27° N. lat. While the tropical summer rains cease between 15° and 20° N., the summer maximum of cloud extends as far as 25° N. In the same way the winter maximum of cloud only extends southwards to 25° N., while the rain extends to 17° N. In these latitudes the minimum of cloud falls in the autumn, and the minimum of rain in spring. Only from 15°-17° to the southwards is the amount of cloud in spring less than in autumn, while northwards of 27° N. both minima coincide in the late summer season. Between 15° and 20° N. the end of the long dry season, lasting from February to June, is very cloudy. The author also compares his cloud-results with those obtained by M. Teisserenc de Bort from independent data (NATURE, vol. xxxvi. p. 15), and on the whole expresses himself satisfied at the agreement between the two investigations.

WE have the pleasure of recording the commencement of the publication of meteorological observations in the *Boletin de Estadistica* of Puebla (Mexico). Observations taken three times a day are published for several stations, and monthly means for several others. The stations are generally at great altitudes above the sea.

PART 2, vol. iv. of the Indian Meteorological Memoirs contains a very lucid discussion of the disastrous storm which visited Orissa in September 1885, and whose centre was at False Point on the 22nd, drawn up by Prof. A. Pedler. This storm is of considerable meteorological interest from several points of view: viz. the rapidity of its formation; its smallness, the diameter at the part of greatest wind-force being only from 100 to 200 miles; its enormous fierceness; particularly as it approached the land; and the decided indraught towards the centre as opposed to the circular theory; the extraordinary low reading of the barometer, 27·135 inches, being recorded at False Point at 6h. 30m. a.m. of the 22nd. The reading at 8h. p.m. of the 21st was 29·622 inches, thus giving a fall of 2·487 inches in 10½ hours. This is the lowest pressure ever recorded in a storm in the Bay of Bengal, and in fact is the lowest on record for any part of the world.

THE Journal of the Scottish Meteorological Society for the year 1886 contains a large amount of useful information, and testifies to increased activity, both observational and experimental. Among the various papers, all of which are of the highest importance, may be specially mentioned, (1) an address by the Hon. R. Abercromby on the modern developments of cloud knowledge (see NATURE, vol. xxxv. p. 575); (2) discussions on the winds and rainfall of Ben Nevis, and on a peculiarity of the cyclonic winds of the mountain, which has an important bearing upon weather forecasting, viz. the outflow of the wind from the cyclone when the centre is north or east of Ben Nevis towards an anticyclone or area of high pressure somewhere in an opposite direction. The prevalent wind on the Ben is north, while south-east and west-south-west are secondary points of maxima. Compared with the winds of other stations in the north of Scotland and Ireland, the wind curve is quite different. The year divides about equally into cyclonic and non-cyclonic periods. The most frequent cyclonic wind is south-west; next to this comes north, apparently due to the cyclones passing to the north of Ben Nevis. The relative frequency of the winds in non-cyclonic periods is quite different: while north still retains its place as a maximum point, the most frequent wind is south-east. In the curve for the whole year tha west-south-west winds are chiefly due to cyclonic winds, south-east to non-cyclonic, and north to both systems. In both systems the north-west wind is wettest while it blows, and the east is driest. The south-east winds, which are generally west at low levels, are the driest on Ben Nevis, with the exception of the east winds. The total amount of precipitation for the year was nearly 108 inches; the wettest month was November, 14·6 inches; and the driest February, 2·8 inches. The journal also contains an interesting account of the biological work of the Scottish Marine Station, and the results of observations at the Northern Lighthouse Station, at the stations connected with the Medical Department, including observations in Iceland, Faroe, and Uruguay, and at fifty-five stations established by the Scottish Meteorological Society, and well distributed over the country.

## *GEMS AND ORNAMENTAL STONES OF THE UNITED STATES.*

ON Saturday, October 22, an evening lecture on this subject was delivered by Dr. A. E. Foote, of Philadelphia, in the Trophy Hall of the American Exhibition. The speaker was introduced by Mr. F. W. Rudler, the President of the Geologists' Association.

Dr. Foote remarked that hitherto mining for gems in the United States had been of a very desultory character, being principally carried on in connection with mica and other mines. The emerald and Hiddenite mines of North Carolina and the tourmaline mines of Maine are the only ones which have been worked systematically. The gems peculiar to America are *chlorastrolite*, *zonochlorite*, and *Hiddenite*. Chlorastrolite, or green star-stone, was discovered by Prof. J. D. Whitney, of the United States Geological Survey, about forty years ago. The only place where it is found is Isle Royale, Lake Superior. The island, belonging to the State of Michigan, forty miles long and five miles wide, and about twenty miles from the mainland, is composed of amygdaloidal trap, in the almond-shaped cavities of which the gem principally occurs. This green stone has a radiating structure, and shows a beautiful *chatoyance* similar to cat's-eye and other fibrous minerals.

*Zonochlorite* is a green-banded stone, similar to chlorastrolite in composition, discovered by Dr. Foote at Neepigon Bay on the north shore of Lake Superior. The full description was published in the Transactions of the American Association for the Advancement of Science in 1872. Its hardness is about 7; it takes a very high polish, and if it could be found in sufficient quantities would undoubtedly be extensively used.

*Hiddenite* is a green variety of the well-known species spodumene. A yellow variety from Brazil has been cut as a gem for many years. The green variety has been known for about seven years, and is fully as beautiful, and valued as highly, as the diamond. It occurs in connection with emeralds in North Carolina. Of *gold quartz* about £28,000 worth is sold annually. Most of this comes from California, where it is not only used as a gem, but in the manufacture of various ornaments.

Although the flexible sandstone, the reputed gangue of the diamond in Brazil, is found in mountain masses in North Carolina and other States, no very large diamonds have as yet been discovered. Many small ones are recorded from California, North Carolina, Virginia, and elsewhere. The largest was found at Manchester, near Richmond, Virginia, and weighed 23¾ carats in the rough and 11 11/16 carats cut. Prof. Whitney states that the largest found in California was 7¼ carats. Rubies and sapphires have been found in the rock in the corundum mines of North Carolina, and Mr. C. S. Bement has an uncut green one in his collection that would give 80 to 100 carats' worth of good stones, one of which would probably weigh 20 carats. The largest red and blue crystal weighs 312 pounds, and belongs to Amherst College. The best sapphires are found in the placer mines of Montana. Asteriated corundums are found in Pennsylvania and elsewhere.

About £2200 worth of quartz or rock crystal is mined annually. The best localities are Hot Springs (Arkansas), North Carolina, New York, and Virginia. A portion of a mass that must have weighed over 40 pounds was recently received from Alaska, that cut a hand-glass 3 inches by 5. Rock crystal is frequently dug up in the prehistoric mounds, and was used by the medicine-men and others for telling future events. Amethysts are found in very fine specimens in Pennsylvania, Georgia, Texas, and the Lake Superior region. From the latter region they are very remarkably lined, some specimens showing "phantom crystals" equal to the Hungarian. Near the Yellowstone National Park and in the chalcedony forests of Arizona are tree-trunks, some of which are 100 feet long, mineralized by the action of silicated waters. Some of these trees are still standing upright, others, having fallen, bridge deep chasms. The once hollow cavities of some are lined with amethyst, others with agate. The Arizona agatized or jasperized wood shows the most beautiful variety of colours of any petrified wood in the world. Probably the most remarkable locality anywhere for smoky quartz, or cairngorm stone, is Pike's Peak, Colorado. Here it is found in a graphic granite associated with Amazon stone, which also makes a very beautiful green ornamental stone. The rutilated quartz, or Cupid's arrows, is found in remarkably fine specimens in North Carolina. Perhaps the most remarkable mass is one 7 inches by 3½, now in the collection of the Academy of Natural Sciences of Philadelphia. The crystals of rutile are about the size of knitting-needles. Some of the North Carolina rutile has been cut, furnishing brilliant gems, closely resembling carbonado. The rutile, geniculated till it forms a perfect circle or rosette, from Magnet Cove, Arkansas, is often mounted and worn as a gem. While opals are found at many places in the United States, they do not rival those of Queretaro in Mexico. Here are found not only the "milky opals that gleam like sullen fires in a pallid mist," but fire opals and almost every other variety known. Rhodonite, in specimens suitable for polishing, is found in Massachusetts and New Jersey. At the latter locality were obtained the finest crystals ever seen. The garnets from New Mexico and Arizona are superior to the "Cape rubies" from South Africa; and from Alaska the most beautiful crystals ever seen, in a setting of gray mica schist, have recently been obtained.

The New Mexican turquoise is mined to the value of about £700 annually. It has recently been described very fully by Prof. Clarke, Curator of the Mineralogical Department of the National Museum, and is especially interesting as being the material from which the "chalchihuitls," or most sacred images of the Aztecs, were made. The Indians still regard it as a lucky stone.

Labradorite, lately so popular for gems and ornamental stones, is found in many localities. The tourmalines of Maine are probably the finest in the world. Here are found the Oriental sapphire, ruby, and emerald, in perfection.

Topaz has recently been found at Pike's Peak, Colorado, in large quantity. Some masses weighed 2 pounds each; and very fine clear white stones have been cut, weighing from 125 to 193 carats.

Among ornamental stones should be mentioned a very beautiful variety of serpentine from Maryland, called verd antique, which is being largely used in the interior decorations of the Philadelphia Court House. Another variety, resembling jade, is the green williamsite from Pennsylvania. Alabaster of various colours abounds in many localities; and marbles, some as beautiful as the Mexican onyx, are found in nearly every State. The malachite and azurite, jet, and many other gems of minor importance were briefly described.

## *THE OCTOBER METEOR-SHOWER OF* 1887.

THE display of Orionids has been recently observed at this station with greater success than has attended my efforts in any previous year. This shower has not, perhaps, exhibited such richness as it did in 1877, but the present occasion has been more favourable as regards the conditions; the moon being absent from the morning sky, and a period of tolerably clear weather occurring just at the important time.

In all, I numbered ninety Orionids between October 11 and 24, and the radiant-point during this period exhibited a stationary position amongst the stars. The shower has this year met with rather a formidable rival in a bright display of forty-five meteors from a radiant at 40° + 20° close to ε Arietis. I have witnessed the latter stream in several preceding years, though not in such conspicuous strength, and have particularly referred to it in the *Monthly Notices*, vol. xliv., pp. 24–26, as furnishing many bright fireballs at this season.

It will be convenient to arrange my new observations in a tabular form:—

| Date 1887 Oct. | Period of Observation. h. h. | Real Duration. | Meteors seen. | Orionids. | Arietids. | Radiant of Orionids. |
|---|---|---|---|---|---|---|
| 11 | 7½ to 12½ | 4½ | 30 | 1 | 2 | 91° + 17° (11–14) |
| 12 | 8½ ,, 12½ | 4 | 31 | 2 | 1 | |
| 13 | 10 ,, 12 | 2 | 16 | 1 | 1 | |
| 14 | 9½ ,, 16¾ | 7 | 75 | 1 | 10 | |
| 15 | 7 ,, 8½; 10½ ,, 17 | 7½ | 86 | 17 | 7 | 91° + 16° |
| 17 | 8 ,, 12½ | 4½ | 29 | 3 | 3 | 90° + 15° |
| 19 | 13 ,, 15 | 1½ | 19 | 10 | — | 90½° + 15½° |
| 20 | 10 ,, 15½ | 5¼ | 61 | 22 | 9 | 90° + 14½° |
| 21 | 9 ,, 16 | 6¼ | 76 | 23 | 7 | 92° + 14° |
| 23 | 12½ ,, 14 | 1½ | 13 | 1 | 3 | — — |
| 24 | 12 ,, 14½ | 2¼ | 23 | 9 | 2 | 91° + 16° |
| 11 nights | | 46¼ | 459 | 90 | 45 | 91° + 15° |

The 16th and 22nd were overcast, and on the 19th and 23rd the observations were much obstructed by clouds. It is noteworthy that I only recorded one Orionid on October 14 during a watch of seven hours, though on the following night this shower supplied seventeen meteors.

The radiant-point of the October meteors has long been accurately known. Prof. A. S. Herschel observed it with great precision on October 18, 1864, and October 20, 1865, and found the centre at 90° + 16°, and 90° + 15° respectively, in those years. All the best of later determinations have agreed closely with these results, and it will be noticed that my value for the present year, as given above, is nearly identical with them. In further confirmation I may mention that Mr. David Booth, of Leeds, observed more than sixty shooting-stars during a watch of five hours, from 10¾h. to 15½h. on the night of October 20 last, and saw twenty-four Orionids which gave a sharply-defined radiant at 90° + 16°.

One of the principal objects of my late observations was to ascertain whether the radiant centre of this stream showed any displacement of position on successive nights, and similar to that affecting the Perseids of August—a peculiarity which I first pointed out in NATURE, vol. xvi. p. 362. But the radiant of the Orionids has (when the small, unavoidable errors of observation are allowed for) quite failed to exhibit any change of place relatively to the contiguous stars. It appeared to maintain an absolutely persistent position 1° north of the star ξ Orionis. My observation on October 15 placed it at 91° + 16°, and nine nights later, viz. on October 24, I found the meteors were radiating from exactly the same focus. In 1877 and 1879, October 15, I derived the radiant at 92° + 15° and 93° + 17°, and in 1878, October 22, I fixed it at 92° + 14°. A comparison of all these values renders it sufficiently obvious that there is no visible displacement in the position of the Orionid radiant during its active display from October 11 to October 24. And there is a high degree of probability that the point is stationary during the whole period of the shower's sustenance from about October 9 to October 29; but I have never secured many paths and been enabled to get a good radiant near the limiting epochs of its display, when it is extremely feeble.

Mr. Booth, at Leeds, has been carefully observing numbers of meteors during the past few months, and a searching comparison of his results with those obtained at Bristol during the progress of the Orionid shower has shown that several of the same meteors were observed at both stations. Three of these are typical members of the October display, whilst three others had their origin in the minor systems which are so plentifully distributed over the sky at this season of the year. The computed heights and paths of these six meteors are:—

| Date 1887 Oct. | Hour G.M.T. h. m. | Mag. | Height at appearance. | Height at disappearance. | Length of real path. | Radiant point. ° ° | Inclination to horizon. ° |
|---|---|---|---|---|---|---|---|
| 13 | 10 25 | 1–2 | 69 | 50 | 26 | 73 + 61 | 48 |
| 13 | 11 25 | 2–4 | 70 | 42 | 37 | 127 + 83 | 49 |
| 14 | 12 5½ | 4–5 | 64 | 40 | 26 | 355 + 36 | 67½ |
| 15 | 14 48½ | 1½–3 | 89 | 61 | 39 | 87 + 15 | 46 |
| 20 | 11 45 | 4–4 | 106 | 90 | 34 | 87 + 21 | 28½ |
| 20 | 12 55 | 1–1½ | 92 | 53 | 70½ | 87 + 13½ | 33½ |

The three last in the list were Orionids, and they appear to have been observed at somewhat greater elevations in the atmosphere than is usual. The 4th magnitude meteor of October 20, 11h. 45m., was no less than 106 miles high at its first appearance, over a point near Eversham, Kent, and the two observations are in perfect agreement in indicating these figures. The mean of the three Orionids gives 96 miles for the beginning points and 68 for the ending, and the average radiant comes out at 87° + 16°, which is 3° or 4° west of the usual position. But the average values deduced from so small a number of instances cannot have much weight as indicating accurately either the heights or radiant of the general body of the meteors forming this notable group.

The Arietids, which have developed into an important shower this year, traverse their paths with medium speed, and are rather conspicuous meteors, without trains or streaks except in exceptional cases. As to the Orionids, they move swiftly, and are accompanied in almost every instance with streaks. The latter will sometimes brighten up considerably after the nuclei of the meteors have died away. The more brilliant Orionids are fine flashing meteors, leaving streaks which are occasionally very durable.

The contemporary showers of the October epoch, though extremely abundant, are not marked by special activity, except perhaps in the case of the Arietids, already referred to. This year the following have been the best of the minor streams:—

| Date. | Radiant. ° ° | Meteors. | Appearance. |
|---|---|---|---|
| October 14–15 | 25 + 44 | 10 | Slow, faint. |
| ,, 14–21 | 54 + 71 | 12 | Swift. |
| ,, 14–21 | 105 + 22 | 12 | Very swift, streaks. |
| ,, 20–21 | 125 + 43 | 7 | Very swift, streaks |
| ,, 14–23 | 135 + 68 | 11 | Swift. |
| ,, 12–20 | 312 + 77 | 8 | Swift. |

Of these the most pronounced is at 105° + 22°, near δ Geminorum, which I also observed in 1877 and 1879. It has also been recorded as a prominent stream by Zezioli and others, and is identical with the Gemellids of Mr. Greg's catalogue (1876). It is chiefly a morning shower; its meteors are often brilliant, and regularly display the phosphorescent streaks which form so characteristic a feature of the Perseids, Orionids, and Leonids. The shower in the head of Ursa Major at 135° + 68° is also an active one at this epoch; I saw it in 1877 at 133° + 68°, October 2–19, and these appear to be the only two observations of it obtained hitherto. W. F. DENNING.

## ON SOME OF THE AFFINITIES BETWEEN THE GANOIDEI CHONDROSTEI AND OTHER FISHES.

THE group of Ganoidei Chondrostei has hitherto been regarded as one developed during the latest period of the history of the earth. Its structure is so different from that of other classes of fish that its relationship with them cannot be easily detected. The zootomic and embryological works of the last ten years, and especially the works of Zalensky in Odessa, Parker in London, Davidoff in Munich, and van der Wighe in Holland, have brought together many important facts as to the organization and development of these interesting animals, but the information provided by these writers is either fragmentary or not full enough, and long study and labour will be required before it can be satisfactorily summed up and completed.

During the last two years I have studied the anatomy of *Acipenser ruthenus*, the commonest representative of the Acipenseridæ to be found here; and although my work is far from being completed I may beg the reader's attention to some interesting facts, which must, I think, be taken into consideration by those who try to settle the question as to the relationship of the Ganoidei Chondrostei to this or to that group of fishes.

We may begin with the teeth of these fishes, as an indication of great value, which served to distinguish this group from other Ganoidei. Teeth have been found in *Polyodon folium*, a member of the Ganoidei Chondrostei, inhabiting the rivers of North America; it has been thought that they might also be found in *Psephurus gladius* of the River Yang-tse-kiang, in China; and Prof. Zalensky has found them in *Acipenser ruthenus*, at the age of from three weeks to three months. I have had the good fortune to find teeth in almost all the Ganoidei Chondrostei of the different ages that I have examined, but they were palatine teeth, not mandibular or maxillary teeth. I have discovered and studied the palatine teeth in a two-months-old sterlet; in an *Acipenser stellatus* of from seven to eight months old; in a *Scaphirhynchus kaufmannii* from Amu-Daria of a year old; in a grown *Scaphirhynchus fedschenkoi* from Sir-Daria; and in full-grown *Polyodon folium*.

The relationship of the dimensions of the snout of fish to the age at which teeth can be found is very interesting. The long and flat snouted *Acipenser stellatus* has teeth to a more advanced age than the short and narrow snouted sterlet; the teeth of a wide-snouted Scaphirhynchus not attaining a good development but are preserved until maturity; the spade-snouted Polyodon preserves its teeth during the whole of its life. In all the other representatives of Acipenser and Scaphirhynchus can be found at any stage traces of palatine teeth in the shape of two similar prominences, which, by their structure, can be distinguished from the surrounding parts of the mouth.

This dependence of a long preservation of teeth on the development of the snout of Ganoidei Chondrostei, together with the geographical distribution of these fish, shows the greater antiquity of the tooth-preserving kinds of Scaphirhynchus and Polyodon, than of the Acipenser. Species of one kind, inhabiting such widely separated water-reservoirs as the Aral Sea and Mississippi, or the Yang-tse-kiang and the continental rivers of North America, must be representatives of very old forms, remains of former fauna; their having, at a mature age, organs that do not serve them, but which merely remain as an inheritance from former periods, is a confirmation of their supposed antiquity—a conclusion drawn from zoogeographical observations.

The structure and development of the dorsal shields, which, in the case of Acipenseridæ, spread all along the dorsal surface, from the back edge of the head down to the dorsal fins, may also, I think, help us to discern affinities between Ganoidei Chondrostei and other fish. The first to pay attention to these shields, and to suppose they were an embryonal dorsal fin, was Prof. Zalensky. About the same time Prof. Goethe described a similar fin of a six-weeks-old sterlet, hinting, by the way, that the dorsal shields might be compared with the dorsal rays of a fossil fish, Cœlacanthus. I have succeeded in investigating the dorsal shields of a two-months-old sterlet, and in making a whole series of cross sections, and I have arrived at the conclusion that Zalensky's and Goethe's suppositions are fully established by facts. Indeed, between the shields spreads a membrane, in which can be seen the same horny rays that are generally seen in developing fins of fish; right and left of each dorsal shield there is a muscle, traces of which can also be found under the shields of grown sterlets. At last, having made cross-sections of oxidized dorsal shields of grown sterlets, a canal could be perceived in them. These canals are particularly well seen in Scaphirhynchus, as an older and a better representative of the original type.

Knowing that Dr. Günther in his excellent book on ichthyology places the Acipenseridæ and Cœlacanthi next to the Polypteroidei, I availed myself of the offer of Prof. Bogdanoff, Director of the Moscow Museum, and my teacher, to let me examine the only dry specimen of *Polypterus senegalensis* that was in the Museum. Comparing the numerous small fins spreading all along the back of Polypterus, there being a great and wide front bone-ray, and the others being thin and horny, I became convinced of their complete similarity to the dorsal shields of a young sterlet and to the membranes which connect them.

In the wide bone-ray of Polypterus a ray channel could also be discerned, and the rays of the membrane that spreads behind the wide ray were also horny, like the rays of the membrane of an embryonal fin of a sterlet. This brought me to the conclusion that the ancestors of both the Acipenseridæ and the Polypteroidei had not only a back fin, but also well developed front dorsal fins, with great bone-rays and smaller horny rays, and were, perhaps, nearer to each other than their present descendants.

A study of other organs, especially those in young Acipenseridæ and Scaphirhynchus, convinces me that there is a closer relationship between the Ganoidei Chondrostei and the Polypteroidei than has hitherto been supposed. It is well known that the conus arteriosus of Acipenser is distinguished from the same organ of the Polypterus and Lepidosteus by a much smaller number of transversal rows of valves. In young sterlets I have found, besides developed valves, undeveloped folds lying between the valves. In place of such undeveloped valves, in the case of grown fish, as for example in a specimen of *Acipenser huso* which I dissected, and which was about 10 feet long, an unevenness and roughness of surface are noticed. The air-bladder, which in Lepidosteus and Polypterus partly resembles the lung of Dipnoi, when attentively studied in the Acipenseridæ does not appear to be so well adapted to its new functions. Its coatings include many ramifications of vessels, the histological structure of which is so similar to the structure of the coatings of the digestive organs that it is much easier to recognize their relative layers than in those of other fishes, where the air-bladder is fully adapted to its functions. The ductus pneumaticus, in young sterlets especially, is very wide; a two-months-old sterlet has it of almost the same width as an œsophagus, and the food of the small fish, consisting mostly of forms of Cladocera and Ostracoda, and also of statoblasts of Polyzoa, especially Alcyonella, fills the cavity of the air-bladder like the cavity of the stomach.

Though the brain of these fishes has been well investigated, yet in its organization one finds much that is interesting. For example, the cerebral hemispheres of the prosencephalon of Scaphirhynchus proved to be more similar to the hemispheres of Dipnoi and Lepidosteus and Protopterus, than to those of Acipenser. The lateral layers are turned upward, so that the upper portion of the hemispheres proved to consist, not of one pallium, as in Acipenser, but also of the coating of the cerebrum. The epiphysis cerebri, being a changeable organ, proved to vary even in the limits of the genus Acipenser. Thus, its front end in *Acipenser sturio* reached as far as the line connecting the two lower nostrils, forming an angle of nearly 28° with the surface of the brain, whereas in *Acipenser ruthenus* the epiphysis forms an angle of almost 80°, and becomes a much shorter organ. In some sterlets the end of the epiphysis cerebri went through the cranium, and was only covered by the bone shields of the exterior coating. Scaphirhynchus had the epiphysis less changeable and more similar to the epiphysis of other Ganoidei and Dipnoi. In other respects the brain of Scaphirhynchus also proved to have a closer resemblance to the other Ganoidei than to the Acipenser. Thus, its valvula cerebelli and lobi inferiores are more developed than those of a sterlet, and even remind one of the brain of Amia and its near relatives Teleostei.

Notwithstanding the scantiness of the facts stated here, I indulge the hope that they may add something to the means at our disposal for the settlement of the relationship between Ganoidei Chondrostei and other Ganoidei.

NICHOLAS ZOGRAFF.

Moscow, 20/8 September 1878.

## SCIENTIFIC SERIALS.

*American Journal of Mathematics*, vol. x. No. 1 (Baltimore: Johns Hopkins University, 1887).—The number opens with the concluding lecture (the 33rd) of Prof. Sylvester's course on the theory of reciprocants, in which is investigated the differential equation of a cubic curve having a given absolute invariant $S^3/T^2$. A supplemental "lecture" is supplied by the reporter (Mr. Hammond) from the lecturer's surplus material: this "constitutes probably the most difficult problem in elimination which has been effected up to the present time." All admirers of Prof. Sylvester's brilliant genius will be glad to have the fine presentment of his features which accompanies this number.—Algebraic surfaces of which every plane section is unicursal in the light of *n*-dimensional geometry is devoted to a proof and to illustrations, by Mr. E. H. Moore, Jun., of a theorem due to Picard, viz. "Les seules surfaces algébriques dont toutes les sections planes sont unicursales sont les surfaces réglées unicursales et la surface du quatrième degré de Steiner."—Mr. Morgan Jenkins, in a paper on Prof. Cayley's extension of Arbogast's method of derivations, presents in a simplified form results given by the elder mathematician in a memoir printed in the Phil. Trans. (read December 1860).—Properties of a complete table of symmetric functions, by Capt. P. A. Macmahon, R.A., establishes some remarkable features of a tabulation set forth by Mr. Durfee in vol. v. of the *Journal*.—Oskar Bolza, in his article on binary sextics with linear transformations into themselves, considers those binary sextics which remain unchanged (or are only changed by a constant factor) for certain linear transformations of the variables.—Prof. Cayley follows with the sequel to his memoir on the transformation of elliptic functions (vol. ix.), and Prof. Woolsey Johnson closes the number with the symbolic treatment of exact linear differential equations.

*Bulletin de la Société des Naturalistes de Moscou*, 1887, iii.—Comparative osteology of the penguins and its bearing upon the classification of birds, by Dr. M. Menzbier (in German; with a plate).—The Hessian fly, by Prof. K. Lindeman (in German).—Chemical composition of the Lipetsk mineral springs, by A. Kislakovsky. A series of chemical analyses has been undertaken in order to ascertain how far the composition of the springs is liable to undergo changes at different times of the year. The admixture of water flowing from sweet springs makes the amount of $FeCO_3$ to vary from 0·016 to 0·032, and from 0·008 to 0·025 in different springs.—On the increase in the number of thunderbolts and its causes, by J. Weinberg (in German).—Enumeration of the vascular plants of Caucasus, by M. Smirnoff (in French). This fourth paper of the introduction which the author has written to precede his enumeration of plants discusses the following important subjects: evaporation, limits of perennial snow in Caucasia and neighbouring highlands, the present and ancient glaciers of Caucasus, and the geology of the country since the later Tertiary. The twelve botanical regions into which the author divides Caucasia are given with short characteristics of their physical features. On the whole the paper is a most valuable contribution to the knowledge of Caucasus.—List of plants growing in the province of Tamboff, by D. Litvinoff (continued).—*Otiorhynchus turca*, Steven, an enemy of the vine-tree, by E. Ballion. It has been found at Novorosiysk, on the east coast of the Black Sea, and must have immigrated from Asia Minor and Syria.

## SOCIETIES AND ACADEMIES.

### LONDON.

**Mathematical Society**, November 10.—Sir J. Cockle, F.R.S., President, in the chair.—Prof. Sylvester, F.R.S., being incapacitated by an accident to his leg from attending in person to receive the De Morgan Medal, awarded him by the Council in June last, deputed Mr. J. Hammond to represent him. The President, after a few remarks eulogistic of Prof. Sylvester's numerous discoveries, presented the medal to Mr. Hammond, who made a felicitous reply.—The Treasurer (A. B. Kempe, F.R.S.), after having read his Report, announced to the meeting that the Society's application to the Privy Council for the grant of a charter had failed.—The following were elected to act as the Council for the ensuing session:—President: Sir J. Cockle, F.R.S. Vice-Presidents: Dr. J. W. L. Glaisher, F.R.S., Prof. Hart, and Lord Rayleigh, Sec.R.S. Treasurer: Mr. A. B. Kempe, F.R.S. Hon. Secs.: Messrs. M. Jenkins and R. Tucker. Other Members: Messrs. A. Buchheim, E. B. Elliott, A. G. Greenhill, J. Hammond, J. Larmor, C. Leudesdorf, Captain P. A. Macmahon, R.A., S. Roberts, F.R.S., and J. J. Walker, F.R.S.—The following communications were made:—On pure ternary reciprocants and functions allied to them, by E. B. Elliott.—On the general linear differential equation of the second order, by the President.—On the stability of a liquid ellipsoid which is rotating about a principal axis under the influence of its own attraction, by A. B. Basset.—On modular equations and geometry of the quartic, by R. Russell.—The differential equations satisfied by concomitants of quantics, by A. R. Forsyth, F.R.S.—On the stability or instability of certain fluid motions (ii.), by Lord Rayleigh, Sec.R.S.—Notes on a system of three conics touching at one point, by Dr. Wolstenholme.

**Geologists' Association**, November 4.—Mr. F. W. Rudler, President, in the chair.—The President delivered the opening address of the session, entitled "Fifty Years' Progress in British Geology." He drew a picture of the state of geology in 1837, and contrasted it with that in 1887. The principal questions discussed were the old controversy between the Catastrophists and Uniformitarians, the development of Palæozoic geology, the origin of the Drift, and the antiquity of man. In recent years the warmest discussions have referred to the Archæan rocks and to the Glacial Drift. Attention was directed to the debt which geology owes to engineering, especially to the development of our railway system and to artesian borings. The sub-Wealden exploration was explained, and a Jubilee boring suggested. Deep-sea exploration was touched upon. Turning to petrology, its low condition in 1837 was pointed out, and its recent development traced to the introduction of microscopic methods of research. The history of palæontology was briefly sketched, special attention being called to the work of the Palæontographical Society. Improvements in the Geological Department of the British Museum were noticed, and reference was made to the history of the Geological Survey and the Museum of Practical Geology. In conclusion, it was pointed out that by a happy accident the meeting of the International Geological Congress in London next year will coincide with the centenary of the foundation of British geology—the original publication of Hutton's "Theory of the Earth" in 1788.

**Chemical Society**, November 3.—Mr. William Crookes, F.R.S., President, in the chair.—The following papers were read:—Note on the atomic weight of gold, by Prof. T. E. Thorpe, F.R.S., and Mr. A. P. Laurie.—The ni teraction of zinc and sulphuric acid, by Mr. M. M. Pattison Muir and Mr. R. H. Adie.—Note on safety-taps, by Mr. W. A. Shenstone.—Note on Guthrie's compound of amylene with nitrogen peroxide, by Dr. A. K. Miller.—The dehydration of metallic hydroxides by heat, with special reference to the polymerization of the oxides and to the periodic law, by Prof. Carnelley and Dr. James Walker, University College, Dundee.—The bromination of naphthalene $\beta$-sulphonic acid, by Mr. G. Stallard.—The constitution of the three isomeric pyrocresols, by Dr. W. Bott.—Preliminary note on certain products from teak, by Mr. R. Romanis.

### PARIS.

**Academy of Sciences**, November 7.—M. Janssen in the chair.—On a paradox analogous to the St. Petersburg problem, by M. J. Bertrand. The paper deals with the doctrine of probabilities, and shows that, if a gambler plays under conditions involving all but inevitable ruin, equity requires the remotely contingent prize to be infinite.—On the state of the potassa in plants, in the soil and vegetable humus, and on its quantitative analysis, by MM. Berthelot and André. These studies have been undertaken to determine how far the potassa present in plants and arable land is in the condition of salts soluble in water, or of insoluble salts capable or not of resisting the action of attenuated acids. The researches are in continuation of those already described connected with the analysis of the soluble and insoluble carbon present in the soil, and of the nitrous compounds in their various forms of nitrates, free ammonia, &c.—Inquiry into the two fundamental principles of the accepted doctrines regarding cerebral dualism in voluntary motions, by M. Brown-Séquard. In continuation of his recent communication on this subject, the author here advances facts and arguments, some of which go directly to show that each half of the encephalon may independently serve for the production of voluntary movements in both sides of the body, while others tend to overthrow the fundamental principles of the views generally held regarding the part played by both hemispheres in producing voluntary movements. Several interesting manifestations are described, proving that the motor effects of cerebral irritations are in absolute contradiction to the current theories.—On the *Elasmotherium*, by M. Albert Gaudry. In connection with some remains of this extinct mammal recently found on the River Kinel in the government of Samara (Russia), and presented to the Academy by M. Paul Ossoskoff, some remarks are made by the author, who assigns to the *Elasmotherium* a position intermediate in size between the mammoth and *Rhinoceros tichorhinus*, his contemporaries. In his general structure he appears to have approached more nearly to the latter animal, the radius, tibia, cubitus, calcaneum, and some other bones presenting the closest resemblance to those of a gigantic rhinoceros.—On a geometric form of the effects of radiation in the diurnal motion of the stars, by M. Gruey. A number of propositions are here announced, whose further development and demonstration are reserved for a future number of the *Bulletin Astronomique*, where a full demonstration will be given of the theorem that, in a sidereal day the apparent position of a star describes a conic section round its true position.—On the internal temperature of glaciers, by MM. Ed. Hagenbach and F. A. Forel. The different temperatures determined by careful experiment in the Arolla glacier are explained by the varying pressure to which different parts of the glacier are subjected. The normal temperature below zero is shown to be the effect of pressure, which lowers the melting-point of ice, thus verifying in Nature facts already theoretically demonstrated by Sir W. Thomson and others, but hitherto studied only in the laboratory.—Remarks on the Gulf Stream, by M. J. Thoulet. Comparing his own observations made on board the *Clorinde* in 1886 with those of Mr. Buchanan during the *Challenger* Expedition, the author finds that the Gulf Stream is comparable to a river with a greater fall in its upper than in its lower reaches. A relatively steep valley separates it on the left from the United States current setting southwards from Newfoundland, while its more gently sloping right bank skirting the ocean presents a much broader expanse. Thus is explained the direction of the driftwood carried from America towards the north-west coast of Europe.—Researches on the distribution of temperature and of barometric pressure on the surface of the globe, by M. Alexis de Tillo. The author describes some general charts which he has prepared, based on the labours of M. Léon Teisserenc de Bort, and of Herr J. Hann, of Vienna, showing the mean isobars and isothermal lines for the year, and the months of January and July, for the whole world. For the general conditions of the terrestrial atmosphere he finds that, when the mean temperature $\left.\begin{matrix}\text{falls}\\\text{rises}\end{matrix}\right\}$ within the limits of 1°·6 and 4°·7, the pressure $\left.\begin{matrix}\text{increases}\\\text{diminishes}\end{matrix}\right\}$ to the extent of 1 millimetre.—On the metallic derivatives of acetylacetone, by M. Alphonse Combes. From the researches here described, the author concludes that this substance decomposes all the carbonates, even that of potassa; that it displaces the acetic acid of the acetate of copper, and even the hydrochloric acid; that it consequently acts as a strong acid on the metallic salts. Nothing, so far, distinguishes its action from that of a monobasic acid, although this function is clearly distinguished by certain properties of its salts from the acid function properly so called.—On the part played by the stomata in the inspiration and expiration of gases, by M. L. Mangin. From the experiments here described the author concludes generally that the stomata are indispensable for the circulation of the gases in aërial plants, the occlusion of these orifices bringing about a greater or lesser diminution in the exchanges of the respiratory gases, and a very considerable decrease in the exchanges of chlorophyllian gases.—On the invasion of *Coniothyrium diplodiella* in 1887, by MM. G. Foex and L. Ravaz. This organism, already observed in 1879 by Spegazzini in Italy, and in 1885 by Viala in the department of the Isère, has this year invaded an extensive region in the South of France. Whether it is a true parasite, or a saprophyte, or whether it assumes both of these characters according to circumstances, is a point which has not yet been decided.

### BERLIN.

**Meteorological Society**, November 1.—Prof. von Bezold, President, in the chair.—Dr. von Helmholtz discussed his most recent researches on the formation of mist under the influence of chemical processes, and laid stress at the same time upon the relation of his results to the phenomena of meteorology.—Dr. Sprung gave an account of observations made with thermometers attached to various barometers. During a comparison of the barometers from various stations with a normal barometer, the experiments being conducted in a cellar, he found that the thermometers showed considerable differences in their readings; their differences were still observed when the comparison of the barometers was made in a room at the surface of the earth, and the barometers were placed side by side in the same frame. The speaker was hence led to compare three thermometers, of which one was surrounded by a nickel-plated cylinder; the second was surrounded by a varnished cylinder, and the third had no covering at all. When placed near an open window the instrument with the nickel-plated covering registered the highest temperature, but when placed near a hot stove it recorded the lowest. The differences in reading varied at different times of the year, and amounted to several degrees. In practice these differences of the thermometer-reading can have no influence on the reading of the barometer, since it may be assumed that the mercury in the barometer has always the same temperature as that indicated by the thermometer, and that the reading of the barometer is reduced to zero.

## BOOKS, PAMPHLETS, and SERIALS RECEIVED.

A Practical Treatise on Bridge Construction: T. Claxton Fidler (Griffin).—The Real History of the Rosicrucians: A. E. Waite (Redway).—Calendar of University College, Nottingham, 1887–88.—Totemism: J. G. Frazer (Black).—Animal Magnetism: Binet and Féré (Kegan Paul).—Living Lights: C. F. Holder (Sampson Low).—L'Homme avant l'Histoire: Ch. Debierre (Baillière).—The Flora of Howth: H. C. Hart (Hodges, Figgis, and Co.).—Lectures on Bacteria: A. De Bary; second improved edition, translated by H. E. F. Garnsey, revised by I. B. Balfour (Clarendon Press).—The Final Results of the Triangulation of the New York State Survey (Albany, N.Y.).—Catalogue of the Moths of India, part 1: Cotes and Swinhoe (Calcutta).—China in America; a Study in the Social Life of the Chinese: S. Culin (Philadelphia).—Catalog der Conchylien-Sammlung, Vierte Lief (Paetel, Berlin).—Fishery Barometer Manual: R. H. Scott (Eyre and Spottiswoode).—Folk-lore Journal, vol. v. part 4 (Stock).—Proceedings of the Royal Society of Edinburgh, No. 123.—Journal of the Royal Agricultural Society, October (Murray).—Archives Italiennes de Biologie, tome viii. fasc. iii. (Loescher, Turin).

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