THURSDAY, NOVEMBER 16, 1882

RECENT CHEMICAL SYNTHESES

DURING the Exhibition of Scientific Apparatus at South Kensington a few years ago one of the most interesting exhibits was the first specimen of Urea from Prof. Wöhler.

This substance and specimen may be said to be the first organic compound, or product of a living organism built up from its mineral elementary constituents, not certainly directly, but very nearly, by an ordinary chemical operation.

The importance of this discovery, made in 1828, was not, however, recognised for many years. Its importance and signification in a physiological sense were first perceived, but its formation is the earliest and best example of an action that plays an important part, and is probably the most interesting question in modern organic chemistry, namely, what the Germans call the "Umlagerung" of the atoms in a molecule or "intermolecular change."

Urea was obtained by Wöhler by simply heating the compound ammonium cyanate, NH_4CNO, in contact with water, whereby the arrangement of the atoms is so changed that the two nitrogen atoms become directly combined to hydrogen and only indirectly to the oxygen as shown in the chemical formula:

$$CO\begin{cases}NH_2\\NH_2\end{cases}.$$

So long ago as 1773 this substance was discovered as a constituent of urine, and since then its importance as a final stage in the retrogressive metamorphosis of the animal tissues, or of albumenoids, has been pretty fully worked out and recognised.

Although albumin has not yet been directly oxidised to urea in the laboratory, the descent takes place in the animal economy through several stages, as for instance, tyrosin, kreatin, xanthin, allantoin, uric acid, &c., probably by a simultaneous oxidation and hydration, or even reduction. Several of these intermediate substances yield, however, urea as a direct product of oxidation not only when taken into the organism but when submitted to ordinary oxidising agents. Even substances like asparagine, leucine, and glycine, which are very near to albumin as products of retrogressive metamorphosis, may be considered as preliminary stages in the splitting up and oxidation of the tissue substance into more simple compounds until a truly *mineral* character is arrived at.

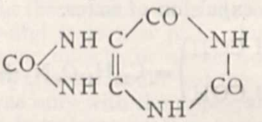
Although urea was synthesized from its mineral elements so long ago, it has until quite recently contributed comparatively little to the syntheses of the more complex members of the class of bodies of which it is almost the final oxidation product. A great number of bodies have, however, been derived from urea by substitution. Probably the most important synthesis obtained by the aid of this body since Wöhler prepared it from its mineral constituents, is the one just announced as having been made by Dr. Horbaczewski in the Vienna Chemical Institute.

This chemist has succeeded in proceeding a step backwards from urea to uric or lithic acid. The method employed, of which the details have been sent to us by Dr. Horbaczewski, is by heating urea with glycocoll at a temperature of 200°–230° C. in a metallic bath until the mass fuses and becomes brown and friable.

Glycocoll is amido acetic acid, $CH_2.NH_2.COOH$, and the reaction which takes place may perhaps be represented:—

$$CO\begin{matrix}NH_2\\NH_2\end{matrix}+(CH_2\,NH_2\,COOH)_2=C_5N_4H_4O_3+OH_2+H_6.$$

The action as represented by this equation indicating conditions the reverse of those supposed to exist when uric acid is converted to urea. As to the structure of the group $C_5H_4N_4O_3$ the simplest view is that of Medicus—



It is somewhat remarkable that this reaction and synthesis has not been attempted or attained earlier, for the converse reaction, represented by the equation—

$$C_5H_4N_4O_3+5OH_2=CH_2.NH_2.COOH+3CO_2+3NH_3$$

has been known for a considerable time.

The same two substances have previously served as materials for an important synthesis, namely, that of hydantoïn or hydantoic acid (*Ber. Ber.*, p. 36).

This synthesis is mostly important as giving a step backwards towards that very complicated atomic group termed albumen.

That this will eventually be arrived at is exceedingly probable, and in the near future, for an even more complicated substance than uric acid has also been built up and its structure or intermolecular constitution settled very conclusively by the method of synthesis employed by Erlenmeyer and Lipp. This substance is tyrosine, a product of the decomposition of albumen in the animal system, and also by putrefactive decomposition and by heating with alkalies or acids.

The method is somewhat more complicated than the one employed by Dr. Horbaczewski. Starting with phenethyl-aldehyde they proceeded by conversion into phenylalanin and nitration to the amide compound—

$$C_6H_4\begin{cases}NH_2\\CH_2-CH(NH_2).COOH\end{cases}$$

paranitrophenylalanine, a substance very similar, as will be seen on comparison of formulæ in its nature to the amido acetic acid or glycocoll employed in the uric acid synthesis. On treating this body with nitrous acid the following reaction takes place:—

$$C_6H_4CH_2:\ CH.\overset{NH_2+NO^2H}{NH_2.COOH}=H_2O+N_2$$
$$+C_6H_4\begin{cases}OH\\CH_2.CH.NH_2.COOH.\end{cases}$$

According to this method of building up, tyrosine is a para-hydroxy phenyl α alanine.

Both reactions are similar in this respect: the end is attained by the splitting away of hydrogen from nitrogen groups NH_2 partly in the form of water.

All these syntheses are really approaches to that of albumen, and in this connection some work lately done and published in brochure form by MM. Loew and Bokorny of Munich gains in importance.

These investigators have proved the presence of aldehyde groups in living plasma, and are of opinion that albumen is a product of the condensation of a relatively simply-constituted molecular group.

These simple groups are what are termed aldehydic groups and ammonia or amide groups.

Their idea is that a group *CHOH*, which, however, has not yet been isolated, combines and condenses somewhat as shown:—

$$4CHOH + NH_3 = \begin{matrix} H_2N\,.\,CH\,.\,COH \\ | \\ CH_2\,.\,COH \end{matrix} + (OH_2)_2$$

This more complex group acting again as an independent individual and yielding a still more complex body, $C_{12}H_{17}N_3O_4$, with expulsion of water.

$$3\begin{pmatrix} H_2NCH\ COH \\ | \\ CH_2COH \end{pmatrix} = C_{12}H_{17}O_4N_3 + {}^2H_2O.$$

A further similar condensation under conditions where it could take up additional hydrogen and some sulphur, conditions easily attainable in living organisms, yield albumen direct:—

$$6\,.\,(C_{12}H_{17}N_3O_4) + SH_2 + {}^6H_2 = C_{72}H_{112}N_{18}S\,.\,O_{22} + {}^2H_2O.$$

This is the formula for albumen, assuming sulphur as an essential constituent. A simpler would be $C_{72}H_{114}N_{18}O_{24}$, and would be a direct product of such condensation.

Both in the fall of this complicated molecule through less and less complicated groupings of atoms to the so-called mineral groups into which they are finally resolved, and in the so far only partial building-up process, the peculiar aptitude of certain elementary substances to combine into very stable groups or individuals is well shown. Carbon and nitrogen compounds exhibit this *par excellence*, but there is no reason to suppose that such a property is confined to them alone. It may be that the range of existence of these compounds are more within our reach than in the case of other so-called elements.

As elements imprint generally their most characteristic property on the compounds they form, it is perhaps not unreasonable to suppose that these elements whose compounds we see so readily group up or polymerise, may themselves be also, in the condition in which we take them to be elementary, in a state of great atomic complexity.

THE BUTTERFLIES OF INDIA

The Butterflies of India, Burmah, and Ceylon. A descriptive Handbook of all the known Species of Rhopalocerous Lepidoptera inhabiting that Region, with Notices of Allied Species occurring in the Neighbouring Countries along the Border; with Numerous Illustrations. By Major G. F. L. Marshall, R.E., and L. de Nicéville. Part I. Royal 8vo. (Calcutta, 1882.)

THE first part of this anxiously-expected book, by Major Marshall and Mr. de Nicéville, has just arrived, and will, I am sure, be gladly welcomed, not only by the naturalists *in esse* of Europe, but by a great number of naturalists *in posse* of our Indian Empire.

For though, thanks to the labours of Hodgson, Blyth, Jerdon, Hume, Blanford, Godwin-Austen, Day, Theobald, and many others, we have excellent handbooks, and a very fairly complete knowledge of the mammals, birds, reptiles, fishes, and land shells of India, we have absolutely nothing to assist the entomologist or collector in identifying and studying the lepidoptera. How many weary hours of hot weather on the plains, how many dreary evenings in camp, and tedious marches in mountains and forests will be made interesting and profitable by this book no one but residents in India have any idea, but I feel sure that its appearance will give such an impulse to the collection and study of the lepidoptera of India that in ten years we shall have as many working entomologists in India as we have had ornithologists, since the publication of Jerdon's Birds of India.

Considering the magnitude of the work, and the many risks and chances of life in India, it is specially fortunate that the work has been undertaken by two gentlemen, of whom one is already known as an ornithologist of repute, and both of whom have excellent opportunities for bringing together the immense amount of material necessary to bring the work to a conclusion.

The little we know at present of the butterflies of India is gathered from the scattered descriptions of Indian species by old authors and from the numerous papers and descriptions in various publications by a few modern entomologists, of whom Mr. F. Moore holds by far the most distinguished place. Unfortunately, however, many of these papers are of a bare and misleading character, and so far from making the work of discriminating the species easier, only confuse it.

The carelessness which has been shown by some writers about the habitat and distribution of species, and about their allied forms, is deplorable in many ways, and shows an entire want of appreciation of the physical geography of India, and of the vastly different zoological regions which it includes; but new light is sure to be thrown on the subject by men who understand and appreciate these facts, and who have personal and local knowledge of the country whose insects they describe. The form of the work, which is printed and published by the Calcutta Central Press Company, 5, Council House Street, Calcutta, is a large octavo; both print and paper are good, and likely to stand the hard wear to which no doubt the work will be subjected. The price is not mentioned in the first part, but will no doubt depend on the number of illustrations which are found necessary. These are of three kinds, viz. chromolithographs, of new and remarkable species by West, Newman, and Co., London, of which one appears as frontispiece, and is very superior to some illustrations of a similar character; autotypes, by the Autotype Company of London, of which nine are given in the first part, illustrating dissections, typical larvæ, and pupæ, and fifteen species of Danainæ; these are well executed, and suitable to their purpose, though perhaps they will hardly be suitable to illustrate the Lycenidæ. The woodcuts, by George Pearson, of which three are given with the text, are not quite so good, but will serve their purpose very fairly. The illustrations are drawn by Babu Behari Lall Dass, and Babu Cris Chunder Chuckerbutty, of Calcutta, under the superintendence of Mr. Wood Mason, and seem to be faithful to nature, as the drawings of good native artists generally are.

The preface and introduction show that the authors thoroughly appreciate the difficulties before them, and are determined to spare no pains to make their work as useful as possible; and though they have, from their inability to examine the types, been obliged temporarily to adopt many species about which they evidently have grave doubts, yet a new edition will no doubt enable these supposed species to be relegated to their proper position. The authors' opinion on this important question may be quoted as follows:—

"With regard to species and varieties we have found it convenient to describe where there is any room for doubt under its own distinctive name, every form that has been separately characterised, the question whether any particular form represents a species or a variety of a species can at present be decided in this country only as a matter of conjecture; for a knowledge of the life-history in all its stages is essential to the authoritative settlement of such questions; at the same time the evidently or apparently allied species are carefully grouped together, and the nature of the variety is indicated as closely as our present knowledge will allow."

With regard to the scope of the work we may again quote the preface as follows:—

"This book does not attempt a life-history of each or any of the insects. The time has not arrived for such a work. The details required for a life-history cannot be gathered until a knowledge of the nomenclature is far more widely diffused. It is simply designed as a handbook of reference, as complete as possible in itself, for the convenience of naturalists in the field, who have no access to libraries. Where necessary full extracts from the works not generally available are given, and where possible and advisable the description of the species are given in the words of the original describers, supplemented by any further details necessary to complete them. For the genera the admirable descriptions by Westwood in the 'Genera of Diurnal Lepidoptera' have been followed as closely as possible.

"The book will comprise detailed descriptions of every genus and species known to occur within the limits of India, British Burmah, and Ceylon, and short descriptions will be added in smaller type of species from neighbouring countries on the border, such as Malacca, Siam, Yunnan, Tibet, South Turkestan, Afghanistan, and Beluchistan, which, though not yet recorded from within Indian limits, may very probably subsequently be found to occur within our border."

If the authors mean to follow out this course it is to be hoped that their descriptions will be of a comparative and not of a general nature. Nothing can be more laborious, more unsatisfactory, and often more useless than wading through long descriptions, when a few words indicating in what character the species in question differs from its nearest allies, are often far more useful. It is just because authors have in many cases been unwilling or unable to make this comparison that they have described species without good cause, and it is frequently found that when such comparison is attempted, the want of distinctive characters is shown at once, whereas in a long wordy description it may easily be concealed. In conclusion, we wish the book success and plenty of supporters, so that it may be completed quickly, and mark the commencement of a new era in Indian entomology.

H. J. Elwes

OUR BOOK SHELF

Winners in Life's Race; or the Great Backboned Family. By Arabella Buckley, Author of *Life and her Children*, &c. With Numerous Illustrations. (London: Edward Stanford, 1882.)

Life, the title of Miss Buckley's thoughtful work now before us would suggest, once it became materially existent, went ever forward, striving after diverse fashions to adapt her children to the best methods of fighting and winning. She felt her way onward in several directions, and in several of these she attained to a fair share of perfection, from shapelessness to symmetry, from a simpleness in structure to a wonderful differentiation thereof; from a mere manifestation of vitality to a high state of instinct, almost of intellect; but there was to all of these a limit all too speedily attained—and it is now plain that no arrangement of epidermis, or muscle, or nerve, no alteration of blood, or alimentary system could get the uppermost in the struggle. It was only with the appearance of a quite new structure—the back-bone of this volume—that Life felt she had acquired a new power, and those of her children who were thus endowed went on gallantly until, Winners in the race, they were left without a rival. The record of their humble beginning was still very incomplete but a few years ago, and there was no clue thereto. Now as the reader will learn in the clearest manner from chapter I., we know of such forms as the Lancelet, and those strange Ascidia who "once tried to be backboned, and yet as they grew fell back into the lap of Invertebrates."

Commencing with these Ascidia, this new volume of Miss Buckley proceeds to tell of those "Winners in Life's Race," which are supposed to culminate in our very selves. It does this in a way that most young people and every fairly educated person can understand as well as with a carefulness in detail and a caution in the statement of facts, most pleasing and grateful to the advanced student of Nature. Ably as this little volume is written, and admirable as, in our mind, is the judgment shown in the selection of details, yet it hardly comes to us with that captivating freshness that made the author's story of "Life and Her Children" so welcome. Why this is so, we can scarcely suggest; but this record of the battle over, of the fight won, seems to have been the result of a more tiresome labour than the author's previously published records of those other legions which led on so steadily to what was but a forlorn hope. Perhaps this is because there is a wondrous charm surrounding the mysterious beginnings of life which is not felt in the same degree as we approach the consideration of those beings who would seem to be the final product of life's genesis. Still, nothing that we thus write about the contrast between these volumes can lead us for a moment to overlook the fact that we know of no book in our language, which for the general reader approaches this, as an introduction to those animals (fish, reptiles, birds, and mammals) to whom the victory in life's race has been vouchsafed.

E. P. W.

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 ensure the appearance even of communications containing interesting and novel facts.*]

Weather Forecasts

I am glad that my letter on this subject has been the means of eliciting the letter of the Rev. W. Clement Ley, printed in your number of November 9. I have also received more than one private communication; and by the courtesy of Mr. Scott I have been permitted to see all the evidence received at the Meteorological Office on the day preceding the great storm of October 24.

The painful conclusion is forced upon my mind that some of the difficulties which lie in the way of a surer and safer forecast of dangerous storms might be removed by a simple increase of expenditure upon the machinery available for meteorological purposes.

Mr. Ley writes: "On the whole, to the minds of many students of the subject it will appear rather strange that the Office, *with the materials at its disposal* [the italics are used by Mr. Ley] does not more often fail to furnish satisfactory warnings of the more serious of our gales. It is easy to say, in view of occasional failures, 'the system itself must be at fault;' it is still easier to reply 'Better it!' If the country cares enough for the welfare of 'fishermen and others' to do so, let it provide the necessary funds for a system of night telegrams, and, if possible, for a system of oceanic stations. If it does not, it must be content with things as they are."

Again, a private correspondent writes to me:—"The weather cannot be treated as though it went to bed at night and tucked itself in under a blanket of cumulus. It unfortunately does nothing of the kind; and while the director and his subordinates are quietly sleeping, atmospheric changes are going on with a rapidity which a constant influx of telegrams must afford the only means of meeting. Yet still in spite of all these we go on, satisfied with having only *two* reports sent in every twenty-four hours. The result is that every now and then a disastrous failure such as that of Tuesday *must* occur."

It must seem, therefore, that without the important assistance of a new class of observations, dependent upon the motions of the higher clouds, much might be done by such an extension of an existing system as common sense seems to demand. At present we appear to be acting upon a method somewhat parallel to that which would be adopted upon our railways, if the companies should send their signalmen to bed at 8 p.m., but with the night-traffic all the same. Collisions of the first magnitude would probably abound under such a system.

I write not as a meteorologist, but as a citizen. Surely if the position of things be such as has been described, and if an important improvement in the forecasting of storms could be ensured by the expenditure of a somewhat larger sum of public money, there could be no difficulty in bringing the matter in such a way under the notice of the Government as to secure the necessary funds. H. CARLISLE

Rose Castle, November 13

The Comet

It may perhaps interest you to know that a most brilliant comet has been visible here for about three weeks. I saw it for the first time on the morning of September 29; at 4.40 a.m. of that day it bore from a house on the ridge overlooking Victoria E. ¼ N. true (nearly), the nucleus being then about three degrees above the horizon; an imaginary line drawn from Rigel through Sirius met the nucleus.

The approximate length of the tail was nearly equal to the distance between Rigel and Betilguex, and its greatest breadth nearly equal to the distance between the two outer stars in the belt of Orion. The tail appeared brighter on the southern than on the northern side.

The following particulars, which may also prove of interest, were communicated to me by Capt. Metcalf, of the White Star Company's steam ship *Oceanic*.

"Monday, September 25—observed a large comet rise about 4.30 a.m., position at the time lat. 30° 18′ N., long. 128° 40′ E. September 26, at 5h. 17m. a.m., apparent time at ship (September 25, 9h. 01m. 13s. G.M.T.), altitude of comet, 7° 20′, distance from Sirius 63° 21′, tail extending nearly in a line from sun to Orion's belt., lat. 27° 52′ N., long. 124° 10′ E. September 27 (at 9h. 02m. G.M.T. September 26), comet's distance from Sirius 62° 32′. At 5h. 32 a.m., altitude of comet 13° 22′, bearing true S. 80° E., lat. 25° 16′ N., long. 119° 56′ E., tail about 7° to 8° long. Comet rose bearing S. 86° E. (true). September 28—distance from Sirius 61° 49′. October 3 (in the Victoria Harbour)—distance of comet from Sirius 58° 43′."

As the comet is still visible I may possibly be able to give you some further information about it by next mail.

The following extract is from the *China Mail* of the 7th inst.:—

A Melbourne despatch, dated September 16, says—"The comet is now extremely bright, being visible through the telescope at noon, a circumstance unprecedented in the experience of the officers of the observatory."

If it is not trespassing too much on your time I should be very much obliged if you would kindly inform me what observations would be useful (which could be taken by an ordinary sextant) should we be visited by another comet.

In conclusion I may add that for the past week the weather has been unusually hot, and although the barometer has fluctuated considerably, no atmospheric disturbance has taken place.

According to M. Dechevrens, S.J., Director of the Zi-ka-wei Observatory, no less than *twenty* typhoons visited the China and Japan seas last year, but up to date of the present year only *three* have been reported. J. P. MCEWEN, R.N.,

Hong Kong, October 9 Assistant Harbour Master

I THINK there must have been some mistake about Major J. Herschel's observation, as recorded in NATURE, vol. xxvii. p. 5. As other observers have shown, the comet appears quite bright in moonlight. On the morning following his observation I was perhaps as much astonished as he was, only in the opposite direction; for I was very much surprised to find then (the 31st ult., at 5 a.m.), that the tail was longer than on any other occasion when I have seen it, viz. 33°. The following observations will also show the brightness of the comet in moonlight and twilight. On the 26th, at 5.25 a.m., nine hours before full moon, and in brightish twilight, the tail was visible through fog and thin cloud to a distance of 13½°. On the 29th, at 5.37 a.m., it was fully 23° long. This morning, at 6.9 a.m., in bright twilight, it was very faint, but still above 18° long. I think Major Herschel cannot have looked low enough down, or his view must have been otherwise obstructed.

The wisp, or horn, that he represents on the 23rd, was certainly a very striking feature at that time. Though not exactly like the drawing in vol. xxvi. p. 622, it was nevertheless very definite, and part of it was brighter than the adjacent part of the comet between it and the head. There appeared that morning to be also two other knots of light, much less conspicuous—one almost a continuation of the "horn," following it, and a little further north; the other, in the *n* branch of the "fish-tail."

Sunderland, November 7 T. W. BACKHOUSE

P.S. November 8.—The "horn" was this morning still a marked feature of the comet, though much less definite than formerly. Its origin (at the point where it begins from the northern branch) is still brighter than the neighbouring portions of the tail for a considerable distance in all directions. It occurs to me that this comet offers a very favourable opportunity of testing theories of the motions of tails; its features are so definite that if careful observations are, and have been, made of the positions of different points, they must throw much light on the subject. T. W. B.

ON the 10th inst., at 5 a.m., the length of the nucleus was 110″, its breadth 12″, and its position angle 112°·5. The length seems fast increasing judging from previous measures. The tail was still about 15° long, but the first glimpse of daylight completely masked it. GEO. M. SEABROKE

Temple Observatory, Rugby, November 14

THE great comet was again a magnificent object in our south-eastern sky, at 5.10 this morning. The startlingly sharp definition of October 23 had given place to a softer outline; but the apparent length of the tail was at least as great, and the nucleus surprisingly bright, with a distinct scintillation, even in comparison with two near stars. Major J. Herschel's experience of finding himself gazing at the comet without seeing it, in a clear sky, differs from mine, as I have on two occasions, since October 23, seen it perfectly visible, though wan, in bright moonlight, and when the sky at that elevation above the horizon was not free from haze. On October 23 I saw the strong apparent shadow spoken of by one of your correspondents, but here it was much blacker below the bright convex line of the tail than between the cleft at the end of clear definition. It did not seem to me the effect of contrast merely; but like that blackness through which the stars shone darkly in the recent southward display of aurora borealis. HENRY CECIL

Bregner, Bournemouth, November 10

Magnetic Arrangement of Clouds

THERE is a small literature on the above subject (dating back to the time of the publication of Humboldt's *Cosmos*) which seems to have escaped the attention of Mr. Romanes. He will find a large number of observations similar to those mentioned in NATURE, vol. xxvii. p. 31, recorded in a paper in the *Phil. Mag.* for July, 1853, by Mr. W. Stevenson, of Dunse. Similar observations have been made by Mr. Birt, *Met. Mag.* January, 1876, and by several others in this country. M. André Poëy also deals with the subject at some length in his work, "Comment on observe les Nuages," chap. iv.

The apparent arrangement of cirri-form clouds "round two opposite poles" is simply the optical effect of the parallelism of the belts of ice-cloud, or "cirrus-bands," as Humboldt designated them. These belts are coincident in direction with what were, at the time of the formation of the clouds, lines of equal pressure in that horizontal plane in which the clouds float; or, in other words, their direction is normal to that of the atmospheric gradient at the cirrus-level. Their position, and therefore that of their vanishing points, has never been proved to have any relation to the position of the magnetic poles. It is true that in Europe a direction coincident with the magnetic meridian is slightly more common than a direction transverse thereto. But this is explained by the fact that the formation of the bands requires somewhat steep gradients in the regions of the cirrus, and that, with us, the steepest gradients in those regions are commonly the north-eastward, being those which prevail in front of and between the cyclonic disturbances at the earth's surface, which travel towards north-east. Thus, the best defined cirrus-bands most commonly stretch from north-west to south-east.

A detailed explanation of the formation of the belts, which bears some similarity to that given by Lamarck, and which is in many, but perhaps not in all points satisfactory, will be found in a paper by Max Möller in the "Annalen der Hydrographie und Maritimen Meteorologie. Organ des Hydrographischen Amtes und der Deutschen Seewarte," 1882, heft iv. pp. 212-226.

The attempts which have been frequently made to apply the terms "polarisation," "polar bands," &c, to the cirrus belts have proved unsuccessful, and will not, it is to be hoped, be renewed. W. CLEMENT LEY

November 11

"A Curious Halo"

THE phenomenon described in NATURE (vol. xxvi. pp. 268, 293, xxvii. p. 30) is far from being unknown in Europe, where it generally receives the title of "*Rayons du Crépuscule*"; although I do not think that it ever presents the brilliant appearance described by Father Marc Dechevrens as noticeable in China. In England it is more common in the winter than in the summer months, and does not appear to occur especially in warm weather, although I do not know that it has been noticed during frost. The furrows between the bands of light are not, so far as I have observed, rapidly movable in the sky in England, and they seem to be traceable to hills beneath the horizon, rather than to cumuli. I have never noticed them where the sun sets beneath a sea horizon. W. CLEMENT LEY

The phenomenon described by M. Dechevrens as often witnessed in China, I have several times seen in this country, namely, beams or spokes in the eastern sky about sunset, springing from a point due opposite to the sun. The appearance is not very strongly marked, and I used to think I must have been mistaken, till I came to see the true explanation, which was the same as that furnished by your correspondent.

There seems no reason why the phenomenon should not be common, and perhaps if looked out for it would be found to be. But who looks east at sunset? Something in the same way everybody has seen the rainbow; but the solar halo, which is really commoner, few people, not readers of scientific works, have ever seen at all. The appearance in question is due to cloud-shadows in an unusual perspective and in a clear sky; now shadow may not only be seen carried by misty, mealy, dusty, or smoky air near the ground, but even on almost every bright day, by seemingly clear air high overhead. Therefore, if this sunset phenomenon is much commoner in China, there must one would think, be some other reason for it than that the sky of England is not heavily charged enough with vapour to carry shadow. Rather it is too much charged, and the edge of the shadow becomes lost with distance and with the thickening of the air towards the horizon before the convergence of the beams eastwards is marked enough to catch the eye.

I may remark that things common at home have sometimes first been remarked abroad. The stars in snow were first observed in the polar regions; it was thought that they only arose there, but now everyone sees them with the naked eye on his coatsleeve. GERARD HOPKINS

Stonyhurst College

Priestley and Lavoisier

I AM sorry that Mr. Rodwell should have thought it necessary to revive the old oxygen quarrel, and the more so, as he has taken an unpatriotic part against Priestley, and indorsed the complacent statement of Wurtz, that chemistry is a French science founded by Lavoisier; forgetting, perhaps, that the title, "La Chimie Française," was invented by Fourcroy, and objected to by Lavoisier.

The fact is, that chemistry has no nationality. It belongs to the universal republic of Nature, and had no proper existence for us until Dalton discovered its laws.

In the scientific democracy, to use Lord Bacon's expression, discoverers are mutually dependent, and it would perhaps be impossible to find any one capable of standing alone. It has even been charged against our great Newton that his astronomical discoveries are to be found in Kepler; but, as Dr. Whewell well remarks, it required a Newton to find them there.

That the compound is always equal to the sum of its elements, was known long before Lavoisier, and so early as 1630 Rey gave the true explanation of the increase of the weight of metals by calcination. Lavoisier's note of 1772 was, as he admitted, based upon Priestley's earlier experiments, begun in 1744; while the acceptance of Lavoisier's doctrine was mainly due to the capital discovery of the composition of water by Cavendish, in 1784.

If at this advanced period we are required to put in national claims, then surely our own countrymen must share largely in the honours which Mr. Rodwell reserves for Lavoisier alone. Black, Priestley, and Cavendish are the founders of pneumatic chemistry. Priestley discovered oxygen in 1774, Cavendish discovered hydrogen in 1784, while Davy abjured Lavoisier's *principe oxygène*, and by his numerous discoveries gave the chemical edifice so rude a shake, that it had to be taken down and rebuilt. C. TOMLINSON

Highgate, N., November 4

Wire Guns

IN the last number of NATURE there is an interesting paper on "Wire Guns," and incidentally various methods of manufacturing guns is mentioned. *Apropos* of this permit me to relate a curious fact regarding gunmaking which came under my notice many years ago, and which supports the adage that there is nothing new under the sun. In the autumn of 1841 Sir H. Gough took the batteries of Chusan by a turning movement and thus spoiled the Chinese preparations. The force captured a large number of guns, some very fine bronze ones, but there were also a good many smaller iron ones, and as these were of no value they were ordered to be destroyed. The Royal Artillery tried to burst these without success at first, and only after sinking the muzzles in the ground did they succeed. It was then ascertained that the reason of the extreme strength of the gun arose from its strange manufacture. It had an inner tube of wrought iron, over which the gun was *cast*, anticipating by many years a somewhat similar plan by Palliser.

Cheltenham, November 3 W. H. C. B.

Palæolithic River Gravels

MR. C. EVANS, in NATURE, vol. xxvii. p. 8, wishes our anthropologists to furnish an explanation why the mortal remains of palæolithic man are not to be found amongst his "so-called 'flint implements.'"

The question is one that naturally occurs to any one whose practical acquaintance with anthropological "finds" is of a limited character; and it may fairly be presumed that the inquirer has not himself seen and handled such relics, else he would scarcely have imagined it within the range of possibility that they could have been "formed by natural causes," by which, I suppose, he wishes to infer that they were not made by *man*.

As I am a mere tyro myself, and therefore unbiassed in the matter, I beg leave to state, for the benefit of any whose acquaintance with the subject is of only a rudimentary nature—or less—what appears to be a reasonable explanation of the case.

1. The implements of foremost scientific interest are probably those which are found in the various well-known caves, in that they retain in the highest degree all the original sharpness of edge possible only under the slow and undisturbed circumstances of the formation of the stalagmitic rock, or silt deposit, in which they have become embedded above the surface of the ancient floor. All such specimens bear clear and unmistakable testimony to their nature and use as weapons.

2. The alternative hunting-grounds for flint implements are the wide-spread gravels which formed the beds and older banks of the ancient rivers, and which have been of late so thoroughly explored by Mr. Worthington Smith, as recorded by him in this journal, in so many interesting and valuable communications. Respecting these it is only natural that in some cases the specimens have been subjected to much detrition; but then a special value attaches to them on that very account. Of the river gravels as localities from which such evidences are obtainable it is quite unnecessary for me to use space in emphasising the importance of river-sides as a habitat of primitive man.

3. "The entire absence of the bones of man," is simply due to the rapid decomposition of the osseous frames of small-boned animals, and the speedy annihilation of which in the case of man—cremation and other means of disposal apart—is particularly noticeable.

Perhaps the position will be best understood by suggesting the question, "Do you imagine it at all probable that you could unearth any trace of a single bone of one of your pedigree ancestors, say only your great-great-grandfather?" If any of you should doubt the impossibility of such a thing, let proof be given by employing the first grave-digger—*out* of "Hamlet"—to bring the treasures to the light of day, and let the facts of the case be placed on careful record.

4. Any connoisseur can at once tell by the touch of a flint flake whether it has been worked or not, and the fracture always bears certain signs by which the operation may be known to have been performed.

It is somewhat remarkable that there should be any so faithless as to seek after signs so easily to be discerned, in opposition to the testimony of reliable authorities; and *it is surely time* that surrounded as we are with national museums and libraries full of patent facts appealing to all who cannot work for themselves, we should cease to throw discredit upon the evidence of many careful observers and honourable truth-seekers.

Highbury WM. WHITE

YOUR correspondent, Mr. C. Evans, raises the question, in your issue of November 2, whether the peculiarly-chipped flint found in the palæolithic gravels, and accepted as the work of man, may not be the result of natural causes.

Mr. Evans mentions "the presence of bones of *recent* and extinct Mammalia." If your correspondent has clear evidence of the presence of bones of *recent* mammalia with the chipped flints that evidence would prove that the flints in question have not been so chipped by Palæolithic man, but are either nature's work, or the product of man of more recent times, and the gravels in such case should not be called Palæolithic gravels.

St. John's Wood, November 7 T. KARR CALLARD

Aurora

A MAGNIFICENT aurora was observed here last night. I first detected quivering sheaves on the northern horizon about 5.40 G.M.T. About 5.47 a dull indigo base, on or against which "sheaves" and "streamers" were playing with great beauty, was noted, surmounted by an arch of light. Soon afterwards, sharply-defined "spines" and "spikes" of great brilliancy and in patches became developed, followed by five great tongues of light stretching towards the zenith. I especially noted streamers reaching towards Vega, and passing over Mizar in Ursa Major, and some of exceptional brilliancy to north-north-east. At 6.50 irregular horizontal belts of a dull indigo tint, alternated with *horizontal* tongues of light, the streamers having generally disappeared, except to north-north-east. At 8.6 p.m. a low indigo belt, surmounted by a bright golden band, fringed the horizon, o'ertopped again by belts of paler tints respectively, while detached brilliant streamers shot up fitfully towards Cassiopeia. At 11 p.m. auroral lights were still seen.

To-day I intend to examine the sun's disc, and expect to see signs of disturbance.

Fort William, November 14 CLEMENT L. WRAGGE

A Dredging Implement

I WAS much interested in reading, in the last number of NATURE, Prof. Milnes Marshall's account of his successful trial of a new dredging implement.

A few summers ago I constructed and used in Lamlash Bay, Arran, a somewhat similar machine, suggested, like Prof. Marshall's, by the Philippine Islander's dredge used in the *Euplectella* fishery. My implement was a rough copy of one brought from Cebu which I had seen at the *Challenger* office in Edinburgh. It had two slight wooden bars, 5 or 6 feet each in length, meeting at about a right angle to form the front of the apparatus, and having several cross-pieces connecting them further back. I attached large fish-hooks, not to cords hanging from the frame, as in Prof. Marshall's instrument, but to the long bars themselves (as in the Philippine Islanders' machine), and also to the cross-pieces. One weight was tied to a cross-piece near the centre of the frame-work, and a second was attached to the rope a few feet from the front of the instrument, so as to make the pull more horizontal, and so prevent the front end from tilting upwards.

The apparatus worked well and brought up quantities of Hydroids and Polyzoa; but as I was not dredging for Giant Pennatulids, after a few trials I gave it up and returned to the ordinary naturalist's dredge. In one case, however, I found my fish-hook apparatus serviceable. I wished to search a remarkably sea-weedy region, in a few fathoms of water, chiefly for Ascidians attached to the sea-weeds. The ordinary dredge I found almost invariably soon after reaching the bottom, got foul of a large *Laminaria* or some other Algæ, which stretched across the mouth and prevented anything entering. The frame-work with hooks, on the other hand, always brought up enormous masses of stuff, in many cases dragging the *Laminaria* up by the "roots," and hoisting also sometimes stones and shells to which the Algæ were attached, and on which were very frequently the Ascidians I was in quest of.

I should think this kind of apparatus would be most useful for obtaining Algæ on rocky ground, and its value in dredging Pennatulids is sufficiently shown by Prof. Marshall's experience at Oban. W. A. HERDMAN

University College, Liverpool

Forged Irish Antiquities

UP to the present we have had little reason to complain of forgeries among Irish antiquities. Shams have frequently been offered for sale, but they could scarcely be called forgeries, as they were so unlike genuine articles that persons of ordinary experience could scarcely be deceived by them. Lately, however, some very clever imitations have come under my notice. The objects imitated are those known as oval tool-stones, which were formerly very rare but are now offered in lots of two or three together. I believe the fabricated articles are produced somewhere about the Giant's Causeway, the ordinary black shore pebbles being used for the purpose. W. J. KNOWLES

Flixton Place, Ballymena, November 11

THE NEW NATURAL HISTORY MUSEUM

SINCE our previous notice of the great building which has been erected at South Kensington for the reception of the Natural History Collections of the British Museum (NATURE, vol. xxiii. p. 549, April 14, 1881), eighteen months have elapsed, and during that period great progress has been made in the transfer and arrangement of specimens. It may not be uninteresting to the readers of NATURE to receive some information concerning the present condition of affairs and the prospective arrangements in connection with the housing and exhibition of the priceless treasures of the national collections.

The first point which strikes a visitor at the present time is that a serious mistake has been made in the erection of a building with such elaborate and ornate internal decorations for museum purposes. Now that the cases are nearly all in position and the specimens are gradually being arranged in them, this incongruity between the style and objects of the building becomes more and more apparent. On the one hand, it is clear that the form, position, and illumination of the cases has in many instances been sacrificed to a fear of interfering with the general architectural effect; and on the other hand it is equally manifest that it will be impossible to make full use of the floor space, and especially the best-lighted portion of it, without seriously detracting from the artistic effects designed by the architect.

Thus we find the beautiful arcade formed by a series of pierced wall-cases in the Coral-gallery has its effect totally destroyed by the floor-cases, which it has been found necessary to place along the central line; and in the British gallery the vistas designed by the architect have been completely marred by the insertion of large cases in some of the arches. Again and again we find massive columns, beautiful in themselves perhaps, breaking up a line of cases, or throwing their contents into deep shade. The peculiar tint of the terra-cotta, too, is far from being suitable for making the objects of the Museum stand out in relief, and this is particularly manifest in the case of the palæontological collections, where a great majority of the specimens have a very similar colouring. When an attempt has been made to remedy this by giving the walls near the objects other tints; it is found that such tints do not harmonize well with the general colouring of the building. Nor is the wisdom apparent of bringing into close proximity natural-history objects with the conventional representations of them adopted by architects. The crowding together, on the same column or moulding, of representations on the same scale of microscopic and gigantic organisms, of inhabitants of the sea and of the land, and of the forms of life belonging to present and those of former periods of the earth's history, seems to be scarcely warrantable in a building designed for educational purposes.

Greatly as we admire the spacious hall, the grand staircase, the long colonnades, and the picturesque colouring of the whole building, we cannot but feel that the adoption of such a semi-ecclesiastical style was a mistake. We fear that in the future there will be a perpetual conflict between the views of the keepers of the Museum-collections and those of the architect of the building; for the erection of cases as they may be required in the most convenient and best-lighted situations cannot fail to detract from the striking and pleasing effects of the architecture.

Apart from this fundamental objection, however, we find nothing but what is praiseworthy in the arrangements which are being made to worthily exhibit to the public these grand collections, of which such large portions have been long buried at Bloomsbury. In a few months the whole of them will have been removed from their old places of exhibition (or more often of sepulture) to the new galleries, where the space available for their arrangement is so much greater. The cases in the Zoological Galleries are now almost completed and fitted, and the collections of osteology and shells with some of the stuffed animals, have been already removed to their new home—so that the public may hope to see the transfer of the whole of the specimens completed by next spring.

The keepers of the geological, mineralogical, and botanical collections, which are housed in the eastern wing and annexes of the building, have had a very difficult task to perform. They were called upon to remove these collections before the fitting of cases in the new buildings was completed, and in consequence of this the re-arrangement of the specimens, with the incorporation of the valuable material long packed away in the cellars at Bloomsbury owing to want of space, was rendered additionally laborious and troublesome. These difficulties have now, for the most part, however, been happily overcome.

The Geological collections, in spite of their vastness have been to a great extent arranged. The Mammalian and Reptilian Galleries are indeed almost completed, and much progress has been made with the Fish Gallery and the several rooms devoted to the exhibition of the invertebrata and the stratigraphical collections. The trustees have been fortunate in securing the services of such an experienced palæontologist as Mr. Etheridge to second the energetic efforts of Dr. Woodward in this department. By the insertion of drawings and tables, illustrative of the structure and classification of the fossil forms, the value of this part of the collection to students has been greatly enhanced.

In the Mineralogical Gallery everyone must be struck by the improvement in the cases, now that the specimens are no longer crowded together, as was the case in the old museum. At the end of the general gallery, and in the adjoining pavilion, there are a number of interesting special collections. First and foremost among these is the unrivalled series of meteorites, which is now displayed to much greater advantage than at Bloomsbury; with these are collections of crystals, both artificial and natural, of pseudomorphs and of rocks, or mineral aggregates—the latter being an entirely new feature in this department. Large specimens, illustrating the abnormal development, the mode of association, and the economic uses of minerals are here being arranged, and they make a very fine display. Working mineralogists will be thankful to Mr. Fletcher for his capital design of setting apart a case, in which new acquisitions to the collection are exhibited for awhile, before being incoporated with the general series.

The portion of the Botanical collection available for public exhibition is small, but Mr. Carruthers, the keeper, has brought together a capital series of examples of all the great divisions of the vegetable kingdom—illustrating the dried specimens, where necessary, by drawings and models.

There are two points, however, in connection with the establishment concerning which the readers of NATURE will naturally be especially desirous of information—first, as to the facilities to be afforded to students for examining the valuable types and rare specimens in which the collections are so rich, and secondly, with respect to the improvements which are sought to be made in the Museum, regarded from the point of view of an educational institution. The surest test of the efficiency of the administration of such a museum as this will be found in the manner in which these two great objects are attained by its keepers.

Close days for students having been now entirely abolished, the trustees of the Museum have provided galleries in each of the departments where scientific workers can pursue their studies undisturbed. We cannot help thinking that this plan is far better than the old one, which required original investigators to attend on those days of the week when the public were not admitted to the galleries—a restriction keenly felt by busy men in this country, and more especially by foreigners, who had perhaps come to this country with the sole object of devoting their time to the study of our national collections. As there are valuable reference libraries in each of the departments, and a general library of scientific journals for the whole establishment, the student has much greater facilities than formerly for carrying on his work, and nothing can exceed the courtesy with which persons actually engaged in scientific research are received and aided by the keepers and their assistants.

The publication of the series of well-known and valuable scientific catalogues is still proceeding. During the pressure of work caused by the removal of these vast collections, the trustees of the Museum have done wisely to avail themselves of the aid of specialists from outside, in connection with certain of the collections. Thus the collection of the fossil foraminifera has been arranged by Prof. T. Rupert Jones, whose catalogue of the same has been recently published. Dr. Hinde has in the same way dealt with the grand collection of fossil sponges; and his illustrated catalogue of them is now in the press.

But while the purely scientific objects of the Museum are not being lost sight of, we are glad to find that the greatest efforts are being directed by the keepers to the development of the institution as a means of popular education. In addition to the three admirable guides, published at the low price of one penny each, other popular works in illustration of the collection are being prepared. Thus Mr. Fletcher has written a penny guide to the collection of meteorites, in which he has drawn up one of the best statements concerning the nature of these bodies, and of the grounds on which they are so greatly valued by scientific inquirers, that we ever remember to have read. Simple in its language and mode of treatment of the subject, this little guide is replete with the most valuable information—information which the student of the collection might ransack a library in vain to find.

Still more interesting is Dr. Woodward's venture in the same direction—an illustrated guide for the department of Geology and Palæontology. The woodcut illustrations of this work are in part original, and in part borrowed from various scientific manuals, the publishers of which have generously granted the use of them to the Museum authorities. By the aid of these woodcuts Dr. Woodward is able to call attention to the chief facts concerning the structure of some of the most remarkable fossils in the collection, and the guide forms an excellent introduction to the study of palæontology. At present the only part of this guide which is illustrated by woodcuts is that which deals with the fossil vertebrates, for these only are as yet fully arranged; but in subsequent editions, no doubt, Dr. Woodward will give equal attention to the description of the most important forms, among the invertebrates. The design is an excellent one, and there is every promise in the present instalment of the work of its being admirably carried out. Such work cannot fail to be the means of diffusing in the widest possible manner accurate notions on the subject of natural history among the people. We hope that its circulation may be as large as that of Prof. Oliver's admirably illustrated guide to Kew Gardens, which we are glad to see has passed through twenty-nine editions.

While on the subject of the means adopted by the Museum authorities to make the collections a means of diffusing correct ideas among the people, we cannot avoid referring to Prof. Owen's design of surrounding the great central hall of the building with an "Index Museum." The idea is most praiseworthy, but its execution will, we fear, be attended with serious difficulties. Prof. Owen proposes to devote the first of the six recesses on the western side of the central hall to the illustration of man, the two next to the other mammalia, the fourth to birds, the fifth to reptiles, and the sixth to fishes. On the other side three recesses are to be devoted to the invertebrata, and one each to botany, mineralogy, and geology. Few naturalists will agree with Prof. Owen that the points which distinguish man from the rest of the animal kingdom, are to the zoologist, of such importance as to necessitate the setting apart of a division of the Index Museum for their illustration; and the limited portion of the available space assigned to botany and geology will occasion much surprise. As structural alterations have interfered with the use of two of these recesses, and the lighting of some of them is far from being satisfactory, the project may perhaps have to be greatly modified. One of the recesses, that devoted to the birds, has been already arranged with instructive diagrams and well-selected specimens, and a penny guide to it, written by Prof. Owen in his well-known clear and attractive style, has been published. If the design is carried further, we hope the greatest care will be taken to make the classification and arrangement adopted in the Index Museum harmonise with that employed in the several galleries, for otherwise such a museum will not serve as an index to the great collection, but will be a source of confusion rather than of assistance to students.

Of the zoological collections we can say little at present. The birds will occupy the ground floor of the western wing of the building, and the mammals the floor above. The osteological collections belonging to these two departments are already arranged in the upper floor, and form a new and most valuable feature of the Museum. The articulated skeletons are exhibited on the floor and in glass cases, behind which cupboards are constructed for the reception of unarticulated skeletons. The Pavilion contains a special series of bones, which are reserved for purposes of study. The skeletons of whales are to be housed in the basement of the building.

Generally we find that the convenience of the public has been fully consulted in the arrangements of the building. The lavatories and cloak-rooms are all that can be desired, but we suspect that much disappointment will be felt with regard to the refreshment department as at present constituted. Small and inconvenient counters are being erected on the highest story of the building, outside the Botanical and Osteological Galleries respectively. The obstacle thus created to the ingress and egress of visitors to those departments, and the fact that mice will infallibly be brought to them, is enough to ensure condemnation of such a plan. We hope that the trustees may yet reconsider the question, and find themselves able to devote to the purpose of refreshment, a room in the building which is centrally situated, and at the same time entirely cut off from the collections.

THE COMET

We take the following from the *Sydney Morning Herald* of September 19:—

Mr. H. C. Russell, Government Astronomer, sends us the following interesting particulars respecting the comet, under yesterday's date:—

The comet discovered on the 7th has developed in brilliance rapidly. When I first saw it on the 8th, the nucleus was equal to a bright star of the second magnitude; by the 11th it was brighter than a first magnitude star, and I was able to see it for eight minutes after sunrise on that day. Subsequently, the mornings were cloudy, and I could not see the comet either then or during the daylight, probably because of the sea haze, which is more or less part of the N.E. wind. The comet has, however, increased in brilliance so rapidly that Mr. Ellery was able to see the comet at noon, and telegraphed to me to that effect, and the air being clear it was found at once. I had not anticipated such a wonderful increase in its light, for now it is easily seen in the full glare of the sunshine, like a star of the first magnitude, even when viewed without a telescope, and it must be many times more brilliant than Venus when at maximum. In the large telescope the nucleus appears round and well defined, and measured three seconds in diameter; from it, extended on each side, the first branches of the coma, like two little cherub wings, and in front, the great body of the coma, forming a brilliant and symmetrical head, and thence turning to form the tail six minutes long. Under close scrutiny it was evident that the coma had one or more dark bands, curved like the outline, which made the form very interesting, but the glare of the sunlight made it very trying to the eyes. It is a splendid object, and it is to be regretted that no stars can be seen by means of which to fix accurately the comet's position; but should the weather continue fine, it will be possible to do this with the transit instrument. My observations this afternoon show that the comet was moving away from the sun again, and should this be maintained, it will become a morning, not an evening object. At 1.15 p.m. to-day the comet was only 9m. 45s. west from the centre of the sun, and 7m. of declination south; by 5 p.m. the distance in right ascension had increased three minutes; the declination was slightly less. Unless some rapid change in the direction of the motion takes place before to-morrow (and now that the comet is so near the sun this may result), the comet will be seen without the aid of a telescope, about seven degrees west of the sun. History tells us of wonderful comets which outshone the sun; but it is usual to receive these statements after liberal discount. Nevertheless the great comet of 1843 was easily seen by spectators when it was only 1° 23′ from the sun (that is, about half the distance between the comet and sun to-day at 1 p.m.); and at Parma the observers standing in the shade of a wall saw the comet with a tail four or five degrees in length. In Mexico, also, the comet was seen near the sun like a star of the first magnitude. It is probable, therefore, that the comet of 1843, the brightest of this century, was brighter than the present one.

We are indebted to Mr. John Tebbutt, of the Private Observatory, Windsor, for the following communications respecting the comet:—

September 16.—I succeeded in obtaining pretty good observations of the comet on the mornings of the 9th and 10th instant, but since the latter date fog and cloud have prevented observation. The following are the positions secured:—September 8d. 17h. 54m. 52s., R.A.=9h. 37m. 7·50s., Declination S. =0° 57′ 46″·4; September 9d. 17h. 49m. 45s., R.A. 9h. 45m. 47·81s., Declination S. = 0° 53′ 36″·2. A third position will, of course be necessary for the approximate determination of the orbit. In the absence, however, of such a determination it may safely be stated that the comet is rapidly coming into conjunction with the sun, and near its ascending node. It is not at all improbable that the comet is passing between us and the sun, and that in consequence its tail will be pointed approximately towards the earth. As we do not at present know the exact apparent track of the stranger, it would be advisable to watch the sun's disc at intervals during the next few days for a possible transit, and to look out at night for any indications of the aurora consequent on a possible near approach of the earth to the tail. It will be remembered that our passage through the tail of the great comet of 1861 was marked by a general exhibition of auroral phenomena. It is highly probable that the comet will, towards the close of next week, become an imposing object in the west during the evenings. Like the recent Wells comet, this body will doubtless be well observed with the transit circle in full sunlight.

September 18.—The extraordinary interest which attaches to the comet now visible will, I trust, afford a sufficient apology for my again trespassing so soon on your valuable space. Supposing, from the rapid increase in the brilliancy of the comet that it would probably be seen in full daylight, I turned my attention to the immediate neighbourhood of the sun about 10h. a.m. yesterday. I at once found the comet without a telescope; it was visible about four or five degrees west of that luminary as a brilliant white dagger-like object. The head was beautifully distinct, and the tail could be readily traced for about twenty minutes of arc. I succeeded in obtaining eleven absolute determinations of position with the equatorial, the approximate right ascension and declination of the last observation, 11h. 25m. a.m., being respectively 11h. 22m. and 1° 10′ north. I attempted to observe with the transit instrument. The comet entered the field of the telescope and was at once bisected by the declination wire; but, unfortunately, just before it reached the first transit wire it was obscured by a passing cloud and remained so till just previously to its quitting the field, when it was still found to be bisected. I trust the Melbourne observers will not fail to avail themselves of every opportunity to observe with the transit circle. If my memory serves me well I believe the history of astronomy does not furnish any previous instance of a comet being seen near the sun with the unassisted eye since the appearance of the extraordinary and well-known comet of 1843. That body was seen at 3h. 6m. p.m. at Portland, U.S., by a Mr. Clark, and consequently in full sunlight, and its distance from the sun measured by him with an ordinary sextant. The present comet was still plainly to be seen without the telescope at 5h. p.m. yesterday. To-day it will probably be too nearly in a line with the sun to be seen; but on Tuesday and Wednesday it will, I think, again be visible. In the absence of any calculation I will here venture to offer one or two remarks. The comet appears, from a rough inspection of its apparent path, to be moving in a track somewhat resembling that which would be followed at this time of the year by the great comet of 1843 on its way to perihelion, and it is a significant fact that the earth is to-day almost exactly on the line of the comet's nodes, and on the ascending side of the sun. At Greenwich mean noon to-day the longitude of the earth will be 355½°, while that of the ascending node of the great comet of 1843 is about 358°. It will be remembered that at the time of the appearance of the great comet of 1880 the parabolic elements of that body were found to be almost precisely those of the great comet of 1843 (see my paper read before the Royal Society of New South Wales in July, 1880)—and it was therefore considered that the two bodies were identical. It will be remembered, too, that at a discussion at one of the Royal Astronomical Society's meetings it was suggested that although the period between the returns of the comet in 1843 and 1880 was 37 years, the time of revolution might be greatly shortened by the comet's passage through the sun's coronal atmosphere. The question therefore arises—Is the appearance of the present comet a return of the same body? Should the comet make its appearance in the west after sunset, it is quite certain that it cannot be identical with that of 1843 and 1880; but if it should now rapidly revolve round the sun, and make its appearance again west of that luminary, it must certainly be a comet of very small perihelion distance. Whether it is the comet of 1843 and 1880 time alone will decide. I dare say your readers will call to mind the speculation of Mr. Proctor on the probable return of the comet of 1843 and 1880.

P.S.—At 11h. 35m. a.m. to-day (September 18) I again detected the comet with the unassisted eye. It was then about three-quarters of a degree west of the sun's western limb, and apparently moving west. In this case the comet in a few days must be again looked for in the morning sky.

The *Herald* writes:—The comet discovered on the 7th instant has increased so greatly in brilliancy that it can be discerned in daylight with the naked eye. The fact was discovered by Mr. Ellery, Government Astronomer in Melbourne, at noon, and by him communicated to Mr. Russell; but the unusual phenomenon was observed by Mr. Tebbutt, of the private observatory, Windsor, at about 10 o'clock. The authorities seem to agree that the history of astronomy does not furnish any previous instance of a comet being seen near the sun, as this is, since the extraordinary and well-known visitant of 1843. It is probable, Mr. Russell states, that the comet may be seen about seven degrees west of the sun, from which luminary it is apparently, however, moving away; and, should this movement be maintained, it will become a morning and not an evening object.

So far the Sydney journal.

We are indebted to Sir H. Lefroy for an extract from the *Eastern Star*, published at Grahamstown, Cape Colony, in which Mr. L. A. Eddie, F.R.A.S, draws attention to the duplication of the nucleus which appears to have been first remarked at the Royal Observatory, Cape of Good Hope, on September 30, and on the same date in the United States: a day or so later European observers very generally perceived it. On the morning of September 24, at 4h. 30m., Mr. Eddie, says: "A most glorious sight presented itself. The head of the comet had not yet risen, but a broad belt of golden light, about two degrees in breadth, streamed upwards from the horizon to about ten degrees; and from the northern margin of this again, a thin streak of less brilliant light extended upwards to about another twelve degrees, and when the head had fully risen above the horizon at 4h. 43m. a.m., there were about twenty-five degrees in length of intensely luminous matter, stretching upwards from a still more luminous head, and inclined to the horizon at an angle of 70°. . . . The head appeared as before, to consist of an apparently very solid though not very large nucleus, surrounded by a dense coma of no great extent, especially preceding the nucleus, and possessing no dark intervals, &c." The weather prevented further observation at Grahamstown till the morning of October 3, when, on directing his 9½-inch Calver upon the nucleus, Mr. Eddie saw not one round planetary disc, as he had last seen it, but "two distinct ellipsoidal nuclei in juxtaposition, each of them brighter on the interior edge, and drawn out, as it were, towards the comet's ulterior boundary, so that their conjugate axes were about double the transverse. They closely resembled, in the inverting telescope, the flames of two candles placed the one above the other, so that the uppermost part of the lower flame almost overlapped the lower portion of the other. There was a dark rift the breadth of the transverse axes of these nuclei, extending from the hindermost one into the tail. These two nuclei were not parallel with the axis of the comet, but the foremost was drawn, as it were, to the south, or nearer to the direction in which the comet is moving." Mr. Eddie further compares the two nuclei to the double-star α Centauri when viewed through a cloud with a low power. When daylight had advanced, they could be seen in the telescope perfectly free from the light of the surrounding coma. On the following morning the nuclei were distinctly divided with powers of 60 and 100 on the reflector: the preceding nucleus was larger and brighter than the other, but both were, if anything, smaller than previously.

The *Natal Mercury* of October 6 describes the imposing spectacle which the comet presented as it rose apparently from the Indian Ocean. The nucleus shone with a brilliancy rivalling Sirius, or even Venus, and the tail was slightly curved, and though, as dawn approached, a little diminished in length, appeared more concentrated and magnificent.

Observers who remember the great comet of 1843, as it presented itself in the southern hemisphere, are somewhat divided in opinion as to which body to give the palm on the score of brilliancy, though most of them appear inclined to favour the former. The Emperor of Brazil, who observed the comet of 1843 close to the sun on February 28, and on the following evenings, considers it was not so remarkable for the brightness of the nucleus as the present comet, but that the tail had a much greater extent.

At Santiago, Chile, the comet was visible on September 17, some minutes before sunrise, and on the next morning could be followed until 11h. 30m. with the greatest facility without the telescope; part of the tail near the nucleus was also visible, the northern border being much brighter than the other. On September 20, though the light of the comet had somewhat diminished, it was seen with the naked eye till 10h. 30m. M. Niesten, Chief of the Belgian expedition for the observation of the transit of Venus, observed the comet in Chile: he found the length of the tail (northern branch) 25° on September 22, and 22° on the following morning.

By the kindness of the Astronomer Royal, we learn that the comet was observed on the meridian at Melbourne on September 15, 16, and 17 civil reckoning; equatorial observations commenced on the morning of September 10: Mr. John Tebbutt observed the comet the previous morning at his private observatory, Windsor, N.S.W. The Melbourne meridian observations will be of great value in the determination of the elements of the orbit prior to the comet's rush through the solar coronal region, the last one having been made only fifteen hours before the perihelion passage.

Subjoined is an ephemeris of the comet for 18h. M.T. at Greenwich. It will be seen that it is now well observable on the meridian.

	Right Ascension.	Declination.	Distance from Earth.	Distance from Sun.
	h. m. s.	° ′		
Nov. 16	9 25 58	−25 3·1	1·496	1·688
18	9 21 25	25 39·0		
20	9 16 40	26 13·5	1·500	1·762
22	9 11 43	26 46·4		
24	9 6 35	27 17·6	1·510	1·835
26	9 1 16	27 46·9		
28	8 55 47	−28 14·2	1·514	1·906

The latest investigations on the motion of this comet tend to indicate, contrary to the expectation that was at first entertained by many astronomers, that it is not identical either with the great comet of 1843, nor with that which appeared with so great a resemblance in the elements of the orbit in 1880. Calculations by Messrs. Chandler, Wendell, and Hind, are so far in accord upon this point.

RECENT DYNAMO-ELECTRIC MACHINES

ELECTRICAL inventions of innumerable kinds have of late followed one another with bewildering rapidity; and the impetus to invention afforded by the present development of electric lighting, and by recent electrical exhibitions, is making itself felt in many ways. Most important, perhaps, of these is the production of improved types of machines for generating electric currents.

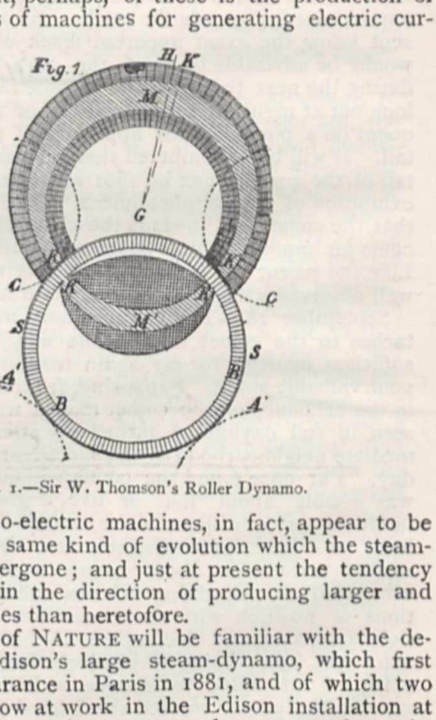
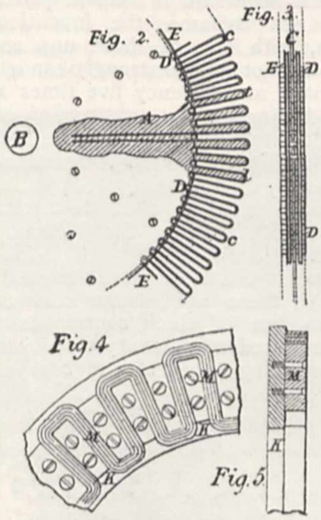


FIG. 1.—Sir W. Thomson's Roller Dynamo.

Dynamo-electric machines, in fact, appear to be undergoing the same kind of evolution which the steam-engine has undergone; and just at present the tendency appears to be in the direction of producing larger and heavier machines than heretofore.

The readers of NATURE will be familiar with the description of Edison's large steam-dynamo, which first made its appearance in Paris in 1881, and of which two examples are now at work in the Edison installation at Holborn Viaduct. These monster dynamos, each requiring from 120 to 150 horse-power to drive it, are capable of lighting from 1000 to 1300 incandescent electric lamps.

Six such machines have been also erected in New York to supply the central station of the Edison Light Company. Here the unexpected difficulty has arisen that if one of the machines drops in speed the currents from the other machines short-circuit themselves through the one, and overpower the steam-engine that is driving it; a fault



FIGS. 2–5.—Sir W. Thomson's Disk-Dynamo

which will probably be remedied by a rearrangement of the governors supplying the steam to the engines.

New forms of dynamo-electric machine have been designed by Sir William Thomson, some of these being for direct currents, others for alternate, but all of them of peculiar construction. The first of them, shown in Fig. 1, may be described as a modification of Siemens' well-known machine, the drum-armature being, however, made up like a hollow barrel, of which BB is a sectional view, the separate staves being copper conductors insulated from one another. They resemble the longitudinal bars used by Siemens in the armatures of his electro-plating machines, and by Edison in his steam-dynamo. At one end of the hollow drum these copper bars are united to each other in pairs, each to the one opposite it. At the other end their prolongations serve as commutator bars. A similar mode of connecting to that adopted by Edison, is also possible. Inside this hollow drum armature is an internal stationary electro-magnet, KM′K, whose poles face those of the external field magnets. This internal magnet answers the purpose of intensifying the magnetic field, and making the magnetic system a "closed" one, as suggested long before by Lord Elphinstone and Mr. Vincent. This hollow armature Sir W. Thomson proposes to support on external antifriction rollers AA′ CC′, the lower pair AA being of non-conducting material, the upper pair being made up of conical cups of copper split radially, and serving, instead of the usual commutator "brushes" to lead away the current. The hollow armature may be driven either by the tangential force of one of the bearing rollers, or by an axle fixed into the closed end of it.

Another machine devised by Sir W. Thomson, and illus-

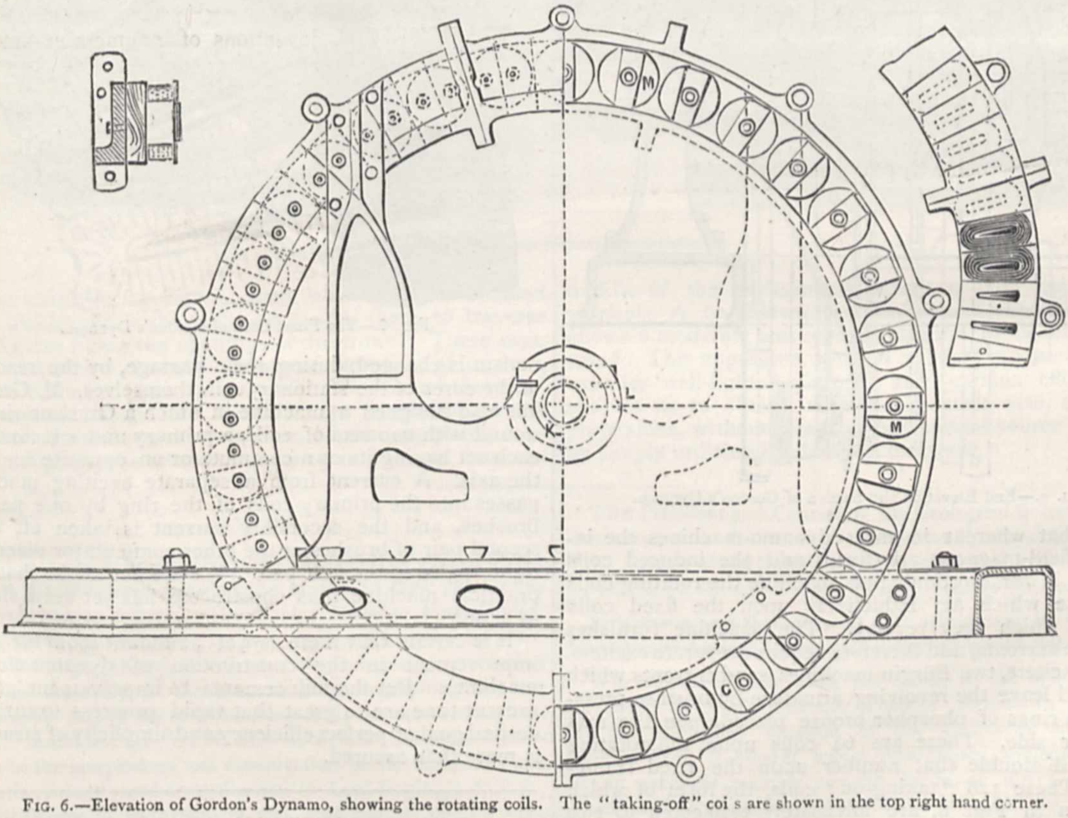


FIG. 6.—Elevation of Gordon's Dynamo, showing the rotating coils. The "taking-off" coils are shown in the top right hand corner.

trated in Figs. 2, 3, 4, and 5, is a disk-dynamo for generating alternate currents, and is therefore allied in certain aspects to Mr. Gordon's machine, described below. The rotating armature has no iron in it; it consists of a disk of wood having upon its sides projecting wooden teeth, as shown in Figs. 2 and 3, between which a wire or strip of copper is bent backwards and forwards, and finally carried to the axle B. This disk is rotated between field-magnets having poles set alternately all round a circular frame. Figs. 4 and 5 show how this is carried out. A cast-iron ring having projecting iron pieces screwed into it is surrounded by zig-zag conductors which carry into it the current from a separate exciter. These currents pass up and down between the projecting cheeks, and excite those on both sides of them.

A still more recent, and still larger generator, is that designed by Mr. J. E. H. Gordon, whose "Physical Treatise on Electricity and Magnetism" is known to most of our readers. This machine, which is given in elevation in Fig. 6, and in end-elevation in Fig. 7, is more than 9 feet in height, and weighs 18 tons. It possesses several points of interest. The rotating armature differs from those of the well-known Gramme or Siemens' armatures, being in form a *disc*, constructed of boiler-plate, upon which the coils are carried. The machine, therefore, resembles in some respects the Siemens' alternate-current machine, though there are notable points of difference, the most important

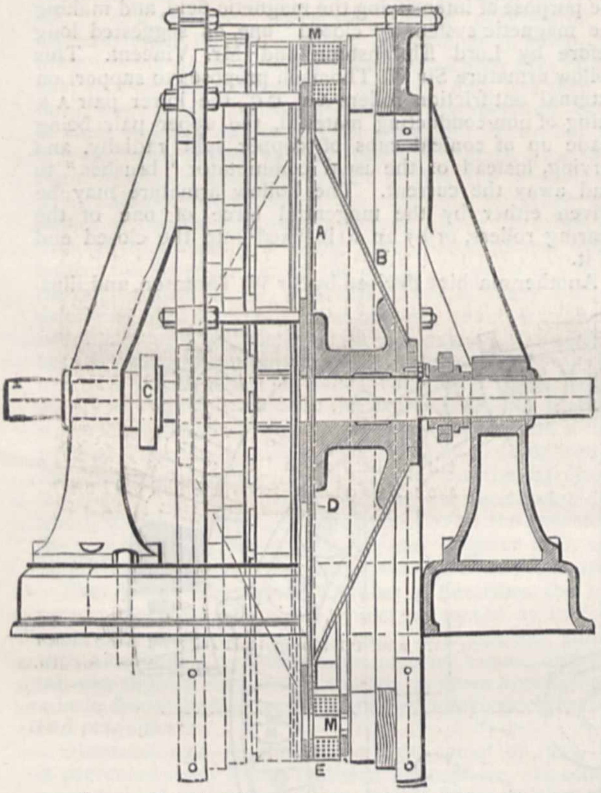


FIG. 7.—End Elevation and Section of Gordon's Dynamo.

being, that whereas in most dynamo-machines the inducing field-magnets are fixed, and the induced coils rotating, in Mr. Gordon's new machine the rotating coils are those which act inductively upon the fixed coils between which they revolve. The machine furnishes alternate currents, and therefore requires separate exciters. These exciters, two Bürgin machines, send currents which enter and leave the revolving armature by brushes pressing upon rings of phosphor bronze placed upon the axis at either side. There are 64 coils upon the rotating disc, and double that number upon the fixed framework. These 128 "taking-off" coils, the form of which is shown in Fig. 8, are alternately connected to two circuits, there being 32 groups in parallel arc, each parallel containing 4 coils in series; thus bringing the total electromotive force to 105 volts when the machine is driven at 140 revolutions per minute. At this speed it actuates 1300 Swan lamps, but is calculated to actuate from 5000 to 7000 if the driving power is proportionately increased. The machine is now in operation at the Telegraph Construction and Maintenance Company's Works, East Greenwich.

A great deal has been said in certain quarters of late about another new dynamo, the invention of Mr. Ferranti, which, with one of those unscientific exaggerations which cannot be too strongly condemned, was pronounced to have an efficiency five times as great as that of existing dynamos. The construction of this machine has not yet been made known, but it is understood that it has no iron in the rotating armature. This is, however, no novelty in dynamos. It appears, also, that Mr. Ferranti has invented an alternate-current machine almost identical with that of Sir William Thomson described above.

Lastly, M. Gravier claims to have designed a form of dynamo in which there are neither commutators nor separate exciters, but in which continuous currents of electricity are produced in stationary coils by the passage near them of a rotating series of iron bars whose mag-

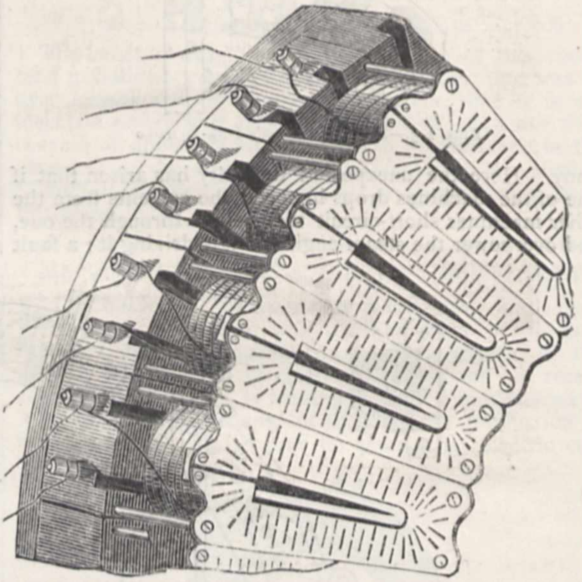


FIG. 8.—The Fixed Coils of Gordon's Dynamo.

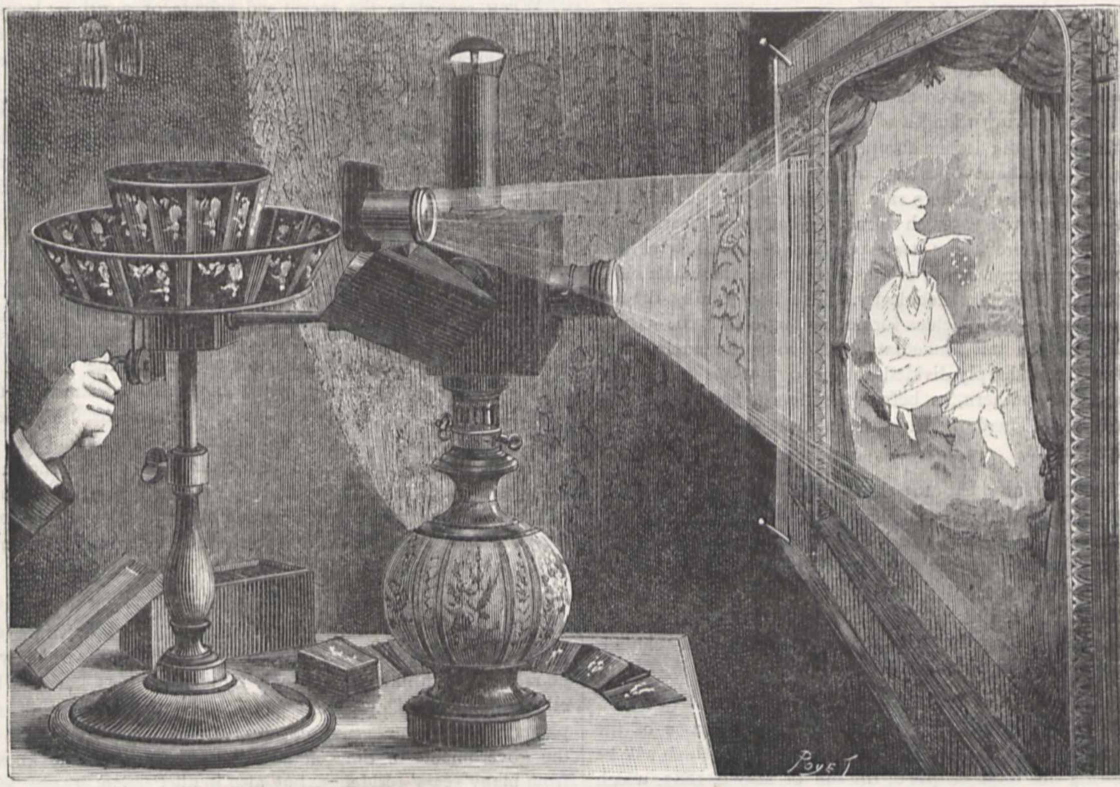
netism is changed, during their passage, by the reaction of the cores of the stationary coils themselves. M. Gravier has also designed a machine in which a Gramme-ring is wound with two sets of coils, a primary and a secondary, each set having its own commutator on opposite ends of the axis. A current from a separate exciting machine passes into the primary coils of the ring by one pair of brushes, and the secondary current is taken off by a second pair of brushes at the other commutator placed at right angles to the first pair. We are not aware that any practical machine thus constructed has yet been shown in action.

It is certain that there is yet abundant room for great improvement in the construction of dynamo-electric machines. But the inducements to improvement at the present time are so great that rapid progress toward the desired goal of perfect efficiency and simplicity of structure is more than assured.

THE PROJECTION PRAXINOSCOPE

M. GASTON TISSANDIER describes in *La Nature* an ingenious adaptation of the praxinoscope, under the above name, by means of which the images are projected on a screen, and are visible to a large assembly.

Our engraving will give an idea of the arrangement and the effect produced. By a modification of the "lampascope," M. Reynaud, the inventor, obtains by means of an ordinary lamp, at once the projection of the scene or background—by the object-glass which is seen at the side of the lantern—and of the subject, by another object-glass which is shown in front of and a little above the same lantern. For this, the positions or phases which form a subject are drawn and coloured on glass, and are connected in a continuous band by means of any suitable material. One of these flexible bands is placed in the wide crown of the praxinoscope, which is pierced with openings corresponding to the phases of the subject. To understand the course of the luminous rays which go to form the image, it is necessary to bear in mind the condensing lens which, placed near the flame of the lamp,



M. Reynaud's new projection-praxinoscope.

is not visible in the figure; then a plane mirror inclined 45°, which reflects the rays and causes them to traverse the figures filling the openings of the crown. These rays, reflected once more by the facets of the prism of mirrors, finally enter the object-glass, which transforms the vertical central image into a real image magnified on the screen. In making the two parts of the apparatus converge slightly, the animated subject is brought into the middle of the background, where it then appears to gambol. A hand-lever on the foot of the instrument allows a moderate and regular rotation to be communicated. This apparatus, with an ordinary moderator lamp, supplies well-lighted pictures and curious effects. It enables us to obtain, with the greatest ease, animated projections, without requiring any special source of light, by simply utilising the lamp in daily use.

NOTES

We take the following from the *Times*:—The council of the Royal Society have awarded the medals in their gift for the present year as follows: The Copley Medal to Prof. Cayley, F.R.S., for his researches in pure mathematics; the Rumford Medal to Capt. Abney, F.R.S., for his photographic researches and his discovery of the method of photographing the less refrangible part of the spectrum, especially the infra-red region; a royal medal to Prof. W. H. Flower, F.R.S., for his contributions to the morphology and classification of the mammalia and to anthropology; and a royal medal to Lord Rayleigh, F.R.S., for his papers in mathematical and experimental physics; the Davy Medal (in duplicate) to D. Mendelejeff and Lothar Meyer for their discovery of the periodic relations of the atomic weights. These medals will be presented at the anniversary meeting of the society on St. Andrew's Day.

The President and Council of the Geological Society hold a *conversazione* in the Society's rooms on Wednesday, the 29th inst. Fellows of the Society who have objects of interest suitable for exhibition are asked kindly to lend them for the occasion.

It is announced that General Pitt Rivers will be appointed Inspector of Ancient Monuments under the recent Act.

We announced last week the death, at the age of sixty-six years, of Prof. Johannes Theodor Reinhardt, Inspector of the Zoological Museum of the University of Copenhagen. Prof. Reinhardt was a well-known zoologist, author of an excellent memoir on the Birds of the Campos of Brazil, and of numerous papers in the scientific periodicals of Copenhagen, and will be regretted by many friends and correspondents in this country.

At the sitting of the Paris Academy of Sciences on November 13, M. Faye read letters from the captain of the *Niger*, French war steamer, on the comet, stating that it was seen at Buenos Ayres, in the streets, on November 18, in close vicinity to the sun, and that the tail was seen for the first time on board the *Niger* on September 26. The expanse of the tail was then 28°, and its transversal dimension 26°. The quantity of light was so great that when the end of the tail began to become visible the officers and sailors witnessing the phenomenon were quite unable to understand the real nature of this splendid illumination.

MR. B. J. HOPKINS, of Dalston, sends us a drawing of the head of the comet, which he saw on November 8, 16h. 50m. Viewed with the naked eye, Mr. Hopkins states, the nucleus appeared equal to a second-magnitude star; the tail was distinctly visible, having a length of about 19°; it was straight for four-fifths its length; it then abruptly curved upwards and spread itself out in the shape of a fan, with a breadth of 4°. It was still brightest on the southern side. Observing at 17h. 30m. the nucleus—as seen with a 5-inch refractor—had the appearance of being double, there being two portions of equal brightness separated by a narrow space of less brightness, the whole being surrounded by a circular nebulosity. The line joining the two bright portions of the nucleus formed an angle with the axis of the tail; and the tail immediately following the nucleus was most clearly and sharply divided into two portions of unequal brightness, the southern, as before mentioned, being by far the most brilliant. The dark rift in the tail was not so conspicuous as on the 5th inst.

M. TRESCA presented to the Academy of Sciences on Monday the third part of his great work on measures taken during the Paris Electrical Exhibition. It relates to the analysis of electric candles, and will be followed by a similar work on incandescent lights. M. Mascart sent a paper on measures taken with the registering electrometer in compliance with the wish expressed by Sir William Thomson to test the relations of the state of the weather and the electrical properties of the air.

AT the same meeting M. Janssen read in the name of the Bureau des Longitudes a report on the observations which will be made during the total eclipse of the sun of May 6, 1883, which will be observed in the Pacific Ocean. He also read a paper on his work on solar spectroscopy, and on the observation of telluric rays. Admiral Mouchez read a letter from M. Henry, who has been sent to the Pic-du-Midi to observe the forthcoming transit of Venus and determine the possibility of establishing an astronomical observatory on the top of the mountain.

THE French *Journal Officiel* has published a decree of the President establishing a council for the Observatory of Mentone.

WE are informed that the contract for the construction and erection of the Forth Bridge has been let to Sir Thomas Tancred, Bart., Mr. J. H. Falkiner, and Mr. Joseph Phillips, Civil Engineers and Contractors, of Westminster, and Messrs. Arrol and Co. of the Dalmarnock Iron Works, Glasgow. Messrs. Tancred and Falkiner have already carried out about seventy miles of railway for Mr. Fowler, and are at present constructing the new line to Southampton. Mr. Phillips has had a very wide practical experience in bridge construction and erection, and Messrs. Arrol and Co. are contractors for the new Tay Bridge, so the works are in good hands. The contract sum is 1,600,000*l.*, which is within 5000*l.* of the engineer's parliamentary estimate. The tenders received ranged from 1,485,000*l.* to 2,300,000*l.*, most of the leading firms being represented.

AT the annual general meeting of the Cambridge Philosophical Society, a resolution recording the deep regret of the Society at the lamentable event which deprived them of their late president, Prof. F. M. Balfour, was carried unanimously, and a letter expressive of their feelings was directed to be sent to Mrs. Henry Sidgwick (Prof. Balfour's sister). The officers for the ensuing year were appointed as follows:—President, Mr. J. W. L. Glaisher, F.R.S.; Vice-Presidents: Profs. Babington, Newton, and Cayley; Treasurer, Dr. Pearson; Secretaries: Mr. J. W. Clark, Mr. Trotter, and Mr. W. M. Hicks; new Members of Council: Dr. Campion, Mr. E. Hill, and Mr. J. N. Langley.

WITH regard to the recent sad suicide of a girl by leaping from one of the towers of Nôtre Dame, Dr. Bronardeli's expressed view that asphyxiation in the rapid fall may have been the cause of death, has given rise to some correspondence in *La Nature*. M. Bontemps points out that the depth of fall having been about 66 metres, the velocity acquired in the time (less than four seconds) cannot have been so great as that sometimes attained on railways, *e.g.* 33 metres per second on the line between Chalons and Paris, where the effect should be the same; yet we never hear of asphyxiation of engine drivers and stokers. He considers it desirable that the idea in question should be exploded, as unhappy persons may be led to choose suicide by fall from a height, under the notion that they will die before reaching the ground. Again, M. Gossin mentions that a few years ago a man threw himself from the top of the Column of July, and fell on an awning which sheltered workmen at the pedestal; he suffered only a few slight contusions. M. Remy says he has often seen an Englishman leap from a height of 31 metres (say 103 feet) into a deep river; and he was shown in 1852, in the island of Oahu, by missionaries, a native who had fallen from a verified height of more than 300 metres (say 1000 feet). His fall was broken near the end by a growth of ferns and other plants, and he had only a few wounds. Asked as to his sensations in falling, he said he only felt dazzled.

DR. SLUNIN has published in Russian a work—"Materials for the Knowledge of Popular Medicine in Russia"—which will be received with interest, not only by medical men but also by ethnographers. Dr. Slunin gives a detailed account of all plants and drugs used not only in Russian popular medicine in the governments of Saratoff and Astrakhan, which he knows from many years' residence, but also in all Persian, Tartar, and Central Asian medicines (with their Arabian names) that have come to his knowledge. His remarks on popular pharmacies and on the popular medical literature which goes as far back as the epoch of the flourishing times of Arabian civilisation are of great interest.

THE Catalogue of the Reference Department of the Derby Free Library is of a handy size and excellent type. We are told it contains 60,000 references to works upon the library shelves; and, upon dipping into it, the minuteness of connection which will lead to a reference to publications of scarcely higher standing than a newspaper, is imposing. We grieve to add, however, that this holds good in both senses of the word. For looking more closely we find most important references are absent. As a sample, eight references are given to the name of Garrick, but neither is his life by Murphy or Davies quoted, nor is any reference made to Boswell's "Johnson," or Goldsmith's Poems; and the extraordinary explanation of this is found in the fact that neither of these works is in the library! And this absence of important works seems to be the rule rather than the exception, carried out also with the most even-handed fairness to all subjects. Looking through the letter B as a sample, we find no works of Babbage, Back, Barbauld, Barry (Sir C.), Baxter, Beale, Baden Powell, Brewster, Barrow (Isaac or Sir Jno.), Bayne, Beckmann, Blackie, Blackstone, Borrow, Boswell, Bowring, Bridgewater Treatises, Browning (Mrs.), Buckmaster, Buxton, Butler (Bp.), or Butler (S.). Among Dictionaries neither the Penny nor the English Cyclopædia is to be found.

Nor is it that a selection of certain writers has been made, for numerous authors of many well-known works are only credited with one or two in the Derby Library Catalogue. The letter B is not a specially unfortunate one. Ancient Geography refers only to *Nature* and the *Quarterly Review* (one reference each). Gladstone and Hugh Miller are equally unknown. Less than a column contains all the references to Geography, while Geology has nine columns allotted to it. Under Astronomy the inquirer is referred to numerous papers where notices may be found of each of the planets and of many of the planetoids, but only fifteen *works* on Astronomy are catalogued. There is no work at all upon the Moon! Moreover, the references to works which are in this library are made with no discretion. "Barbarossa" does not refer the reader to Gibbon; "Borgia" only refers him to one article—on Lucrezia—in the *Nineteenth Century*! The spelling is not only unscholarly, but the correcting of proofs is careless. It were endless to point out the blunders everywhere; we need only refer to the name of Prof. Haeckel, spelt in four different ways upon pp. 41, 42 only! If some little town struggling against the smallness of the 1*d.* rate wishes to draw as much as possible from its Free Library with its motley collection of books contributed from various quarters, we can strongly recommend the *system* upon which this catalogue is drawn up. But that a place of the size and importance of Derby, whose rate also has been so helped by the munificence of Mr. Bass and others, should think it worth while to print and distribute a catalogue, displaying a knowledge and a collection of books in this rudimentary state, is beyond our comprehension.

THE population of Cascia (Italy) is being constantly disturbed by repeated subterranean shocks.

A VOLCANIC eruption is reported to have taken place from a mountain in the Caucasus, which has not shown any volcanic phenomena during historic times. It is the Karabetow mountain, near Temrink, in the government of Jekaterinodar (Caucasia). The subterranean noise was heard 4 versts away, the lava flowed for a distance of half a verst, and a large crater was formed.

NEWS from Belgrade states that some railway workmen have discovered a nearly perfect mammoth skeleton. It is being photographed on the spot, and will be handed over to the National Museum at Belgrade.

A NATURAL intermittent spring has recently formed in the Jachère (Hameau de l'Argentière, Hautes Alpes). At regular intervals of five and seven minutes it yields 10 litres of water each time. It is very remarkable that the first time it consists of lukewarm and colourless water, but the second of cold but wine-red water. MM. Chester and Hadley are now studying the phenomenon.

M. J. OLLER, the proprietor of the St. Germain racing establishment, is preparing to organise night races. He intends to build a central lighthouse, of which the rays will be directed on the contending horses, so that spectators sitting in the centre may follow the proceedings with as much accuracy as in open day.

AT the annual meeting for the distribution of prizes in Mason College, Birmingham, Prof. Tilden gave a sensible and interesting address on Technical Education, which has been published in a separate form.

THE Captain-General of the Philippines reports another destructive hurricane on November 5, and it is worthy of remark that since the previous hurricane, a few weeks ago, the cholera, which had been very bad, has nearly disappeared from Manila.

MESSRS. SONNENSCHEIN AND CO. announce the forthcoming publication of Dr. Coppinger's Notes of the four years' voyage from which the *Alert* has recently returned.

MR. MURRAY has issued a cheap edition of Dr. Blaikie's "Life of David Livingstone."

THE additions to the Zoological Society's Gardens during the past week include two Macaque Monkeys (*Macacus cynomolgus* ♂ ♂) from India, presented respectively by Mr. J. Knight and Mrs. Snell; a Sooty Mangabey (*Cercocebus fuliginosus* ♂) from West Africa, presented by Lady Stafford; two Globose Curassows (*Crax globicera* ♂ ♀) from British Honduras, presented by Mr. R. W. Ryass; a —— Buzzard (——) from Demerara, presented by Mr. G. H. Hawtayne, C.M.Z.S.; three Common Chameleons (*Chameleon vulgaris*) from Egypt, presented by Mr. W. J. Ford; a Hawk's-billed Turtle (*Chelone imbricata*) from West Indies, presented by Mr. W. Cross; a Pig-tailed Monkey (*Macacus nemestrinus* ♂) from Java, a Black Wallaby (*Halmaturus ualabatus* ♀) from New South Wales, a Greek Land Tortoise (*Testudo græca*), South European, deposited; an American Bison (*Bison americanus* ♀) from North America, a Capybara (*Hydrochœrus capybara* ♀) from South America, two Eastern Goldfinches (*Carduelis orientalis*) from Afghanistan, two Brent Geese (*Bernicla brenta*), a Red-throated Diver (*Colymbus septentrionalis*), British, purchased; three Capybaras (*Hydrochœrus capybara* ♂ ♂ ♀), a Bluish Finch (*Spermophile cærulescens*) from South America, received in exchange.

GEOGRAPHICAL NOTES

AT the opening meeting of the Geographical Society on Monday Mr. A. R. Colquhoun gave an account of his recent adventurous journey, in company with the late Mr. Wahab, from Canton through Yunnan to Bhamo. Mr. Colquhoun's object was mainly to discover trade-routes between Burmah and China, but he collected some interesting information on Further Yünnan, parts of which have not before been visited by European travellers. Mr. Colquhoun describes Yünnan, which is the most westerly of the eighteen provinces of China, as a great uneven plateau, of which the main ranges trend north and south; those in the north reaching an elevation of from twelve to seventeen thousand feet, while in the south they sink to seven or eight thousand feet. In the south, and especially in the south-west, there are many wide fertile plains and valleys, some with large lakes in them. These plains are very rich and thickly populated, the number of towns and villages and the comfortable appearance of the peasantry being very remarkable. Fruits of all kinds—pears, peaches, chestnuts, and even grapes—are found in abundance, while roses, rhododendrons, and camelias of several varieties grow untended on the hill-sides. Minerals are found in great quantities. The travellers constantly passed caravans laden with silver, lead, copper, and tin in ingots; and gold is beaten out into leaf in Tali, and sent in large quantities to Burma. Coal, iron, silver, tin, and copper mines were frequently passed. Mr. Colquhoun also found that the celebrated Puerh tea, the most fancied in China, is not really a Chinese tea at all, but is grown in the Shan district of I-bang, some five days south of Puerh, the nearest prefectural town. In the south the temperature is moderate, and the rains by no means excessive; but the farther north the travellers went, the more sparse became the population, and the more sterile the country, until in the extreme north the hills were enveloped in almost perpetual fogs, rains, and mists, and were practically uninhabitable. The people themselves are mostly the old aboriginal tribes—Lolo, Pai, and Maio—the Chinese being mostly of the official class, and found only in the towns. These aborigines have a much more distinct physiognomy than the bullet-headed Celestial, and are remarkable for their frank and genial hospitality. The women do not crush their feet, and they adopt a picturesque dress not unlike that worn of old by Tyrolese and Swiss maidens. They have a novel way of making marriage engagements. On New Year's Day the unmarried people range themselves, according to sex, on either side of a narrow gully. The ladies in turn toss a coloured ball to the other side, and whoever catches it is the happy man. It is said they are so skilful in throwing the ball that the favoured man is always sure to catch it; which is reassuring. As in Marco Polo's days, the *couvade* still prevails in some parts. When a child is born, the husband goes to bed for thirty days, and the wife looks after the work. At the conclusion of the paper, Lord Northbrook and Col. Yule paid a well deserved tribute to the late Capt. Gill, Prof. Palmer, and Lieut. Charrington. Capt. Gill, our readers may remember, had himself done some first-rate work on the South-East Chinese frontier, and described it in his "River of Golden Sand;" while Prof. Palmer's loss as an Arabic scholar is almost irretrievable.

SAMOYEDES report to Archangel that they have recently seen, south of Waigatz Island, the wreck of a large vessel crushed in the ice. If the statement be true, and if we remember their never-credited story of the unfortunate *Jeannette*, it is more than probable that the vessel is either the Danish exploring vessel the *Dijmphna*, with Lieut. Hovgaard's expedition, or the Norwegian steamer *Warna* with the Dutch meteorological expedition, bound for Port Dickson, both of which in September last froze in in the Kara Sea, from which place the ice may subsequently have carried the unfortunate vessel to where she now is stated to be. The last intelligence received from Lieut. Hovgaard was dated September 22, and addressed to Herr Aug. Gamil, of Copenhagen, the principal promoter of the expedition, from which it appears that all was then well with both vessels, but that the *Dijmphna* was, when caught in the ice, some considerable distance from shore, in fact in a spot where the whole force of the polar ice, when in drift, would strike her. Herr Aug. Gamil having telegraphed to the Russian Admiralty for any confirmation of the above report, has received a reply that no official information on the subject has been received at St. Petersburg; but that nevertheless instructions would be at once given to the officials on the north coast to scour the same, and gather further particulars. A search party is also being contemplated in Copenhagen, which will, if decided on, be led by M. Larsen, a Dane, who accompanied the American expedition in search of the crew of the *Jeannette*, as the special artist of the *Illustrated London News*.

THE German Government has raised the fund for the scientific exploration of Central Africa and other countries, which in 1882-83 was fixed at 75,000 marks (3750*l.*) to 100,000 marks (5000*l.*) for the financial year 1883-84.

THE AIMS AND METHOD OF GEOLOGICAL INQUIRY[1]

II.

IT will be observed that the results obtained by geologists could not have been arrived at had they confined themselves solely to the detection of resemblances and correspondences between the phenomena of the present and the past. The natural forces have always been the same in kind, if not in degree, and we can often watch the gradual development by their means of products which more or less closely resemble the rocks of our sections. But experimental evidence of this kind takes us only a short way, and we are sooner or later confronted by appearances, which are not reproduced by nature before our eyes. As another example of this I shall adduce one which, although it has far-reaching issues, has yet the merit of being readily comprehended without much preliminary geological knowledge. It is moreover instructive as showing how the imaginative faculty works in a mind trained to clear and steady observation of nature. The fact that a large proportion of the lakes of the world rest in rocky hollows or basins had been long known before it occurred to any one to ask how such rocky hollows had come into existence. The question was first asked and the answer given by Prof. (now Sir) A. C. Ramsay. He had pondered over the problem for years before its solution dawned upon him. None of the ordinary agents of geological change seemed capable of producing the phenomena. The most common of all denuding agents—water—certainly could not do so, for although it may dig long and deep trenches through rocks, water could not scoop out a basin like that occupied by Loch Lomond, or any of our Highland lakes. The tendency of water is, on the contrary, to silt up and to drain such hollows, by deepening the points of exit at their lower ends. Did the hollows in question occupy areas of depression—had they, in short, been formed by unequal subsidences of the ground? Some considerable inland seas, as for example the Dead Sea, and doubtless many larger and smaller sheets of water, owe their origin to local movements of this kind. But it is incredible that all the numerous lakes and lakelets of Northern Alpine regions could have originated in this way. In many cases these lakes are so abundant that it is hard to say of some countries, such as Finland, and large parts of Sweden, and even of our own islands, whether it is land or water that predominates. If all these numerous and closely aggregated rock-basins represent so many local subsidences, then the hard rocks in which most of them appear must have been at the time of their formation in a condition hardly less yielding than dough or putty. It was suggested that the lakes of the Alps and other hilly regions might have been caused, not by local sinkings confined to the valleys themselves, but by a general depression of the central high-grounds and water-sheds. The subsidence of the central mountains would of course entail depression in the upper reaches of the mountain-valleys, and in this way the inclination of those valleys would be reversed—each being converted into an elongated rock-basin. But a little consideration showed that before the lakes of such a region as the Alps could have been produced in this manner, those mountains must have been some 15,000 feet higher than at present. Or to put it the other way, in order to obliterate the Alpine lakes and restore the slopes of the valleys to what, if this hypothesis were true, must have been their original inclination, the Alps would need to be pushed up until they attained twice their present elevation. Now, we are hardly prepared to admit that the Swiss mountains were 30,000 feet high before the glacial period. If our Alpine and Northern lake-basins cannot be attributed to movements of depression, still less can they be accounted for by any system of fractures;—they lie neither in gaping cracks nor on the down-throw sides of dislocations. In a word, a study of the structure, inclination, and distribution of the rock-masses in which our lake-basins appear throws no light upon the origin of those hollows. We probably find in many cases that the position and form of a basin have been influenced in some way by the character of the rocks in which it lies—but we detect no evidence in the rock-masses themselves to account for its production. It is not necessary, however, that I should on this occasion mention each and every cause which has been suggested for the origin of rock-bound hollows. Some of these suggestions are unquestionably well founded. For example, there can be no doubt that certain lakes have been produced by the sudden damming-up of a valley in consequence of a fall of rock from adjoining slopes or cliffs; others, again, occupy holes caused by the falling in of the roofs of caves and subterranean tunnels; while yet others have been formed by a current of lava flowing across a valley and thus ponding back its stream, just as many a temporary sheet of water has been brought into existence in a similar way by the abnormal advance of a glacier. In these and other ways lakes have doubtless originated again and again, but the causes just referred to are all more or less exceptional, and manifestly incapable of producing the phenomena so conspicuous in the lake-regions of Britain, Scandinavia, and the Alps.

Ramsay, to whom the varied phenomena of glacier-regions had been long familiar, was struck by the remarkable fact that freshwater lakes predominate in Northern and Alpine countries, while they are comparatively rare in regions further south and outside of mountainous districts. The great development of lakes in Finland finds no counterpart in the low grounds of southern latitudes. It is in regions where glacial action formerly prevailed that rock-basins are most numerous, and this suggested to Ramsay that in some way or other the lakes of the Alps and the North were connected with glaciation. The final solution of the problem flashed upon him while he was studying the glacial features of Switzerland. His scientific imagination enabled him to reproduce in his own mind the aspect presented by the Alps during the glacial period, when the great mountain-valleys were choked with glacier-ice, which flowed out upon the low grounds of Germany, France, and Northern Italy, so as to cover all the sites of the present lakes. He saw that under such conditions enormous erosion must have been effected by the ice, by means of the rocky rubbish which it dragged on underneath, and that this erosion, other things being equal, would be most intense where the ice was thickest and the ground over which it advanced had the gentlest inclination. Such conditions, he inferred, would be met with somewhere in the lower course of a valley between the steeper descent of its upper reaches and the

[1] The Inaugural Lecture at the opening of the Class of Geology and Mineralogy in the University of Edinburgh, October 27, 1882, by James Geikie, LL.D., F.R.S. L. and E., Regius Professor of Geology and Mineralogy in the University. Continued from p. 46.

termination of the glacier. This inference was suggested by the consideration that pressure and erosion would be least when the glacier was flowing upon a steep slope, while at the base of such a slope where the valley flattened out, the ice would tend to heap up, as it were, and produce the maximum amount of pressure and erosion. Thereafter, as the ice continued to flow down its valley, it would become thinner and thinner until it reached its termination—and pressure and erosion would diminish with the gradual attenuation of the glacier. Such conditions, after some time, would necessarily result in the formation of elongated rock-basins, sloping in gradually from either end, and attaining their greatest depth at some point above a line drawn midway between the upper and lower ends of a hollow. There are many other details connected with this most ingenious theory which I cannot touch upon at present. It will be sufficient to say that the observed facts receive from it a simple and satisfactory explanation. Like all other well-based theories, it has been fruitful in accounting for many other phenomena, a study of which has developed it in various directions, and enabled us to understand certain appearances which the theory as at first propounded seemed hardly adequate to explain. As a proof of the soundness of Ramsay's conclusion that ice is capable of excavating large rock-basins, I may mention that his theory has led to the prediction of facts which were not previously known to geologists. He had pointed to the occurrence, in many of the sea-lochs of Western Scotland, of deep rock-bound hollows, which he concluded must have been formed by great valley-glaciers in the same way as the hollows occupied by fresh-water lakes in this and other similarly glaciated countries. Some years later, having discovered that the Outer Hebrides had been glaciated across from side to side by a *mer de glace* flowing outwards from the mainland, and having been satisfied as to the truth of the glacial-erosion theory, I was led by it to suppose that deep rock-basins ought to occur upon the floor of the sea along the inner margin of most of our Western Islands. This expectation was suggested by the simple consideration that those islands, presenting, as they for the most part do, a steep and abrupt face to the mainland, must have formed powerful obstructions to the out-flow of the *mer de glace* in the direction of the Atlantic. This being so, great erosion, I inferred, must have ensued in front of those islands. The lower part of the *mer de glace* which overflowed them would be forced down upon the bed of the sea by the ice continually advancing from behind, and compelled to flow as an under-current along the inner margin of the islands, until it circumvented the obstruction, and resumed the same direction as the upper portion of the *mer de glace*. A subsequent careful examination of the Admiralty's Charts of our western seas, which afford a graphic delineation of the configuration of the sea-bottom, proved that the deduction from Ramsay's theory was perfectly correct. Were that sea-bed to be elevated for a few hundred feet, so as to run off the water, and unite the islands to themselves and the mainland, we should find the surface of the new-born land plentifully diversified with lakes—all occupying the positions which a study of the glaciation of the mainland and islands would have led us to expect. Among the most considerable would be a chain of deep lakes extending along the inner margin of the Outer Hebrides, while many similar sheets of water would appear in front of those islands of the Inner Group that face the deep fiords of our western shores.

The few examples now given of geological methods of inquiry may suffice to show that the process of reading and interpreting the past in the light of the present necessitates not only accurate observation, but an extensive acquaintance with the mode in which the operations of Nature are carried on. They also serve to show that just as our knowledge of the past increases, so our insight into the present becomes more and more extended. For if it be true that the present is the key to the past. it is not less certain that without that unfolding of the past which a study of the rocks has enabled us to accomplish, we should not only miss the meaning of much that we see going on around us, but we should also remain in nearly complete ignorance of all that is taking place within the crust of our globe. Thus, although our science may be correctly defined as an inquiry into the development of the earth's crust and of the faunas and floras which have successively clothed and peopled its surface—yet that definition is somewhat incomplete. For, as we have seen, this inquiry into the past helps us to understand existing conditions better than we should otherwise do. In this respect it is with geology as with human history. The philosophical historian seeks in the past to discover the germ of the present. He tells us that we cannot hope to understand the complicated structure and relations of a society like ours without a full appreciation of all that has gone before. And so it is in the case of geological history. The present has grown out of the past, and bears myriad marks of its origin, which would either be unobserved or remain totally meaningless to us, were the past a sealed book. No student of physical geography, or of zoology and botany, therefore can afford to neglect the study of geology, if his desire be to acquire a philosophical comprehension of the bearings of those sciences. For it is geology which reveals to us the birth and evolution of our lands and seas—which enables us to follow the succession of life upon the globe, and to supply many of the missing links in that chain, which, as we believe, unites the beginning of life in the far distant past with its latest and highest expression in man. By its aid we track out the many wanderings of living genera and species which have resulted in the present distribution of plants and animals. But for geology, indeed, that distribution would be for the most part inexplicable. How, for example, could we account for the often widely separated colonies of arctic-alpine plants which occur upon the mountains of Middle and Southern Europe? How could these plants possibly have been transferred from their head-quarters in the far north to the hills of Britain, and Middle Germany, to the Alps and the Pyrenees? Not the most prolonged and laborious study of the botanist could ever have solved the problem. But we learn from the geologist that the apparent anomalous distribution of the flora in question is quite what his study of the rocks would have led him to expect. He now, indeed, appeals to the occurrence of those curious colonies of arctic-alpine plants as an additional proof in support of his view that during a comparatively recent period our continent experienced a climate of more than arctic severity. He tells us that at that time the reindeer, the glutton, the arctic fox, the musk ox, and other arctic animals migrated south into France, while a Scandinavian flora clothed the low grounds of Middle Europe. By and by, when the arctic rigour of the climate began to give way, the northern species of plants and animals slowly returned to the high latitudes from which they had been driven. Many plants, however, would meet with similar conditions by ascending the various mountains that lay in the path of retreat, and there they would continue to flourish long after every trace of an arctic-alpine flora had vanished from the low ground. This explanation fully meets the requirements of the case. It leaves none of the facts unaccounted for, but is in perfect harmony with all. But as if to make assurance doubly sure, Dr. Nathorst, a well-known Swedish geologist, recently made a search in the low grounds of Europe for the remains of the arctic-alpine flora, and succeeded in discovering these in many places. He detected leaves of the arctic willow and several other characteristic northern species in the glacial and post-glacial deposits of Southern Sweden, Denmark, England, Germany, and Switzerland, and thus supplied the one link which might have been sidered necessary to complete a chain of evidence already almost perfect.

From this and many similar instance that might be given we learn that the reconstruction of the past out of its own ruins is not mere guess-work and hypothesis. The geologist cannot only demonstrate that certain events have taken place, but he can assure us of the order in which they succeeded one after the other, during ages incalculably more remote than any with which historians have to deal. The written records out of which are constructed the early history of a people cannot always be depended upon—allowance must be made for the influences that may have swayed the chroniclers, and these are either unknown or can only be guessed at. It follows therefore that events are seldom presented to us in a consecutive history exactly as they occurred. They are always more or less coloured, and that colouring often depends fully as much upon the idiosyncrasies of the modern compiler as upon those of the contemporaneous recorder. The geologist has at least this advantage over the investigator of human history, that his records, however fragmentary they may be, tell nothing more and nothing less than the truth. Any errors that arise must be due either to insufficient observation or bad reasoning, or to both, while the progress of research and the penetrating criticism which every novel view undergoes must sooner or later discover where the truth lies. In this way the history of our globe is being gradually reconstructed—to an extent, indeed, that the earlier cultivators of the science could not have believed possible. But although many blanks in the records have been filled up, and our knowledge will doubtless be yet greatly increased, it must nevertheless be admitted that this knowledge must always bear but a very small proportion to our ignorance. In this, however, there is nothing to discourage us, as we may be quite sure that the work remaining to be done will far exceed all the energies of many generations to accomplish.

It is sometimes objected to Geology that its results are not always so exact as those which are obtained by an experimental science like chemistry. We are reproached with the fact that our theoretical conceptions undergo frequent modification, and are even often abandoned, to be succeeded by others which, after flourishing for a time, are in like manner overturned and thrown aside. But the same reproach, if it be one, might be brought against other sciences. Each advancing science has its problems and speculations. And we cannot often feel assured that the solution now given of those problems will in all cases stand the test of time. Our theoretical conceptions of the ultimate constitution of matter, for example, have within comparatively few years undergone considerable change, and yet no one values chemistry the less. Let our theories be what they may, they do not and cannot overturn the results obtained by verified observation and often repeated and varied experiment. It remains for ever true that water is composed of oxygen and hydrogen, let our views of the atomic theory change as they may. And so it is not less certain that strata of conglomerate and sandstone containing marine or fresh-water fossils are of aqueous origin, however much our theoretical conceptions may vary as to the uniformity in degree between the past and present operations of Nature. It is true we did not see the conglomerate and sandstone in process of formation, but we know by observation that these rocks exactly resemble deposits of gravel and sand which are now being accumulated in water. Nature in this case makes the experiment for us, whereas the chemist has to do this for himself. The latter, having well ascertained by varied experiments the composition of certain samples of water, henceforth concludes that all water is made up of the same two gases in definite proportions. But this conclusion of his is just as much an assumption as the inference of the geologist that strata containing marine or freshwater fossils are aqueous accumulations. It is when we come to the larger generalisations of our science that we are more likely to go astray. The problems we have to solve demand not only an accurate knowledge of widely scattered phenomena, but a ready command of logical analysis. The facts may be sufficiently abundant, but if we reason badly we of course miss their meaning. Or, on the other hand, the evidence may be more or less imperfect. There are blanks which we fill up with conjecture—which can do no harm so long as we do not treat our conjectures as if they were facts. But when the gaps in the evidence are numerous, each theoriser will fill them up after his own fashion, and very various results will thus be obtained. Even in cases of this kind, however, a rigorous application of logical analysis will enable us to detect the fallacies which may underlie all the competing theories; and we are thus prepared to frame a new explanation for ourselves, and to set about searching for additional facts to prove or disprove our notions. In all such investigations it is obviously the duty of a careful observer and theoriser to see well to his premises—to be absolutely sure as to his facts, and to distinguish clearly between what is substantial knowledge, and what is mere conjecture. He will thus be in a position to judge whether his conclusions are based on a solid foundation or not. In a science of observation like geology, theory is necessarily often in advance of the facts. Some, indeed, have insisted that all conjectural explanations are quite a mistake; that it would be better to avoid theorising altogether, and to wait patiently until the chain of evidence had completed itself. I am afraid that, were it possible to follow this advice, we might often have to wait a very long time. After all, a heap of bricks is only a potential house: it will not grow up into walls without the aid of architect and builder. Discoveries in science have no doubt been made occasionally by isolated and haphazard observations; but that is exceptional, and we should not be where we are now had the examination of Nature been always conducted after such a fashion. If additional evidence be required, we must first have some notion where to look for it. In other words, it is essential to progress that we should have preconceived opinions or theories, which enable us to arrange the facts we already possess, and to point out the directions in which further evidence may be looked for. We cannot be too careful, however, that our preconceived notions do not lead us to colour the evidence or to blind us to facts that tell against our views. Every theory should be considered provisional until its truth has been fully demonstrated by an overwhelming array of testimony in its favour. Until this consummation is arrived at we must be constantly testing its truth, and be ready to abandon it at once whenever the evidence shows it to be erroneous. The failure of one theory after another need not disconcert or discourage us; for each failure, by reducing the number of possible explanations, must necessarily bring us nearer to our goal—the truth. I cannot but deem it a strong point in favour of geology as a branch of education that it not only cultivates the faculty of clear and continuous observation, but abounds in unsolved problems which are ever suggesting new ideas and thus stimulating that imagination which is one of the noblest gifts of our race. It is no reproach that the progress of our science is marked by the modification and abandonment of numerous hypotheses and theories. On the contrary, these afford a measure of the rate at which geology advandes—just as this last yields the strongest testimony to the good results that accrue from having some provisional view by which to direct the course of our observations.

It is unavoidable that in the onward march of a science the facts become at last so numerous as to task all the energies of its votaries to keep abreast of their time. When a beginner first surveys the wide field embraced by geological inquiry, he may not unnaturally experience a feeling akin to despair. How is it possible, he may think, that I can master all these manifold details—how can I test the truth of all those numerous inferences and conclusions—and yet have sufficient leisure and energy left to undertake original observation? Well, no one can hope to advance the science in all its departments. When we reflect that in order to obtain a complete comprehension and mastery of the existing condition of things we should require to be adepts in physics, mechanics, chemistry, and every branch of natural science, it is obvious that such a perfect knowledge is beyond attainment. It is needless, therefore, that we should strive to become "admirable Crichtons" in this nineteenth century, and no beginner need be discouraged by the greatness of the science which he desires to cultivate. It is only by division of labour that so much has been accomplished; and the results are now so systematised that it is quite possible for any intelligent inquirer to gain a thorough comprehension of the principles of the science. But this it is absolutely necessary to acquire, and the student, therefore, should at first devote all his energies to learn as much as he can of those principles and their application. When he has progressed so far, he is then ready to set out as an explorer in the well-assured hope that if he be true to the logical methods which have hitherto succeeded so well, he will not fail to reap his reward in the discovery of new truths. But to secure success we must be content to be specialists. In other words, we must concentrate our energies upon some particular lines of inquiry, and do our utmost to work these out in all their details. At the same time we should make a great mistake if we did not always keep in mind the broader bearings of our science, and endeavour to maintain as wide a knowledge as we can of all its branches. Each of these, we may be sure, has something to tell which will aid us in our own special inquiries. We cannot, therefore, afford to neglect the side-lights which are thrown upon our path from the lamps of others who are working in adjacent fields. One cannot help thinking that many specialists would have given us more and better work if they had not allowed themselves to be cramped and narrowed by continuing too long in one rut or groove. They dig so deep that they get into a hole out of which it is sometimes difficult to climb, and thus not infrequently the work being done by fellow-labourers, escapes them, and they miss the suggestions which a knowledge of that work might otherwise have yielded them.

I have said nothing as to the practical applications of our science—that branch of our subject which is termed economic geology—not because I consider it the less important, but because its value is generally recognised and need not now be insisted upon. Many, I do not doubt, enter upon their geological studies with a distinct view of obtaining from the science such help as it can afford them in the practical pursuits of life. To such inquirers it will be my pleasure not less than my duty to give every assistance that is in my power. But I would point out to them that there is no short cut to the attainment of the knowledge they are in quest of. The study of economic geology cannot be separated from that of the recognised principles and methods of inquiry which must be followed by the scientific investigator. On the contrary, the more thoroughly we devote ourselves to the prosecution of geology for its own sake the better able shall we be to appreciate its economic bearings.

In beginning the duties of this Chair, if I enjoy certain advantages over my predecessor, I also at the same time labour under considerable disadvantages. The Class Museum formed by him, and the other appliances and aids to teaching which he laboriously gathered together have been generously handed over to the Chair—and this, I need not say, has greatly smoothed my path. But, on the other hand, he has left behind him a reputation which must bear hard upon me. He has not only sustained but increased the fame of what has been termed the Scottish School of Geology, and I feel that it will task all my energies to emulate the high standard he maintained as a teacher. It is not without diffidence, therefore, that I commence this course; but my hope is that the love of science, which has hitherto carried me over many years of a laborious occupation, may at least succeed in warming and sustaining the enthusiasm of those who come here to study with me what geology has to reveal concerning the past and present.

A METHOD FOR OBSERVING ARTIFICIAL TRANSITS[1]

As many astronomers who intend to observe the coming transit of Venus have neither the time nor means for making the necessary arrangements to practice on artificial transits, the simple method here proposed may be advantageously employed. Instead of observing an artificial sun and planet placed at a distance of several thousand feet from the observer, I would suggest that the real sun be observed, and the planet Venus to be represented by a circular disk, held, in the common focus of the objective and eye-piece, by means of a narrow metallic arm fastened to the eye-piece.

The relative motion of the sun and Venus can then be produced by so adjusting the rate of the driving-clock that the angular motion of the telescope on the hour-axis shall exceed the diurnal motion of the sun by seventeen seconds of time per hour. In this way, as the atmospheric disturbances of the sun's limb are real, a near approach to the phenomena observed during an actual transit will result. If a light-shade glass is employed, the opaque disk will be seen before it comes into apparent contact with the sun. The observer can, however, by an exercise of the will, confine his whole attention to the sun's limb.

By using a heavier shade-glass the disk will not be seen until it is projected against the image of the sun. The angular diameter of Venus at the time of transit being about 65″, the diameter of the opaque disk should be $65 \cdot l \cdot \sin 1'' = 0 \cdot 00031 \cdot l$, l being the focal length of the telescope used. The position angle of the point of contact can be changed at will by simply moving the telescope in declination.

ELECTRIC LIGHTING, THE TRANSMISSION OF FORCE BY ELECTRICITY[2]

Having received the honour of being elected Chairman of the Council of the Society of Arts for the ensuing year, the duty devolves upon me of opening the coming Session with some introductory remarks. Only a few months have elapsed since I was called upon to deliver a presidential address to the British Association at Southampton, and it may be reasonably supposed that I then exhausted my stock of accumulated thought and observation regarding the present development of science, both abstract and applied; that, in fact, I come before you, to use a popular phrase, pretty well pumped dry. And yet so large is the field of modern science and industry, that, notwithstanding the good opportunity given me at Southampton, I could there do only scanty justice to comparatively few of the branches of modern progress, and had to curtail, or entirely omit, reference to others, upon which I should otherwise have wished to dwell. There is this essential difference between the British Association and the Society of Arts, that the former can only take an annual survey of the progress of science, and must then confide to individuals, or to committees, specific inquiries, to be reported upon to the different sections at subsequent meetings; whereas the Society of Arts, with its 3,450 permanent members, its ninety-five associated societies, spread throughout the length and breadth of the country, its permanent building, its well-conducted *Journal*, its almost daily meetings and lectures, extending over six months of the year, possesses exceptionally favourable opportunities of following up questions of industrial progress to the point of their practical accomplishment. In glancing back upon its history during the 128 years of its existence, we discover that the Society of Arts was the first institution to introduce science into the industrial arts; it was through the Society of Arts and its illustrious Past President, the late Prince Consort, that the first Universal Exhibition was proposed, and brought to a successful issue in 1851; and it is due to the same Society, supported on all important occasions by its actual President, the Prince of Wales, that so many important changes in our educational and industrial institutions have been inaugurated, too numerous to be referred to specifically on the present occasion.

Amongst the practical questions that now chiefly occupy public attention are those of Electric Lighting, and of the transmission of force by electricity. These together form a subject which has occupied my attention and that of my brothers for a great number of years, and upon which I may consequently be expected to dwell on the present occasion, considering that at Southampton I could deal only with some purely scientific considerations involved in this important subject. I need hardly remind you that electric lighting, viewed as a physical experiment, has been known to us since the early part of the present century, and that many attempts have, from time to time, been made to promote its application. Two principal difficulties have stood in the way of its practical introduction, viz., the great cost of producing an electric current so long as chemical means had to be resorted to, and the mechanical difficulty of constructing electric lamps capable of sustaining, with steadiness, prolonged effects. The dynamo-machine, which enables us to convert mechanical into electrical force, purely and simply, has very effectually disposed of the former difficulty, inasmuch as a properly conceived and well constructed machine of this character converts more than ninety per cent. of the mechanical force imparted to it into electricity, ninety per cent. again of which may be re-converted into mechanical force at a moderate distance. The margin of loss, therefore, does not exceed twenty per cent., excluding purely mechanical losses, and this is quite capable of being further reduced to some extent by improved modes of construction; but it results from these figures that no great step in advance can be looked for in this direction. The dynamo-machine presents the great advantage of simplicity over steam or other power-transmitting engines; it has but one working part, namely, a shaft which, revolving in a pair of bearings, carries a coil or coils of wire admitting of perfect balancing. Frictional resistance is thus reduced to an absolute minimum, and no allowance has to be made for loss by condensation, or badly fitting pistons, stuffing boxes, or valves, or for the jerking action due to oscillating weights. The materials composing the machine, namely, soft iron and copper wire, undergo no deterioration or change by continuous working, and the depreciation of value is therefore a minimum, except where currents of exceptionally high potential are used, which appear to render the copper wire brittle.

The essential points to be attended to in the conception of the dynamo-machine, are the prevention of induced currrents in the iron, and the placing of the wire in such position as to make the whole of it effective for the production of outward current. These principles, which have been clearly established by the labours of comparative few workers in applied science, admit of being carried out in an almost infinite variety of constructive forms, for each of which may be claimed some real or imaginary merits regarding questions of convenience or cost of production.

For many years after the principles involved in the construction of dynamo-machines had been made known, little general interest was manifested in their favour, and few were the forms of construction offered for public use. The essential features involved in the dynamo-machine, the Siemens armature (1856), the Pacinotti ring (1861), and the self-exciting principle (1867), were published by their authors for the pure scientific interest attached to them, without being made subject matter of letters patent, which circumstance appears to have had the contrary effect of what might have been expected, in that it has retarded the introduction of this class of electrical machine, because no person or firm had a sufficient commercial interest to undertake

[1] By Prof. J. M. Schaeberle, Ann Arbor, Michigan. From the *American Journal of Science*.

[2] Address by Dr. C. W. Siemens, F.R.S., Chairman of the Society of Arts, November 15.

the large expenditure which must necessarily be incurred in reducing a first conception into a practical shape. Great credit is due to Monsieur Gramme for taking the initiative in the practical introduction of dynamo-machines embodying those principles, but when five years ago I ventured to predict for the dynamo-electric current a great practical future, as a means of transmitting power to a distance, those views were still looked upon as more or less chimerical. A few striking examples of what could be practically effected by the dynamo-electric current such as the illumination of the Place de l'Opera, Paris, the occasional exhibition of powerful arc lights, and their adoption for military and lighthouse purposes, but especially the gradual accomplishment of the much desired lamp by incandescence in vacuum, gave rise to a somewhat sudden reversion of public feeling; and you may remember the scare at the Stock Exchange affecting the value of gas shares, which ensued in 1878, when the accomplishment of the sub-division of the electric light by incandescent wire was first announced, somewhat prematurely, through the Atlantic cable.

From this time forward electric lighting has been attracting more and more public attention, until the brilliant displays at the exhibition of Paris, and at the Crystal Palace last year, served to excite public interest, to an extraordinary degree. New companies for the purpose of introducing electric light and power have been announced almost daily, whose claims to public attention as investments were based in some cases upon only very slight modifications of well-known forms of dynamo-machines, of arc regulators, or of incandescent carbon lights, the merits of which rested rather upon anticipations than upon any scientific or practical proof. These arrangements were supposed to be of such superlative merit that gas and other illuminants must soon be matters simply of history, and hence arose great speculative excitement. It should be borne in mind, however, that any great technical advance is necessarily the work of time and serious labour, and that when accomplished, it is generally found that so far from injuring existing industries, it calls additional ones into existence, to supply new demands, and thus gives rise to an increase in the sum total of our resources. It is, therefore, reasonable to expect that side by side with the introduction of the new illuminant, gas lighting will go on improving and extending, although the advantage of electric light for many applications, such as the lighting of public halls and warehouses, of our drawing-rooms and dining-rooms, our passenger steamers, our docks and harbours, are so evident, that its advent may be looked upon as a matter of certainty.

Our Legislature has not been slow in recognising the importance of the new illuminant. In 1879, a Select Committee in the House of Commons instituted a careful inquiry into its nature and probable cost, with a view to legislation, and the conclusions at which they arrived were, I consider, the best that could have been laid down. They advised that applications should be encouraged tentatively by the granting of permissive Bills, and this policy has given rise to the Electric Lighting Bill, 1882, promoted by Mr. Chamberlain, the President of the Board of Trade, regarding which much controversy has arisen. It could, indeed, hardly be expected that any act of legislation upon this subject could give universal satisfaction, because while there are many believers in gas who would gladly oppose any measure likely to favour the progress of the rival illuminant, and others who wish to see it monopolised, either by local authorities, or by large financial corporations, there are others again who would throw the doors open so wide as to enable almost all comers to interfere with the public thoroughfares, for the establishment of conducting wires, without let or hindrance.

The law as now established takes, I consider, a medium course between these diverging opinions, and, if properly interpreted, will protect, I believe, all legitimate interests, without impeding the healthy growth of establishments for the distribution of electric energy for lighting and for the transmission of power. Any firm or lighting company may, by application to the local authorities, obtain leave to place electric conductors below public thoroughfares, subject to such conditions as may be mutually agreed upon, the terms of such license being limited to seven years; or an application may be made to the Board of Trade for a provisional order to the same effect, which, when sanctioned by Parliament, secures a right of occupation for twenty-one years. The license offers the advantage of cheapness, and may be regarded as a purely tentative measure, to enable the firm or company to prove the value of their plant. If this is fairly established, the license would in all probability be affirmed, either by an engagement for its prolongation from time to time, or by a provisional order which would, in that case, be obtained by joint application of the contractor and the local authority. At the time of expiration of the provisional order, a pre-emption of purchase is accorded to the local authority, against which it has been objected with much force by so competent an authority as Sir Frederick Bramwell, that the conditions of purchase laid down are not such as fairly to remunerate the contracting companies for their expenditure and risk, and that the power of purchase would inevitably induce the parochial bodies to become mere trading associations. But while admitting the undesirability of such a consummation, I cannot help thinking that it was necessary to put some term to contracts entered into with speculative bodies at a time when the true value of electric energy, and the best conditions under which it should be applied, are still very imperfectly understood. The supply of electric energy, particularly in its application to transmission of power, is a matter simply of commercial demand and supply, which need not partake of the character of a large monopoly similar to gas and water supply, and which may therefore be safely left in the hands of individuals, or of local associations, subject to a certain control for the protection of public interests. At the termination of the period of the provisional order, the contract may be renewed upon such terms and conditions as may at that time appear just and reasonable to Parliament, under whose authority the Board of Trade will be empowered to effect such renewal.

Complaints appear almost daily in the public papers to the effect that townships refuse their assent to applications by electric light companies for provisional orders; but it may be surmised that many of these applications are of a more or less speculative character, the object being to secure monopolies for eventual use or sale, under which circumstances the authorities are clearly justified in withholding their assent; and no licenses or provisional orders should, indeed, be granted, I consider, unless the applicants can give assurance of being able and willing to carry out the work within a reasonable time. But there are technical questions involved which are not yet sufficiently well understood to admit of immediate operations upon a large scale.

Attention has been very properly called to the great divergence in the opinions expressed by scientific men regarding the area that each lighting district should comprise, the capital required to light such an area, and the amount of electric tension that should be allowed in the conductors. In the case of gas supply, the works are necessarily situated in the outskirts of the town, on account of the nuisance this manufacture occasions to the immediate neighbourhood; and, therefore, gas supply must range over a large area. It would be possible, no doubt, to deal with electricity on a similar basis, to establish electrical mains in the shape of copper rods of great thickness, with branches diverging from it in all directions; but the question to be considered is, whether such an imitative course is desirable on account either of relative expense or of facility of working. My own opinion, based upon considerable practical experience and thought devoted to the subject, is decidedly adverse to such a plan. In my evidence before the Parliamentary Committee, I limited the desirable area of an electric district in densely populated towns to a quarter of a square mile, and estimated the cost of the necessary establishment of engines, dynamo-machines, and conductors, at 100,000*l*. while other witnesses held that areas from one to four square miles could be worked advantageously from one centre, and at a cost not exceeding materially the figure I had given. These discrepancies do not necessarily imply wide differences in the estimated cost of each machine or electric light, inasmuch as such estimates are necessarily based upon various assumptions regarding the number of houses and of public buildings comprised in such a district, and the amount of light to be apportioned to each, but I still maintain my preference for small districts.

By way of illustration, let us take the parish of St. James's, near at hand, a district not more densely populated than other equal areas within the metropolis, although comprising, perhaps, a greater number of public buildings. Its population, according to the preliminary report of the census taken on the 4th April, 1881, was 29,865, it contains 3,018 inhabited houses, and its area is 784,000 square yards, or slightly above a quarter of a square mile.

To light a comfortable house of moderate dimensions in all its parts, to the exclusion of gas, oil, or candles, would require about 100 incandescent lights of from 15 to 18-candle power each, that being, for instance, the number of Swan lights employed by Sir William Thomson in lighting his house at Glasgow University. Eleven-horse power would be required to excite this number of incandescent lights, and at this rate the parish of St. James's would require 3,018 × 11 = 33,200-horse power to work it. It may be fairly objected, however, that there are many houses in the parish much below the standard here referred to, but on the other hand, there are 600 of them with shops on the ground floor, involving larger requirements. Nor does this estimate provide for the large consumption of electric energy that would take place in lighting the eleven churches, eighteen club-houses, nine concert halls, three theatres, besides numerous hotels, restaurants, and lecture halls. A theatre of moderate dimensions, such as the Savoy Theatre, has been proved by experience to require 1,200 incandescent lights, representing an expenditure of 133 horse power; and about one-half that power would have to be set aside for each of the other public buildings here mentioned, constituting an aggregate of 2,926-horse power; nor does this general estimate comprise street lighting, and to light the six and a half miles of principal streets of the parish with electric light, would require per mile, thirty-five arc lights of 350-candle power each, or a total of 227 lights. This, taken at the rate of 0·8-horse power per light, represents a further requirement of 182-horse power, making a total of 3,108-horse power, for purposes independent of house lighting, being equivalent to one-horse power per inhabited house, and bringing the total requirements up to 109 lights = 12-horse power per house.

I do not, however, agree with those who expect that gas lighting will be entirely superseded, but have, on the contrary, always maintained that the electric light, while possessing great and peculiar advantages for lighting our principal rooms, halls, warehouses, &c., owing to its brilliancy, and more particularly to its non-interference with the healthful condition of the atmosphere, will leave ample room for the development of the former, which is susceptible of great improvement, and is likely to hold its own for the ordinary lighting up of our streets and dwellings.

Assuming, therefore, that the bulk of domestic lighting remains to the gas companies, and that the electric light is introduced into private houses, only, at the rate of, say twelve incandescent lights per house, the parish of St. James's would have to be provided with electric energy sufficient to work (9 + 12) 3,018 = 63,378 lights = 7,042-horse power effective; this is equal to about one-fourth the total lighting power required, taking into account that the total number of lights that have to be provided for a house are not all used at one and the same time. No allowance is made in this estimate for the transmission of power, which, in course of time, will form a very large application of electric energy; but considering that power will be required mostly in the day time, when light is not needed, a material increase in plant will not be necessary for that purpose.

In order to minimise the length and thickness of the electric conductor, it would be important to establish the source of power, as nearly as may be, in the centre of the parish, and the position that suggests itself to my mind is that of Golden-square. If the unoccupied area of this square, representing 2,500 square yards, was excavated to a depth of twenty-five feet, and then arched over so as to re-establish the present ground level, a suitable covered space would be provided for the boilers, engines, and dynamo-machines, without causing obstruction or public annoyance; the only erection above the surface would be the chimney, which, if made monumental in form, might be placed in the centre of the square, and be combined with shafts for ventilating the subterranean chamber, care being taken of course to avoid smoke by insuring perfect combustion of the fuel used. The cost of such a chamber, of engine power, and of dynamo-machines, capable of converting that power into electric energy, I estimate at 140,000*l.* To this expense would have to be added that of providing and laying the conductors, together with the switches, current regulators, and arrangements for testing the insulation of the wire.

The cost and dimensions of the conductors would depend upon their length, and the electromotive force to be allowed. The latter would no doubt be limited, by the authorities, to the point at which contact of the two conductors with the human frame would not produce injurious effects, or say to 200 volts, except for street lighting, for which purpose a higher tension is admissible. In considering the proper size of conductor to be used in any given installation, two principal factors have to be taken into account; first, the charge for interest and depreciation on the original cost of a unit length of the conductor; and, secondly, the cost of the electrical energy lost through the resistance of a unit of length. The sum of these two, which may be regarded as the cost of conveyance of electricity, is clearly least, as Sir William Thomson pointed out some time ago, when the two components are equal. This, then, is the principle on which the size of a conductor should be determined.

From the experience of large installations, I consider that electricity can, roughly speaking, be produced in London at a cost of about one shilling per 10,000 Ampère-Volts or Watts (746 Watts being equal to one horse-power) for an hour. Hence, assuming that each set of four incandescent lamps in series (such as Swan's, but for which may be substituted a smaller number of higher resistance and higher luminosity) requires 200 volts electromotive force, and 60 Watts for their efficient working, the total current required for 64,000 such lights is 19,200 ampères, and the cost of the electric energy lost by this current in passing through 1-100th of an ohm resistance, is 16*l.* per hour.

The resistance of a copper bar one quarter of a mile in length, and one square inch in section, is very nearly 1-100th of an ohm, and the weight is about 2¼ tons. Assuming, then, the price of insulated copper conductor at 90*l.* per ton, and the rate of interest and depreciation at 7½ per cent., the charge per hour of the above conductor, when used eight hours per day, is 1⅓*d.* Hence, following the principle I have stated above, the proper size of conductor to use for an installation of the magnitude I have supposed, would be one of 48·29 inches section, or a round rod eight inches diameter.

If the mean distance of the lamps from the station be assumed as 350 yards, the weight of copper used in the complete system of conductors would be nearly 168 tons, and its cost 15,120*l.* To this must be added the cost of iron pipes, for carrying the conductors underground, and of testing boxes, and labour in placing them. Four pipes of 10 inch diameter each, would have to proceed in different directions from the central station, each containing sixteen separate conductors of one inch diameter, and separately insulated, each of them supplying a sub-district of 1,000 lights. The total cost of establishing these conductors may be taken at 37,000*l.*, which brings up the total expenditure for central station and leads to 177,000*l.* I assume the conductors to be placed underground, as I consider it quite inadmissible, both as regards permanency and public safety and convenience, to place them above ground, within the precincts of towns. With this expenditure, the parish of St. James's would be supplied with the electric light to the extent of about 25 per cent, of the total illuminating power required. To provide a larger percentage of electric energy would increase the cost of establishment proportionately; and that of conductors, nearly in the square ratio of the increase of the district, unless the loss of energy by resistance is allowed to augment instead.

It may surprise uninitiated persons to be told that to supply a single parish with electric energy necessitates copper conductors of a collective area equal to a rod of eight inches in diameter; and how, it may be asked, will it be possible under such conditions to transmit the energy of waterfalls to distances of twenty or thirty miles, as has been suggested? It must indeed be admitted that the transmission of electric energy of such potential (200 volts) as is admissible in private dwellings would involve conductors of impracticable dimensions, and in order to transmit electrical energy to such distances, it is necessary to resort in the first place to an electric current of high tension. By increasing the tension from 200 to 1,200 volts the conductors may be reduced to one-sixth their area, and if we are content to lose a larger proportion of the energy obtained cheaply from a waterfall, we may effect a still greater reduction. A current of such high potential could not be introduced into houses for lighting purposes, but it could be passed through the coils of a secondary dynamo-machine, to give motion to another primary machine, producing currents of low potential to be distributed for general consumption. Or secondary batteries may be used to effect the conversion of currents of high into those of low potential, whichever means may be found the cheaper in first cost, in maintenance, and most economical of energy. It may be advisable to have several such relays of energy for great distances, the result of which would be a reduction of the size and cost of conductor at the expense of final effect, and the policy of the electrical engineer will, in such cases, have to be governed by the relative cost of the conductor, and of the power at its original source. If secondary batteries should become more permanent in their action than they are at the present time, they may be largely resorted to by consumers, to receive a charge of electrical energy during the day time, or the small hours of the night, when the central engine would otherwise be unemployed, and the advantage of resorting to these means will depend upon the relative first cost, and cost of working the secondary battery and the engine respectively. These questions are, however, outside the range of our present consideration.

The large aggregate of dwellings comprising the metropolis of London covers about seventy square miles, thirty of which may be taken to consist of parks, squares, and sparsely inhabited areas, which are not to be considered for our present purpose. The remaining forty square miles could be divided into say 140 districts, slightly exceeding a quarter of a square mile on the average, but containing each fully 3,000 houses, and a population similar to that of St. James's.

Assuming twenty of these districts to rank with the parish of St. James's (after deducting the 600 shops which I did not include in my estimate) as central districts, sixty to be residential districts, and sixty to be comparatively poor neighbourhoods, and estimating the illuminating power required for these three classes in the proportion of 1 to $\frac{2}{3}$ to $\frac{1}{3}$, we should find that the total capital expenditure for supplying the metropolis with electric energy to the extent of 25 per cent. of the total lighting requirements would be—

$$20 \times 177{,}000 = 3{,}540{,}000l.$$
$$60 \times \tfrac{2}{3} \times 177{,}000 = 7{,}080{,}000l.$$
$$60 \times \tfrac{1}{3} \times 177{,}000 = 3{,}540{,}000l.$$
$$14{,}160{,}000l.$$

or say 14,000,000*l.*, without including lamps and internal fittings, and making an average capital expenditure of 100,000*l.* per district.

To extend the same system over the towns of Great Britain, and Ireland would absorb a capital exceeding certainly 64,000,000*l.*, to which must be added 16,000,000*l.* for lamps and internal fittings, making a total capital expenditure of 80,000,000*l.* Some of us may live to see this capital realised, but to find such an amount of capital, and, what is more important, to find the manufacturing appliances to produce work representing this value of machinery and wire, must necessarily be the result of many years of technical development. If, therefore, we see that electric companies apply for provisional orders to supply electric energy, not only for every town throughout the country, but also for the colonies, and for foreign parts, we are forced to the conclusion that their ambition is somewhat in excess of their power of performance; and that no provisional order should be granted except conditionally on the work being executed within a reasonable time, as without such a provision the powers granted may have the effect of retarding instead of advancing electric lighting, and of providing an undue encouragement to purely speculative operations.

The extension of a district beyond the quarter of a square mile limit, would necessitate an establishment of unwieldy dimensions, and the total cost of electric conductors per unit area would be materially increased; but independently of the consideration of cost, great public inconvenience would arise in consequence of the number and dimensions of the electric conductors, which could no longer be accommodated in narrow channels placed below the kerb stones, but would necessitate the construction of costly subways—veritable *cava electrica*.

The amount of the working charges of an establishment comprising the parish of St. James's would depend on the number of working hours in the day, and on the price of fuel per ton. Assuming the 64,000 lights to incandesce for six hours a day, the price of coal to be 20*s.* a ton, and the consumption 2lbs. per effective horse power per hour, the annual charge under this head, taking eight hours' firing, would amount to about 18,300*l.*, to which would have to be added for wages, repairs, and sundries, about 6,000*l.*, for interest with depreciation at seven-and-a-half per cent., 13,300*l.*, and for general management say, 3,400*l.*, making a total annual charge of 41,000*l.*, or at the rate of 12*s.* 9½*d.* per incandescent lamp per annum. To this has to be added the cost of renewal of lamps, which may be taken at 5*s.* per lamp of sixteen candles, lasting 1,200 hours, or to 9*s.* per annum, making a total of 21*s.* 9½d. per lamp for a year.

In comparing these results with the cost of gas-lighting, we shall find that it takes 5 cubic feet of gas, in a good argand burner, to produce the same luminous effect as one incandescent light of 16-candle power. In lighting such a burner every day for six hours on the average, we obtain an annual gas consumption of 10,950 cubic feet, the value of which, taken at the rate of 2*s.* 8*d.* per thousand, represents an annual charge of 29*s.*, showing that electric light by incandescence, when carried out on a large scale, is decidedly cheaper than gas-lighting at present prices, and with the ordinary gas-burners.

On the other hand, the cost of establishing gas-works and mains of a capacity equal to 64,000 argand burners would involve an expenditure not exceeding 80,000*l.* as compared with 177,000*l.* in the case of electricity; and it is thus shown that although it is more costly to establish a given supply of illuminating power by electricity than gas, the former has the advantage as regards current cost of production.

It would not be safe, however, for the advocates of electric lighting to rely upon these figures as representing a permanent state of things. In calculating the cost of electric light, I have only allowed for depreciation and 5 per cent. interest upon capital expenditure, whereas gas companies are in the habit of dividing large dividends, and can afford to supply gas at a cheaper rate, by taking advantage of recent improvements in manufacturing operations, and of the ever-increasing value of their by-products, including tar, coke, and ammoniacal liquor. Burners have, moreover, been recently devised by which the luminous effect for a given expenditure of gas can be nearly doubled by purely mechanical arrangements, and the brilliancy of the light can be greatly improved.

On the other hand, electric lighting also may certainly be cheapened by resorting, to a greater extent than has been assumed, to arc lighting, which though less agreeable than the incandescent light for domestic purposes, can be produced at less than half the cost, and deserves on that account the preference for street lighting, and for large halls, in combination with incandescent lights. Lamps by incandescence may be produced hereafter at a lower cost, and of a more enduring character.

Considering the increasing public demand for improved illumination, it is not unreasonable to expect that the introduction of the electric light to the full extent here contemplated, would go hand in hand with an increasing consumption of gas for illuminating and for heating purposes, and the neck-to-neck competition between the representatives of the two systems of illumination, which is likely to ensue, cannot fail to improve the quality, and to cheapen the supply of both, a competition which the consuming public can afford to watch with complacent self-satisfaction. Electricity must win the day, as the light of luxury; but gas will, at the same time, find an ever-increasing application for the more humble purposes of diffusing light.

In my address to the British Association I dwelt upon the capabilities and prospects of gas, both as an illuminant and as a heating agent, and I do not think that I was over-sanguine in predicting for this combustible a future exceeding all present anticipations.

I also called attention to the advantages of gas as a heating agent, showing that if supplied specially for the purpose, it would become not only the most convenient, but by far the cheapest form of fuel that can be supplied to our towns. Such a general supply of heating separately from illuminating gas, by collecting the two gases into separate holders during the process of distillation, would have the beneficial effects—

1. Of giving to lighting gas a higher illuminating power.
2. Of relieving our towns of their most objectionable traffic—that in coal and ashes.
3. Of effecting the perfect cure of that bugbear of our winter existence—the smoke nuisance.
4. Of largely increasing the production of those valuable by-products, tar, coke, and ammonia, the annual value of which already exceeds by nearly 3,000,000*l.* that of the coal consumed in the gas-works.

The late exhibitions have been beneficial in arousing public interest in favour of smoke abatement, and it is satisfactory to find that many persons, without being compelled to do so, are now introducing perfectly smokeless arrangements for their domestic and kitchen fires.

The Society of Arts, which for more than 100 years has given its attention to important questions regarding public health, comfort, and instruction, would, in my opinion be the proper body to examine thoroughly into the question of the supply and economical application of gas and electricity for the purposes of lighting, of power production, and of heating. They would thus pave the way to such legislative reform as may be necessary to facilitate the introduction of a national system.

If I can be instrumental in engaging the interest of the Society in these important questions, especially that of smoke prevention, I shall vacate this chair next year with the pleasing consciousness that my term of office has not been devoid of a practical result.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—In the Higher Local Examination, in which the majority of the candidates are women, there was a notable falling off this year in the number of candidates in the Natural Science group of subjects. In 1880 there were 99, and 26 failed; in 1881 there were 89, and 17 failed; in 1882, only 39, and 9 failed. The total number of candidates increased from 882 in 1881 to 961 in 1882. The examiners' reports do not indicate any special falling off in the attainments shown by the candidates. In the elementary paper (including Physics, and Biology) the results were not particularly satisfactory. Confusion in the use of terms was common, and the inability to use chemical formulæ was very marked in some cases. In Physiology mistakes were made with regard to subjects of great practical interest, and many of them might have been avoided by reference to every-day experience. In Chemistry the theory was better understood than practical laboratory details.

A supplementary local examination was held in September, for the benefit of candidates seeking exemption from the Previous Examination, and of others desiring to become medical students, &c. Nineteen intending medical students entered, none of whom satisfied the requirements of the General Medical Council.

The Fellows elected at St. John's College last week included Prof. W. J. Sollas, 1st class in the Natural Science Tripos, 1873, Professor of Geology in University College, Bristol, and author of many valuable geological and palæontological memoirs; Mr. J. S. Yeo, Second Wrangler and Second Smith's Prizeman, 1882.

Dr. Hans Gadow will conduct an advanced class in the Morphology of the Vertebrata at the New Museums during the remainder of the present term.

The Members appointed by the Senate on the General Board of Studies, on which much important work will henceforth devolve, are Messrs. Bradshaw (University Librarian), J. Peile, Prof. Cayley, Aldis Wright, Dr. Parkinson, Coutts Trotter, Dr. Phear (Master of Emmanuel College), and Prof. Stuart.

The special Boards of Studies relating to Natural Sciences have selected the following representatives on the General Board of Studies:—Medicine, Prof. Paget; Mathematics, Dr. Ferrers; Physics and Chemistry, Prof. Liveing; Biology and Geology; Music, Mr. Sedley Taylor.

Prof. Stuart has issued his address as the liberal candidate for the University, in succession to the Right Hon. Sir H. Walpole, who proposes to resign.

SCIENTIFIC SERIALS

The American Journal of Science, October.—Notes on physiological optics, No. 5.—Vision by the light of the electric spark, by W. L. Stevens.—Crystals of monazite from Alexander county, North Carolina, by E. S. Dana.—Occurrence and composition of some American varieties of monazite, by S. L. Penfield.—Irregularities in the amplitude of oscillation of pendulums, by C. S. Peirce.—The Deerfield dyke and its minerals, by B. K. Emerson.—Occurrence of *Siphonotreta scotica* in the Utica formation near Ottawa, Ontario, by J. F. Whiteaves.—A recent species of *Heteropora*, from the Strait of Juan de Fuca, by the same.—Notes on interesting minerals occurring near Pike's Peak, Colorado, by W. Cross and W. F. Hillebrand.

Journal of the Asiatic Society of Bengal, vol. 4, part 2, No. 1 (August 31, 1882), contains: On a collection of Japanese Clausiliæ made by Surgeon R. Hungerford in 1881, by Dr. O. F. von Möllendorff (plate 1); out of 21 species, 10 are described as new. Also, by the same author, on *Clausilia nevilliana*, a new species from the Nicobars, and descriptions of three new Asiatic Clausiliæ.—Second list of Diurnal Lepidoptera from the Nicobars, by J. Wood-Mason and L. de Nicéville (plate 3).—On some new or little-known Mantodea, by J. Wood-Mason

Bulletin de l'Academie Royale des Sciences de Belgique, No. 8.—On the new note of M. Dupont concerning his re-vindication of priority of M. Dewalque.—On the means proposed for calming the waves of the sea, by M. Van der Mensbrugghe.—On the dilatation of some isomorphous salts, by M. Spring.—Notes of comparative physiology, by M. Fredericq.—On some brominated derivatives of camphor, by M. de la Royère.—On the central bone of the carpus in mammalia, by M. Lebourcq.—Action of chlorine on sulphonic combinations, and on organic oxysulphides, by MM. Spring and Wissinger.

Verhandlungen der Naturforschenden Gesellschaft in Basel, Theil 7, Heft 1, 1882, contains: Studies on the history of the deer family, No. 1.—The skull structure, by L. Rütimeyer.—Studies on *Talpa europæa*, by Dr. J. Kober. The literature is given in detail, followed by notes on the mole's place in the order, its local names and habits, and on its anatomy and development (plates 1 and 2, chiefly relating to dentition and embryos).—First supplement to the Catalogue of the Collection of Reptiles in the Basle Museum, by F. Müller. Notes are appended to some of the rarer species, and a new genus and species (*Tropidocephalus azureus*) are indicated for a form allied to *Leiodera chilensis*, Gray, taken in Uruguay; it is figured on plate 3. The register of the collection to December, 1881 indicates 933 species.—On the hail-storm of June 29, 1879, by E. Haigenbach-Bischoff and others.—On the explosive powers of ice and on the Gletscherkorn, by E. H. Bischoff.—Meteorological Report for 1881, with reports by L. Rütimeyer on the comparative anatomy collections, and by F. Burckhardt and R. Holtz, on the map collection of the Society.

SOCIETIES AND ACADEMIES

LONDON

Mathematical Society, November 9.—Mr. S. Roberts, F.R.S., president, in the chair.—After the reading of the Treasurer's and Secretaries' reports, the Chairman briefly touched upon the loss the Society had sustained during the recess, by the death of Prof. W. Stanley Jevons, F.R.S.—After the ballot for the Council of the ensuing session had been taken, Prof. Henrici, F.R.S., the newly elected president, took the chair, and called upon Mr. Roberts to read his address, which was entitled, "Remarks on Mathematical Terminology and the Philosophical Bearing of Recent Mathematical Speculations concerning the Realities of Space."—Mr. W. M. Hicks was admitted into the Society.—The following communications were made:—On in- and circumscribed polyhedra, Prof. Forsyth.—Note on quartic curves in space, Dr. Spottiswoode, P.R.S.—Note on the derivation of elliptic function formulæ from confocal conics, Mr. J. Griffiths.—On the explicit integration of certain differential resolvents, Sir J. Cockle, F.R.S.—On compound determinants, Mr. R. F. Scott.—On unicursal twisted quartics, Mr. R. A. Roberts.

Geological Society, November 1.—J. W. Hulke, F.R.S., president, in the chair.—Prof. Louis Lartet, of Toulouse, was elected a Foreign Correspondent of the Society.—The following communications were read:—The Hornblendic and other schists of the Lizard District, with some additional notes on the Serpentine, by Prof. T. G. Bonney, M.A., F.R.S., Sec. G.S. The author described the metamorphic series, chiefly characterised by hornblendic schist, which occupies the southern portion of the Lizard and an extensive tract to the north of the serpentine region, besides some more limited areas. He found that this series was separable into a lower or micaceous group—schists with various green minerals (often a variety of hornblende), or with brownish mica; a middle or hornblendic group, characterised by black hornblende; and an upper or granulitic group, characterised by bands of quartz-felspar rock, often resembling in appearance a vein-granite. These are all highly metamorphosed; yet the second and third occasionally retain to a remarkable extent indications of the minuter bedding structures, such as alternating lamination and current bedding of various kinds. They form, in the author's opinion, one continuous series, of which the uppermost is the thinnest. The general strike of the series, though there are many variations, is either north-west or west-north-west. The junctions of the Palæozoic with the metamorphic series at Polurrian and at Porthalla were described. These are undoubtedly faulted: and the two rocks differ greatly, the former being a slate like any ordinary Palæozoic rock, the other a highly metamorphosed schist. Moreover, fragments of the hornblende schist and a kind of gneiss occur in a conglomerate in the former, south of Nare Point. The author considers the metamorphic series (the microscopic structure of which was fully described) undoubtedly Archæan, and probably rather early in that division. The rocks of the micaceous group have considerable resemblance in the greenish and lead-coloured schists of Holyhead Island and the adjoining mainland of Anglesey, and of the Menai Strait. Two outlying areas of serpentine, omitted in his former paper, were described—one at Polkerris, the other at Porthalla. The latter shows excellent junctions, and is clearly intrusive in the schist. The author stated that he had re-examined a large part of the district described in his former paper, and had obtained additional evidence of the intrusion of the serpentine into the sedimentary rock with which it is associated. This evidence is of so strong a nature that he could not conceive the possibility of any one who would carefully examine the district for himself, entertaining a doubt upon the matter.—Notes on some Upper Jurassic Astrorhizidæ and Lituolidæ, by Dr. Rudolf Häusler, F.G.S.

Paris

Academy of Sciences, November 6.—M. Blanchard in the chair.—The following papers were read:—On the comparative observation of telluric and metallic lines as a means of estimating the absorbent powers of the atmosphere, by M. Cornu. He selects telluric lines (caused by aqueous vapour, and varying in intensity with the amount of it) near D, the scale being four times as large as Ångström's. Metallic lines, for comparison, are indicated; also a method of deducing the total quantity of vapour.—Results of experiments made at the exhibition of electricity, &c. (continued), by M. Allard and others. Three more systems are here discussed.—On M. Siemens' new theory of the sun, by M. Hirn. The recombination of the elements dissociated in space could occur only at a notable distance from the sun's photosphere, and on falling into this they must be anew entirely dissociated, an action which would cost the heat developed by combination. Again, the work done by solar radiation in dissociation must reduce the intensity of radiation; so that the brightness of the sun, stars, and planets should diminish much more rapidly than inversely as the square of the distances. M. Hirn also supports M. Faye's objections by numerical examples.—On the functions of seven letters, by M. Brioschi.—The earthquake of the Isthmus of Panama, by M. de Lesseps. The phenomena (of which he gives a scientific account) seem to have been much exaggerated. The character of comparative immunity of the isthmus (as compared with regions near) is not seriously affected; and in any case, the construction of a maritime canal without locks is justified. There is no ground for apprehension as to the banks of the canal.—M. Peligot presented a "Treatise of Analytical Chemistry applied to Agriculture," and indicated its scope.—MM. de la Tour du Breuil addressed a further note regarding their process for separation of sulphur; they have modified the process so that it is applicable either to resistant or to pulverulent ores.—On the comet observed in Chili in September, by M. de Bernardières.—On the great southern comet observed at the Imperial Observatory of Rio de Janeiro, by M. Cruls. *Inter alia*, he refers to the aspect of the tail as of a current of extremely bright light, in which were distinct bright lines. Behind the nucleus was a dark space, and one was reminded of a bridge-pile in a strong current. The tail extending a length of 12°, seemed suddenly interrupted, and the extension for 15° beyond was of much less width and brightness. Sodium and carbon lines were observed in the spectrum.—On the functions of the genus zero and of genus one, by M. Laguerre. —On a result of calculation obtained by M. Allégret, by M. MacMahon.—On the relation between the electromotive force of a dynamo-electric machine and its velocity of rotation, by M. Levy.—Spectrophotometric measurements of different points of the solar disc, by MM. Gouy and Thollon. They could measure separately the 200,000th part of the solar disc, and the thousandth part of the spectrum. The figures obtained show the decrease of radiation on approaching the limb (greater the more refrangible the rays). The method is also applied to spots.—On the comparison of mercury thermometers with the hydrogen thermometer, by M. Crafts. Fifteen Paris thermometers examined (the crystal containing 18 per cent. lead oxide) behaved like the thermometers of ordinary glass studied by Regnault, but very unlike those of Choisy-le-Roy crystal (with nearly twice as much oxide). A German thermometer of soda-glass gave a curve much nearer the mean than many others of Paris crystal.—On a hydrate of molybdic acid, $MoO_3 2HO$, by M. Parmentier.—On the transformation, in cold, of the blood of animals into solid and inodorous manure, by a new ferric sulphate, by M. Marguerite-Delacharlonny. This sulphate has the formula $Fe_2O_3 4SO_3$. With it the elimination of the water attains nearly one-half. It forms a hydrate which crystallises easily, and dissolves readily in heat. On adding a solution of the sulphate to fresh blood, the latter forms in a few seconds a firm elastic paste. It is then treated in a hydraulic press, and forms a sort of cake.—Researches on the passage of alcoholic liquor through porous bodies, by M. Gal. His experiments show the influence of the surrounding atmosphere on the alcoholic strength of liquids in bladders (an influence that has been too much overlooked).—On the reduction of sulphates by living beings, by MM. Etard and Olivier. The authors proved experimentally the reduction of sulphates, by Beggiatoa, and found at least three other algæ capable of the same action.—On mono-chlorised allylic alcohol and $CH_2{=}CCl{-}CH_2\,(OH)$ and its derivatives, by M. Henry.—Chemical studies on white beet of Silesia (continued), by M. Leplay.—On the reduction of nitrates in arable land (continued), by MM. Deheraine and Maquenne. *Bacillus amylobacter* is probably the reducing agent.—Direct fermentation of starch; mechanism of this metamorphosis, by M. Mercano. Diastase is a product of the vital activity of the microbe of maize, which produces it incessantly as it traverses the envelopes of the starch grains, thus favouring its action on the stratified granulose. The microbe is that which causes the fermentation of sugar-cane juice.—On the *rôle* of earthworms in propagation of charbon, and on the attenuation of the virus, by M. Feltz. His experiments confirm the views of M. Pasteur as against those of M. Koch.—On the disinfectant and antiseptic action of copper, by M. Burcq. He suggests treatment of infectious diseases with salts of copper, injection of the wood of huts with copper sulphate, also applications of copper to infected furniture, clothing, &c.—Analysis of the reflex of C. Loven, by M. Laffont.—On the venomous apparatus and the poison of the scorpion, M. Joyeux-Laffuie. The poison should be placed among poisons of the nervous system (Bert) and not among blood-poisons (Jousset de Bellesme).—Researches on the genital organ of oysters, by M. Hoek.

Vienna

Imperial Academy of Sciences, October 5.—E. v. Bruecke, vice-president, in the chair.—The following papers were read:—L. Ditscheiner, on Guebhard's rings.—L. Pebal, note on the mechanical separation of minerals.—H. Schwarz, on new bodies obtained from coal-tar, isomerides of pyrocressol.—F. Schroeckenstein, geological leisure hours; a contribution to the petrography of crystalline rocks.

CONTENTS