THURSDAY, OCTOBER 13, 1887.

THE SCENERY OF SCOTLAND.

The Scenery of Scotland viewed in Connexion with its Physical Geology. By Archibald Geikie, LL.D., F.R.S. (London: Macmillan, 1887.)

THAT truth is great, and that it will in the end carry the day, we are assured by the most venerable and most hackneyed of aphorisms. We profess implicit belief in the doctrine, but, as we survey the history of the growth of opinion, our faith is apt to be rudely shaken when we note countless instances of the marvellous persistence and vitality of notions, however erroneous they may be, when they have once become firmly rooted in the minds of men. It is at such times hard to help doubting whether the vaunted power of knowledge is always competent to sweep away the dead weight of prejudice and obstinacy which cumbers the approaches to the abode of truth. The infancy of every science furnishes illustrations of the tenacity with which even men of science cling to preconceived beliefs, none perhaps more striking than that supplied by the branch of geology which the volume before us is intended to illustrate.

Well-nigh a century has slipped away since Hutton enunciated the doctrine that the surface features of the land are in the main due to the carving and sculpturing action of denudation, and gave reasons for his belief which are now held to be unanswerable by nearly every geologist. But his proved to be a veritable voice crying in the wilderness. Scrope reiterated the truth and enforced it by fresh examples, notably those furnished by Auvergne; but his testimony availed not to charm ears still deaf or unwilling to be convinced. Even Ramsay, afterwards a most strenuous champion of the doctrine, failed to see the whole truth when he wrote his classical memoir on "The Denudation of the South-West of England." Jukes struck the right note in his memorable paper on "The River-Valleys of the South of Ireland"; Ramsay, the year following, gave precision and definite shape to the theory, which had so long a birth-throe, in his "Physical Geology and Geography of Great Britain"; Foster and Topley showed how this theory furnished a rational explanation of the growth of the puzzling physical geography of the Weald of Kent and Sussex; and Whitaker summed up the evidence in its favour in a paper singularly exhaustive in its facts and lucid in its arguments. Nothing perhaps shows more forcibly the difficulty of persuading mankind even to listen to views which seem new to them, than the fact that Whitaker's singularly temperate and unaggressive memoir was refused a place in their Quarterly Journal by the Council of the Geological Society of London. The writer may perhaps claim to have added his mite when, following in the steps of these pioneers, he pointed out how the striking escarpments and dip-slopes of the Millstone Grit moors in Derbyshire and Yorkshire have arisen.

It was when the controversy was at its height that Dr. A. Geikie furnished a weighty and memorable contribution to it in his work on "The Scenery of Scotland viewed in Connexion with its Physical Geology." He then gave no uncertain sound as far as his own convictions went, but he admitted in his preface that the views to which he had been led ran directly counter to what were at that time the prevailing impressions on the subject of the book, and that he was prepared to find them disputed or perhaps thrown aside as mere dreaming. Now, after a lapse of twenty-two years, during which many a young geologist has been hungering for access to the book long out of print, a second edition appears, and the author is able to state that these very views are accepted as part of the general stock of geological knowledge. How largely this result is due to his own steady and powerful advocacy all geologists are aware; but he gracefully reminds us that we also owe much to the labours of those American geologists who have found in the Western Territories such convincing instances of the work of denudation in shaping the surface, and have further brought these instances to our doors by means of the admirable illustrations of them which they have supplied in such profusion, and which the American Government distribute so liberally among the geologists of the whole world.

The first part of Dr. Geikie's book deals with land-sculpture in general, and describes the working of Nature's sculpturing tools. It is possible that, here and in the corresponding portions of other geological works, sufficient stress is not laid on the paramount importance of frost among those denuding agents which are generally classed together as "sub-aërial." We might almost say that the results of its work exceed in importance those of all the other denuding forces put together. Such was the impression made upon me when it was once my lot to spend an autumn and winter at St. Bees. South of the bold scarp of St. Bees Head the coast is formed by a line of low cliffs of Boulder Clay, and on a strip of smooth sand at the foot of these it was my practice to take my daily "constitutional." The summer had been hot and dry, and the clay was abundantly cracked; the autumn was a time of incessant and often heavy rain. This almost continuous downpour produced but little destruction; streams of mud stained every here and there the clean sand, but the amount carried down was insignificant. Then came one night's frost, and the beach next day was a sight not easily forgotten. Huge masses of clay, some half as big as a small cottage, cumbered the shore all along; that single night's frost wrought more havoc than the deluge of rain which had been pouring down during the preceding three months almost without cessation.

Having cleared the ground by a preliminary exposition of the principles that are to be our guide, the author takes us away to the Highlands. He insists on the fact that there is nothing in Scotland that can be called a mountain chain in the scientific sense of the expression, and enforces, both by verbal description and apt pictorial illustration, the truth that, when from some commanding height we look over the wild tumbled sea of the Highland hills, it becomes forcibly borne in upon us that they nearly all rise to about the same height. The conclusions to be drawn are that the country was first of all worn down by denudation to an approximately uniform level, and that the valleys are merely ditches dug out by sub-aërial denuding agents across this old table-land. No visitor to the Highlands, who has on a clear day from some point of vantage looked around over the landscape that lies spread below him, can for a moment gainsay the fact, whatever may be his opinion as to the conclusions drawn from it: by nearly all geologists they are accepted as the only reasonable explanation. But we need not go to the Highlands to find instances of old table-lands, which have been trenched by sub-aërial denudation; and perhaps some examples on a smaller scale may be more easily appreciated by beginners. An admirable case is found in the south-west of England. Anyone who walks up from Bristol on to Clifton and Durdham Downs cannot fail to be struck by the remarkable evenness of their surface; after a long pull up a succession of steep inclines you find yourself all at once on a plateau as flat as an alluvial meadow. By dropping down into the gorge of the Avon, an equally good instance of a river-trench cut through the plateau is supplied, and at the same time proof is furnished that the present surface, so suggestive of level-bedded strata underneath, really cuts sheer across beds tilted at high angles, broken by faults, and bent into complicated folds. The flat top runs on along the line of limestone hills that connect Bristol with Clevedon; it is specially noticeable around Clevedon; and after we have crossed a broad depression occupied by softer Coal Measures and Secondary rocks, we find it reappearing in the flat-topped Mendips. Nor is it confined to the exposed portions of the limestone area. Where that rock is covered by Secondary strata, shafts sunk in making tunnels and other excavations show that the newer beds rest on an almost level surface of Palæozoic rocks. Over the whole country there can be traced, whether exposed or hidden, the clearest remnants of an old pre-Triassic table-land.

We also find in the Avon gorge that the limestone has undergone disturbances smaller in amount, but identical in kind, with the gigantic displacements of Sutherland and Ross-shire, of which a short account is given in the present volume, and which are most graphically depicted in a longitudinal section by Mr. Peach. Anyone who wishes to understand what "thrust-planes" are, will find here very good miniature examples. An announcement of the greatest interest is made by the author while touching on this part of his subject. He states that the general assemblage of the organisms in the Durness Limestone recalls none of the Lower Silurian formation of Wales, but rather some of the still older groups of the Lower Palæozoic series of Canada. This reminds us that Lapworth finds the best palæontological parallel to his Moffat series in North America. To speculate on the geographical distribution of animals at so distant a time is risky work, but we may be tempted to conjecture that one great life province included both Scotland and North America, while Wales and Central Europe formed parts of another. Maybe the buried Archæan ridge, the tops of which stick up through the Secondary rocks of the centre of England, formed a portion of the barrier between the two.

But to return to the book before us. Having made good his contention that there was a time when the whole of what is now the Highlands was a broad undulating table-land, and that all its manifold diversity of feature has been carved out by sub-aërial denudation, the author takes us to the hills, the valleys, and the lakes, and enforces his conclusion with a wealth of illustration and a series of word-pictures of the most vivid character, which can be appreciated only by a study of the work itself. The Southern Uplands he treats in a similar manner, and incidentally he puts in a strong plea for a district which possesses much beauty of an unobtrusive kind, but which is apt to be condemned as bare and monotonous.

The Midland Valley is next brought before our notice. How delightful is even a railway ride on a bright sunny day over this charming country! It is in the main a land of broad rolling hills and wide valleys, well wooded and well watered, pleasant to the eye from its brightness and its richness. But, if this were all, there would be, it must be confessed, somewhat of a sameness about it that might be accounted tiresome. But it is redeemed from any risk of monotony by numerous ranges or groups of hills, of moderate elevation, but high enough to tower well above the general level, of ruggeder and wilder forms than the flowing contours of the body of the country, and many of them peaky and mountainous in outline. These are formed of the products of the old volcanoes which were once sprinkled so thickly over the district: their rocks, being harder than the sedimentary beds among which they occur, have been able better to hold out against denudation and have therefore not been worn down to so low a level. A very similar little tract is found in West Shropshire, where the Wrekin, Caer Caradoc, the Cardington Hills, and some other hill-groups—none very high, but all mountains in miniature—introduce a delicious diversity in the rich pastoral country of the Severn valley.

So far we have looked at the book solely from a scientific point of view, and, if no more were said, a suspicion might arise in the minds of the readers of this notice that perhaps the work was a trifle dry. But a very slight acquaintance with the book itself will dispel any misgiving on this head. No one has done more than the author to elucidate the geology of Scotland, but he knows and loves his fatherland too well to look upon it merely as a field for geological research. Legend and history, old ballad and modern poetry, have all been pressed into his service, and he interweaves into his narrative allusion and quotation in a way that enlivens even the most technical parts of the volume. The chapter on "The Influence of the Physical Features of Scotland upon the People" shows well what a vast amount of human interest attaches even to so special a science as geology.

If the intending tourist in Scotland will before he starts read enough of this book to enable him to comprehend its general drift and line of argument, and if he will then take the book with him and study on the ground such of its illustrations and examples as lie on his road, he will ever after thank the author for having supplied him with a new pleasure. One great charm of travel in Scotland is that it is ever leading us through scenes rich in historic associations. The enjoyment derived from such a source may be vastly enhanced by the aid of this book; for he who has mastered its contents will feel an interest not in the events of the human epoch only, but will see in every peak, hill-side, valley, and lake that he passes the monuments of a history which carries him back through that long vista of the ages which geology has opened out to us.

A. H. GREEN.

OUR BOOK SHELF.

Longmans' Shilling Geography. (Longmans, 1887.)

THIS book is dated 1887. It would have disgraced 1862. On the first three pages a volcano is defined as "a mountain from which smoke, flames, ashes, and lava are thrown," the words "continent" and "hemisphere" are treated as synonymous, and the unqualified statement is made that Yorkshire is the basin of the River Ouse. On p. 94 the tributary States of India are styled independent, and on p. 137 the warm water which drifts towards the Pole is placed "low" (deep?). The mass of the book is of the old vicious type—composed of lists of names and disconnected remarks; and what remains is a disorderly compilation of statements intended to be scientific, but from which the essential point is often omitted. The maps are numerous, but not of a high order. On some of them dials are inserted, showing relative time; but why this should be done for European countries where the difference of time from Greenwich time is counted in minutes, and yet not for the United States, India, or Australia, is not quite obvious. The book is careless and ignorant, and its plan radically bad. We hope that teachers will not be deceived by the title, and imagine that they have here a shortened form of "Longmans' School Geography" by Chisholm. H. J. M.

Les Plantes des Champs et des Bois. Par Gaston Bonnier. (Paris, 1887.)

IT is an accusation which has been justly brought against the botanists of this country that they habitually write in an austere style, which will repel rather than attract the general public; it would be difficult to point to any among the younger men representative of the science who have taken the trouble to please or interest the laity. It is true Miss Plues and Mrs. Gatty have made the attempt, but theirs are books which date many years back. The French are much less open to this charge, having a peculiar and in some cases even a dangerous aptitude for dressing science in popular colours. The "Vegetable World" of Figuier, well known to us from its English translation, has done good service in the past, and now Prof. Bonnier has produced a popular book, made attractive by numerous illustrations, and written in a style which will be readily followed by those who as yet know nothing of the science of botany.

The plan of the book is well adapted to the object before its author: an introduction of some 50 pages suffices for the definition of terms, and of the fundamental points in organography, together with a brief sketch of classification. Armed with this limited but sufficient knowledge, the reader may enter upon his studies in the field. The author divides these into four parts, according to the season of the year, and starting with spring. The description of the plants likely to be found is so arranged as to form a series of progressive lessons, and when autumn is reached the attentive reader will have acquired a fair knowledge of the external form and relationships of many common plants, both Phanerogamic and Cryptogamic. The book is not, and does not pretend to be, any contribution to the sum of knowledge; nevertheless, by means of the easy text and suitable illustrations, the effort of its author to make the rudiments of his science acceptable to the eye, as well as to the understanding, of the general public, should meet with the success it well deserves. F. O. B.

The Hand-book of Jamaica for 1887-88. By A. C. Sinclair and Laurence R. Fyfe. (London: Edward Stanford, 1887.)

THE compilers of this "Hand-book" have brought together a great mass of trustworthy and useful information about Jamaica. A good description of the island is followed by an historical sketch, after which comes a chronological history, brought down to June 30 last. Then we find all the necessary facts about the political constitution, the revenue, and expenditure, the various departments of the public service, and many other subjects. The articles which appeared in previous editions have been revised, and a good deal of new matter has been introduced. Most persons who may have occasion to refer to the volume will be glad to find in it an account (reprinted from the *Jamaica Gazette*) of the cyclone of last year, by Mr. Maxwell Hall, the list of medicinal and economic plants of the colony prepared by Mr. Fawcett, and the list of sugar-canes prepared by Messrs. Fawcett and Morris.

LETTERS TO THE EDITOR.

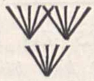
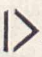
[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

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

The Natural History of the Roman Numerals.

THAT the Roman numerals, in their primitive forms, articulately symbolized a quinary notation based on the hand sign , is the view which the following observations are intended to explain.

A system of enumeration which arose naturally in the progress of the race would be moulded by the kind of expedient adopted in learning to count, by the methods employed in communicating numbers, and by the difficulty of retaining in the memory more than a very few similar signs or sounds repeated in succession. It is not generally doubted that primitive man learned to count, like the child, on his fingers, first on the one hand, and then on the other. The first stage of numeration was thus reached at five, the second at five and five. Numbers were thought of as represented by fingers and hands. From mental helps these bodily members naturally passed into communicative signs: the uplifted finger or fingers, the outspread hand or hands. This would be followed by the use of numerical language. At first only three numbers would have names, there would be a name for one, for five, and for double five. In communicating numbers four times would seem to have been the limit within which the same sign or sound could be repeated in succession without risk of confusion. If this influence alone had been at work, a new name and sign would have been reached at five, at five times five, and at five times five times five, and a perfect and consistent quinary scale would have been the result. But to the primitive man the two hands together would as naturally represent in thought and in communication two fives as the single hand would five ones; so that after double five the next stage would be five double fives, or five times the outspread hands. For this a fresh sound and a new sign would have to be found. It would be vain to conjecture the name, but surely not unreasonable to suppose that this sign would be made by some manner of placing the hand between the feet.

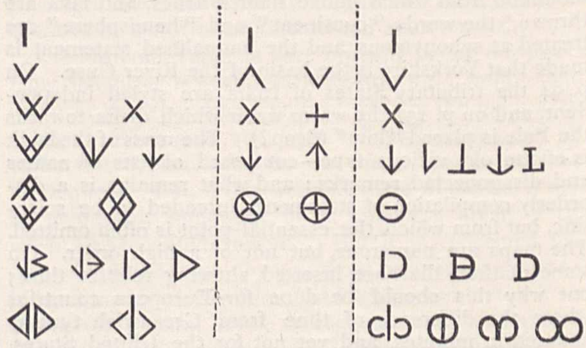
Having reached this point, and in so doing exhausted the simple bodily signs which would naturally be made use of, recourse would be had to marks drawn with the finger upon soft earth or sand. The first written symbols would almost certainly be numerals: nor is it unlikely that from their use arose the idea of an alphabet, and from their shapes the first forms which letters assumed. And these shapes could be nothing else than imitations of the gesture signs. The finger sign would give the stroke |, the five fingers in the unity of the hand would be represented by five strokes converging together, ; this, again, would be doubled and conjoined, , to resemble the combined hands, and tripled, , to imitate the sign for five times double five—the hand added to the outspread feet. The instinct in the primitive mind to represent concretely in the symbol all that was contained in the idea would sooner or later have to give way to the desire after facility and clearness. All that was found unnecessary to the distinctness of the figure would be done away with, strokes would be dropped or shortened, and complex forms would be made simple. In process of time, therefore,  became ;  first  and then X; and , after coalescing in , was simplified into . Before this last change took place, however, it would appear that a double-fifty form was employed, , unifying in , and rounding into  the Etruscan hundred. It was probably because this double-fifty form was used that no need was felt for a name or sign to represent five times fifty, and that a new form only arose when five times double fifty was reached. By this time the simplified fifty, , had become contracted into , and it was plain that a simpler figure could be got by representing double-five times fifty  than by any way of symbolizing five times double fifty. This figure, , would naturally change into , then be altered into , and become joined into one in . By the simple process of doubling this symbol, the next higher form,  or , was attained. This figure does not stand for a thousand, but for five hundred and five hundred. If c|ɔ had been, as is generally supposed, a unity meaning 1000, the doubled length of the stroke would have been unintelligible, and the multiple forms would have been

c|ɔɔ, c|ɔɔɔ, and so on, and not cc|ɔɔ, ccc|ɔɔɔ, and so on.

With the double five hundred, , we have probably reached the limit of what may be called the primitive numerical notation—the notation of a people who spoke of, counted by, and had symbols for ones, fives, double fives, fifties, double fifties, double-five times fifty, and twice double-five times fifty. And it was in the main with this cumbrous system of enumeration that the Romans were content during their whole existence as a people, hardly making any advance beyond substituting a hundred form, C, for the double fifty, and a thousand form, M, for the double five hundred.

TABULAR VIEW.

Supposed early forms. | Etruscan. | Roman.



Glasgow University, September 23. J. LYMBURN.

The "Sky-Coloured Clouds."

THE last distinct display of these that I have seen this season was during the night of July 29–30, and there was a very slight display, if really one, on August 9. They seem only to be visible for a short period before and after the summer solstice. I have looked up all the recorded dates to be found in NATURE and elsewhere when these clouds have been seen, either by myself or others, and the following are the first and last noted dates each year: 1885, June 8, July 7; 1886, May 28, August 12; 1887, June 18, July 30—but a suspected display of the phenomenon was observed four days earlier (June 14), and an equally doubtful one (mentioned before) as late as August 9.

It does not appear to me possible to attribute their luminosity to anything but direct solar illumination. Mr. Rowan in his letter (NATURE, vol. xxxvi. p. 245) thinks otherwise, though in an earlier letter (vol. xxxiv. p. 192) he seems to express a similar opinion to mine. With regard to Prof. C. Piazzi Smyth's letter on the subject (vol. xxxiv. p. 311) I have had a conversation with him since that letter was written, and he said he did not intend to convey the idea (which it had done to Mr. Rowan as well as to myself) that the auroral line appertained to the spectrum of the clouds; and my observations with the spectroscope quite agree with his belief that they are not self-luminous, for I have failed to see any bright line. Prof. Smyth says the spectrum of these clouds is purely that of twilight.

The earliest observations on these clouds would appear to be Mr. Rowan's. Some authoritative assertion of when they were first seen would be very interesting in considering their cause. I do not know that any one else perceived them before 1885, but Mr. Rowan, writing in 1886, says they had occupied his attention during the previous *two or three* years—if two years, the date, 1884, would be after the Krakatão eruption, and would add to the plausibility of their suggested connexion therewith; but if three years, it would disprove such connexion.

Sunderland, September 30. T. W. BACKHOUSE.

A Light Fog.

AT Blowing Rock, Watauga Co., N.C., a part of the main chain of the Blue Ridge Mountains, at this point possessing an elevation of about 4000 feet above the sea, on the night of the 6th inst., while the writer was crossing a causeway through a mill-pond a light fog, obscuring objects at a hundred yards, covered the water. The moon, a little past the full, produced upon the bank of fog a very distinct bow. The bow was luminous white, without any trace of colour, about 2° in breadth. The ends apparently rested on the water, the entire arc being reflected in the water. The segment of fog within the bow was faintly lit up, the lighting up being distinctly seen by contrast with the fog outside the bow. At the same time on turning and looking at the moon it was seen surrounded by a corona about 2° in diameter (four times the moon's diameter), the colours—fairly bright—being in order, going from the moon's limb, yellow, orange, red. A little later, the same night, on the brow of the ridge, in the faint mist which rose in masses, the bow was again seen vividly, against a background of trees; the bow being within 40 paces of the observer. W. G. BROWN.

Washington and Lee University, Lexington, Va.
September 23.

Destruction of Young Fish.

MAY I call your attention to the wholesale destruction of young fish which is carried on to a great extent round our coast? A few facts may not be out of place. Recently I have been visiting a small fishing village on the east coast, and have carefully noted the amount of young fish rejected by the fishermen on their return from trawling and shrimping. For example, from 4¼ pecks of shrimps no less than 793 flat-fish (dabs, soles, and turbots) were thrown on the beach useless; to this must be added about 200 whiting and an amount of young cod, herring, and skate beyond my power to count. Surely something can be done to remedy this! It is well known to the fishermen that the net does not injure the fish; so that before landing, if the net was roughly examined, all young fish could be thrown into the water again. DAVID WILSON-BARKER.

66 Gloucester Crescent, Regent's Park, N.W.

ON HAMILTON'S NUMBERS.

FOLLOWING in the footsteps of Hamilton in his Report to the British Association, contained in the Proceedings for the year 1836, we may arrive at a solution, in a certain sense the simplest, of a problem in algebra the origin of which reaches back to Tschirnhausen, born 1651, deceased 1708. Every tyro knows how a quadratic equation, and all equations of a superior degree thereto, may be transformed into another in which the second term is wanting. Tschirnhausen showed that a cubic equation, and all equations superior in degree to the cubic, might be deprived of their second and third terms by solving linear and quadratic equations. Then over a century later Bring, of the University of Lund, in 1786 showed that every equation of the 5th, or any higher degree, might be deprived of its first three terms by means of solving certain cubic, quadratic, and linear equations.[1] What, then, it may be asked, is the law of the progression of which the three first terms are 2, 3, 5? What is the lowest degree an equation can have in order that it may admit of being deprived of four consecutive terms by aid of equations of the 1st, 2nd, 3rd, and 4th degrees, or more generally of i consecutive terms by aid of equations of the 1st, 2nd, 3rd, . . . and ith degrees, *i.e.* by equations none of a higher degree than the ith?[2]

In the 100th volume of *Crelle's Journal* (1886) I have shown that the progression continued as far as the case of eight terms being abolished is as follows—

2, 3, 5, 10, 44, 905, 409181, 83762797734.

These, with the exception of the three first, are not exactly what I call Hamilton's numbers, but serve to lead up to them.

Hamilton's numbers are—

2, 3, 5, 11, 47, 923, 409619, 83763206255, . . .

I will endeavour to explain wherein the difference consists between the two series.

Whilst it is true that four terms may be abolished in an equation of the 10th degree without solving equations beyond the 4th degree, there is this difference in favour of equations of the 11th or any higher degree, viz. that *fewer* biquadratics will be required for them than in the case of an equation limited to the 10th degree. And so in general whether we take, as our inferior limit to the degree of the equation to be transformed, the ith number in the upper series or the ith number in the lower one—whilst in neither case it will be necessary to solve any equations of a degree exceeding i—the total system in the latter case will be of a simpler character than in the former.

The numbers which I have named in honour of Hamilton may be obtained by a process exhibited in the table below—

1	0	0	0	0	0	0	0	...
	1	1	1	1	1	1	1	...
		2	3	4	5	6	7	...
		1	5	9	14	20	27	...
			6	15	29	49	76	...
			5	21	50	99	175	...
			4	26	76	175	350	...
			3	30	106	281	631	...
			2	33	139	420	1051	...
			1	35	174	594	1645	...
				36	210	804	2449	...
				&c.	&c.	&c.	&c.	...

We may now isolate the greatest figure which occurs in each column, and in this may we obtain the numbers 1, 1, 2, 6, 36 . . . which I call hypotenusal numbers; then adding these numbers together and increasing each sum so obtained by unity we arrive at the so-called Hamilton's numbers, viz. 2, 3, 5, 11, 47. . . . Now the question arises as to how they may be calculated; for obviously the crude method above given will be impossible to carry out in practice beyond the first few numbers in the scale. The method of generating functions—of which the idea occurred first to my coadjutor Mr. James Hammond, which certainly ought not to, and probably in the long run could not, have escaped me—leads to a wonderfully beautiful law, by means of which these numbers may be derived successively each from those that go before, just as is the case with Bernouilli's numbers.

The simplest and best mode of proceeding is as

[1] In a letter to Leibnitz (1677), which I have not seen, and the *Acta Eruditorum* for 1683.

[2] How the elevation of the degree of the equation to be transformed makes it possible to abolish a greater number (μ) of terms by an auxiliary system of equations of degrees none exceeding μ will be understood if we consider the cases of a quintic and quartic.

Supposing $(x, 1)^5$ to be a given quintic, on writing

$$\alpha x^4 + \beta x^3 + \gamma x^2 + \delta x + \epsilon = 0$$

we obtain, by elimination of x, $(\alpha, \beta, \gamma, \delta, \epsilon)^5 = 0$, and any solution of his equation will enable us, by a well-known process, to find x by a linear equation.

If we select any letter, α, of the five we may equate it to a linear function of $y, \beta, \gamma, \delta, \epsilon$, so as to obtain

$$y^5 + (\beta, \gamma, \delta, \epsilon)^2 y^3 + (\beta, \gamma, \delta, \epsilon)^3 y^2 + (\beta, \gamma, \delta, \epsilon)^4 y + (\beta, \gamma, \delta, \epsilon)^5 = 0.$$

If in this equation we can find any system of ratios $\beta : \gamma : \delta : \epsilon$ such that $(\beta, \gamma, \delta, \epsilon)^2 = 0$, and $(\beta, \gamma, \delta, \epsilon)^3 = 0$, we can find y by solving a trinomial quintic, and therefore a system of admissible ratios $\alpha : \beta : \gamma : \delta : \epsilon$ becomes known.

All that is requisite therefore is to be able to obtain any point whatever of intersection of two given quadratic and cubic surfaces represented by $(\beta, \gamma, \delta, \epsilon)^2$ and $(\beta, \gamma, \delta, \epsilon)^3$ which obviously may be done by first finding a point (any point) in the quadratic surface (which only necessitates solving some quadratic equation or other); second, at this point drawing a right line (either one of a pair) lying on the surface, which may be effected by a well-known method involving only the solution of a quadratic; and third, finding any one of the three intersections of such line with the cubic surface.

Thus, then, by solving quadratic and cubic equations a quintic may be deprived of three consecutive terms. But not so a quartic; for in the case of a quartic we could not (with any real advantage) use a subsidiary equation of a higher degree than the 3rd, we should thus have only three letters, β, γ, δ, instead of four in the equation in y, and to make $(\beta, \gamma, \delta)^2 = 0$, $(\beta, \gamma, \delta)^3 = 0$, simultaneously, is the problem of finding an intersection of a quadratic and a cubic curve, which necessitates the solution of an equation of the 6th degree.

In the case of the quintic it may be well to notice that the ratios $\alpha : \beta : \gamma : \delta : \epsilon$ will not be all real, and consequently the trinomial quintic into which the original one has been transformed will not have its coefficients real, unless the quadric surface is a hyperboloid of one sheet (since it is only that species of quadric surfaces which contains real straight lines); and I have shown in my paper in Crelle that this is the case then, and then only, when the original quintic has four imaginary roots.

[2] If the number of equations of degrees $i, i-1, i-2, \ldots$ to be solved in the one case reckoned in DESCENDING order are $a, b, c, \ldots l, \ldots$ and in the other $a', b', c', \ldots l' \ldots$ respectively, if l, l' are the two first corresponding numbers which are not identical l' will be less than l.

follows:—Look at the successive lines of figures in the table and write

$$1 + 0.x + 0.x^2 + 0.x^3 + 0.x^4 + 0.x^5 + \ldots\ldots = F_0$$
$$x + x^2 + x^3 + x^4 + x^5 + \ldots\ldots = {}^1F_0 = F_1$$
$$2x^2 + 3x^3 + 4x^4 + 5x^5 + \ldots\ldots = {}^1F_1 = F_2$$
$$x^2 + 5x^3 + 9x^4 + 14x^5 + \ldots\ldots = {}^1F_2$$
$$6x^3 + 15x^4 + 29x^5 + \ldots\ldots = {}^2F_2 = F_3$$
$$5x^3 + 21x^4 + 50x^5 + \ldots\ldots = {}^1F_3$$
$$4x^3 + 26x^4 + 76x^5 + \ldots\ldots = {}^2F_3$$
$$3x^3 + 30x^4 + 106x^5 + \ldots\ldots = {}^3F_3$$
$$2x^3 + 33x^4 + 139x^5 + \ldots\ldots = {}^4F_3$$
$$x^3 + 35x^4 + 174x^5 + \ldots\ldots = {}^5F_3$$
$$36x^4 + 210x^5 + \ldots\ldots = {}^6F_3 = F_4$$

and so on.

Then evidently

$${}^1F_i = (1 - x)^{-1} F_i - x^i$$

and in general

$${}^{j+1}F_i = (1 - x)^{-1}\,{}^jF_i - x^i$$

and consequently calling the ith number in the hypotenusal series 1, 1, 2, 6, 36, ... a_i, and bearing in mind that ${}^{a_i}F_i = F_{i+1}$, we shall have

$$F_{i+1} - (1 - x)^{-a_i} F_i$$
$$= -x^i\{1 + (1 - x)^{-1} + (1 - x)^{-2} + \ldots + (1 - x)^{-a_i+1}\}$$
$$= x^{i-1}\{(1 - x) - (1 - x)^{-a_i+1}\}$$

which obviously regarded as an equation in differences of the 1st order in F_i, gives the means of expressing F_{i+1} as a function of x and $a_i, a_{i-1} \ldots . a_0$, and consequently must enable us to express all the coefficients in F_{i+1}, of which the first is the hypotenusal number a_{i+1}, in terms of all the hypotenusal numbers of lower order. But what is surprising and unexpected is that, as we shall in a moment see, the relation obtained is expressed by an immediate equation between the sums of the hypotenusals 1, 1, 2, 6, 36, ..., each increased by 2, *i.e.* by an equation between the *ipsissimi* numbers of Hamilton augmented by unity.

In fact, multiplying each side of the equation by $(1 - x)^{S_i+1}$, where

$$S_{i+1} = a_0 + a_1 + a_2 + \ldots + a_i,$$

(so that $S_1 = 1$, $S_2 = 2$, $S_3 = 4$, $S_4 = 10$, $S_5 = 46$, ...), it becomes

$$(1 - x)^{S_i+1} F_{i+1} - (1 - x)^{S_i} F_i$$
$$= x^{i-1}(1 - x)\{(1 - x)^{S_i+1} - (1 - x)^{S_i}\}$$

which equation, it may be noticed, proved for all values of i down to 1 may be extended also to $i = 0$, provided we make $S_0 = 0$.

Accordingly, giving i all values down to 0 inclusive, we shall easily obtain by addition

$$(1 - x)^{S_i} F_i = 1 + x^{i-2}(1 - x)^{S_i+1} - x^{-1}(1 - x)$$
$$+ x^{i-3}(1 - x)^{S_{i-1}+2} + x^{i-4}(1 - x)^{S_{i-2}+2} + \ldots .$$
$$+ x^{-1}(1 - x)^{S_1+2},$$

or which is the same thing

$$(1 - x)^{S_i} F_i - 2 + x^{-1} - x^{i-1}(1 - x)^{S_i+1}$$
$$= x^{i-2}(1 - x)^{S_i+2} + x^{i-3}(1 - x)^{S_{i-1}+2} + \ldots .$$
$$+ x^{-1}(1 - x)^{S_1+2}.$$

Hence, equating the coefficients of x^i and using $\beta^k q$ in general to signify $\frac{q(q-1)\ldots.(q-k+1)}{1.2\ldots.k}$, if we call $1 + S_i = H_i$ we obtain

$$a_i + S_i + 1 = H_{i+1}$$
$$= \beta^2(H_i + 1) - \beta^3(H_{i-1} + 1) + \beta^4(H_{i-2} + 1) - \ldots .$$
$$+ (-)^{i+1}\beta^{i+1}(H_1 + 1)$$

And on calling $1 + H_i = E_i$ this equation becomes

$$1 - \beta E_{i+1} + \beta^2 E_i - \beta^3 E_{i-1} + \beta^4 E_{i-2} - \ldots .$$
$$+ (-)^{i+1}\beta^{i+1}E_1 = 0.$$

This relation between the sharpened Hamiltonian numbers (*i.e.* these numbers increased by a unit) is in a slightly different form from the result obtained by Hammond. By aid of this formula the values of the successive numbers can be calculated with wonderful facility. The series of them commencing with 1, which although not properly speaking a Hamiltonian number, belongs to the class $S_i + 1$, have been found to be

1, 2, 3, 5, 11, 47, 923, 409619, 83763206255,
35081259062908587981 71,
61534736870965787584485228092750775204331 67, ...

Thus *ex. gr.* having found $H_6 = 923$ and all the Hamiltonian numbers inferior to it, we have

$$H_7 = \frac{924.923}{1.2} - \frac{48.47.46}{1.2.3} + \frac{12.11.10.9}{1.2.3.4} - \frac{6.5.4.3.2}{1.2.3.4.5}$$
$$= 426426 - 17296 + 495 - 6$$
$$= 409619.$$

I have alluded to Bernouilli's numbers as a parallel case to that of Hamilton's in so far as they too are subject to a scale of relation by which each can be expressed in terms of those of a lower order than itself.

If we use

$$B_1, B_2, B_3, \ldots .$$

to signify as usual the Bernouillian numbers

$$\frac{1}{6}, \frac{1}{30}, \frac{1}{42}, \ldots .$$

and write

$$G_0 = -1,\ G_1 = -1,\ G_2 = (-4)B_1,\ G_3 = 0,$$
$$G_4 = (-4)^2B_2,\ G_5 = 0,\ G_6 = (-4)^3B_3,$$

and so on, the well-known scale of relation for Bernouilli's numbers may (provided only that n be odd) be written under the form

$$\Sigma_{k=0}^{k=n}(-)^k\beta^k n.G_{n-k} = 0.$$

If in this formula we suppress the n which intervenes between the operative symbol β^k and G_{n-k}, so that the former is brought into juxtaposition with and acts on the latter, it becomes identical with that which we have found for the sharpened Hamiltonian numbers.

Those who wish to pursue the subject further may consult my memoir "On the so-called Tschirnhausen Transformation" (*Crelle*, vol. c. pp. 465–86), another "On Hamilton's Numbers," by Mr. Hammond and myself conjointly, just published in the Philosophical Transactions, and an addition thereto about to be presented to the Royal Society, in which a large generalization of the theory discussed by Hamilton in his Report to the British Association for 1836, but not brought by him to perfection, is resolved with a completeness which leaves nothing to be desired.

J. J. SYLVESTER.

New College, Oxford, October 1.

MODERN VIEWS OF ELECTRICITY.[1]

PART I.

II.

FIRST you have an inextensible endless cord circulating over pulleys; this is to represent electricity flowing in a closed circuit. Electromotive forces are forces capable of moving the cord, and you may consider them applied either by a winch, or by a weight on the hook W. A battery cell corresponds to a small weight; an electric machine to a slow but powerful winch. Clamping the cord with the screw S corresponds to making the resistance of the circuit infinite. Instead of the cord, clamp, and driving

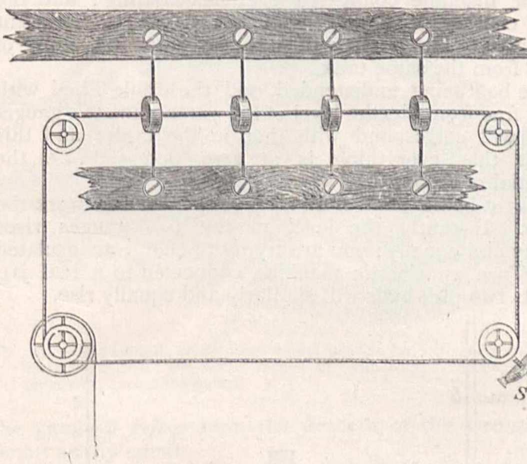


FIG. 5.—Mechanical analogy of a *metallic* circuit.

pulley, one might consider an endless pipe full of liquid with a stop-cock and a pump on it, but for many purposes the cord is sufficient and more simple. In Fig. 5, the only resistance to the motion is friction, and there is no tendency to spring back. Fixed beads are shown on the cord to typify atoms of matter, and they may be more or less rough to represent different specific resistances. If the cord be moved, heat is the only result.

Now pass to Fig. 6. Here the cord is the same as before

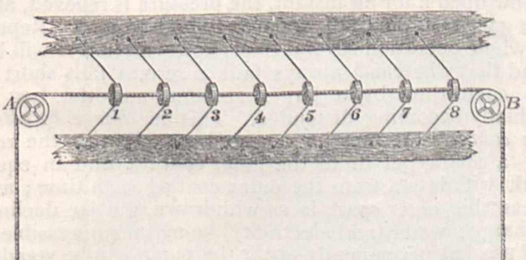


FIG. 6.—Mechanical analogy of a circuit partly *dielectric*: for instance, of a charged condenser. A is its positive coat, B its negative.

but the beads are firmly attached to it, so that if it moves they must move with it. They represent, therefore, the particles of an insulating substance. Nevertheless, their supports are not rigid—they do not prevent the cord moving at all; they allow what is called electric "*displacement*," not conduction; they can be displaced a little from their natural position, but they spring back again when the disturbing E.M.F. is removed. The beads in this figure are supposed to be supported by elastic threads: if the cord were replaced by a closed pipe full of water they would be replaced by elastic partitions.

Apply a given E.M.F. to this cord and a definite displacement is produced. One side gets more cord than usual—it is positively charged; the other gets less—it is negatively charged. If the applied E.M.F. exceeds a certain limit the strain is too great. The elastics break, and you have disruptive discharge with a spark. But even when the strain is only moderate some of the supports may yield viscously, or be imperfectly elastic and permit a gradual extra displacement of the cord, known to telegraphists as "soaking in."

When discharge is now allowed, it will not at once be complete; a large portion of the displacement will be at once recovered, but the rest will gradually "soak out" and cause residual discharges.

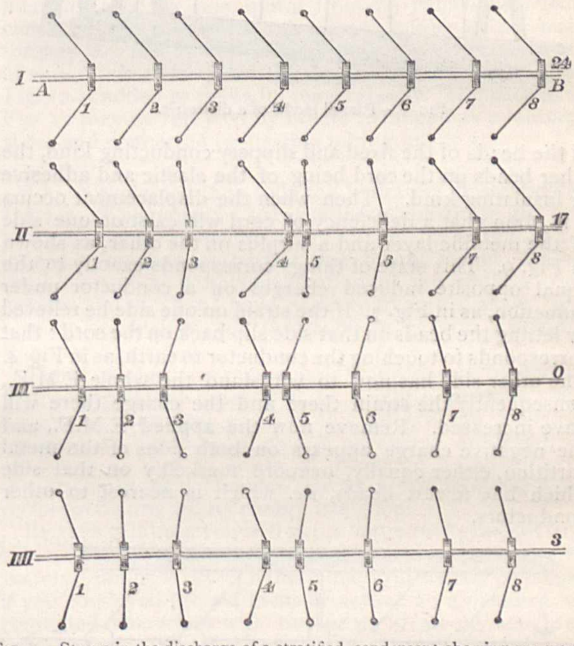


FIG 7.—Stages in the discharge of a stratified condenser; showing one way in which the phenomena of "residual charge," "internal charge," and "soaking out" are produced.

If the dielectric is at all stratified in structure, so that some of the beads allow cord to slip through them—or yield more than others—then this residual charge effect will become very prominent.

Fig. 7 illustrates the various stages of a stratified dielectric, with layers of imperfect insulating power. I. represents a recent charge, of E.M.F. 24. II. represents the same after lapse of time, reduced to 17 by partial internal leakage; and shows internal charge. The circuit itself is supposed to have been perfectly insulating all the time. III. shows the first discharge; and IIII. shows the state attained after again waiting, viz. a residual charge with an E.M.F. 3 in the old direction.

Return, however, to the simple discharge, and see how it occurs. Will it take place as a simple sliding back of the beads to their old position? Yes, if the resistance of the circuit is great, but not otherwise. If the cord is fairly free the beads will fly past their mean position, overshooting their mark, then rebound, and so, after many quick oscillations, will finally settle down in their

[1] Expansion of a lecture delivered by Dr. Oliver Lodge, partly at the London Institution on January 1, 1885, and partly at the Midland Institute, Birmingham, November 15, 1886, but not hitherto published. Continued from p. 536.

natural position. Thus is represented the fact that the discharge of a Leyden jar is in general oscillatory; the apparently single and momentary spark, when analyzed in a very rapidly rotating mirror, turning out to really consist of a series of alternating flashes rapidly succeeding one another, and all over in the hundred-thousandth of a second or thereabouts. These oscillatory currents were predicted and calculated beforehand by Sir William Thomson; they were first observed experimentally by Feddersen. The oscillations continue until the energy stored up in the strained medium has all rubbed itself down into heat.

Fig. 8 shows part of an actual model of the kind.

To make the model represent *charge by induction* all that has to be done is to immerse a conductor into the polarized dielectric—in other words, to make one or more

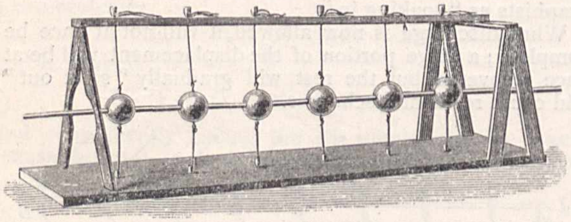


FIG. 8.—Partial model of a dielectric.

of the beads of the fixed and slippery conducting kind, the other beads on the cord being of the elastic and adhesive or insulating kind. Then when the displacement occurs it is plain that a deficiency of cord will exist on one side of the metallic layer and a surplus on the other, as shown in Fig. 9. This state of things corresponds exactly to the equal opposite induced charges on a conductor under induction, as in Fig. 3. If the strain on one side be relieved by letting the beads on that side slip back on the cord: that corresponds to touching the conductor to earth, as in Fig. 4. The other side has now to withstand the whole E.M.F., consequently the strain there and the charge there will have increased. Remove now the applied E.M.F., and the negative charge appears on both sides of the metal partition, either equally, or more markedly on that side which has fewest beads, *i.e.* which is nearest to other conductors.

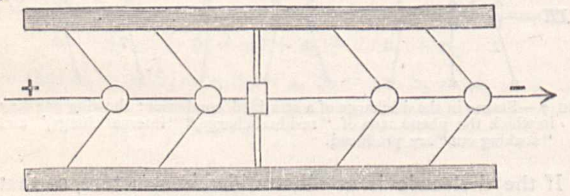


FIG. 9.—Metallic layer in the midst of a polarized dielectric, showing opposite charges "induced" on its surfaces. (Compare Fig. 3.)

Hydraulic Model of a Leyden Jar.—So much for the cord model, but I will now describe and explain an hydraulic model which illustrates the same sort of facts: some of them more plainly and directly than the cord model. Moreover, since all charging is essentially analogous to that of a Leyden jar, let us take a Leyden jar and make its hydrostatic analogue at once.

The form of jar most convenient to think of is one supported horizontally on an insulating stand, with pith ball electroscopes supplied to both inner and outer coatings.

To construct its hydraulic model, procure a thin india-rubber bag, such as are distended with gas at toy-shops; tie it over the mouth of a tube with a stop-cock, A, and insert the tube by means of a cork into a three-necked globular glass vessel or "receiver," as shown in the diagram, Fig. 10.

One of the other openings is to have another stop-cock tube, B; and the third opening is to be plugged with a cork as soon as the whole vessel, both inside and outside the bag, is completely full of water without air-bubbles.

This is the insulated Leyden jar: the bag represents the dielectric, and its inner and outer coatings are the spaces full of water.

Open gauge-tubes, *a* and *b*, must now be inserted in tubes A and B, to correspond to the electroscopes supplied to the jar; and a third bent tube, C, connecting the inner and outer coatings, will correspond to a discharger. Ordinarily, however, of course C will be shut.

A water-pump screwed on to A will represent an electric machine connected to inner coating; and the outer coating, B, should open into a tank, to represent the earth. The pump will naturally draw its supply of water from the same tank.

The bag being undistended, and the whole filled with water free from air, the level of the water in the two gauge-tubes will correspond with that in the tank; and this means that everything is at zero potential, *i.e.* the potential of the earth.

Now, C being shut, shut also B, open A, and work the pump. Instantly the level in the two gauges rises greatly and equally: you are trying to charge an insulated jar. Turn an electric machine connected to a real jar, and its two pith balls will similarly and equally rise.

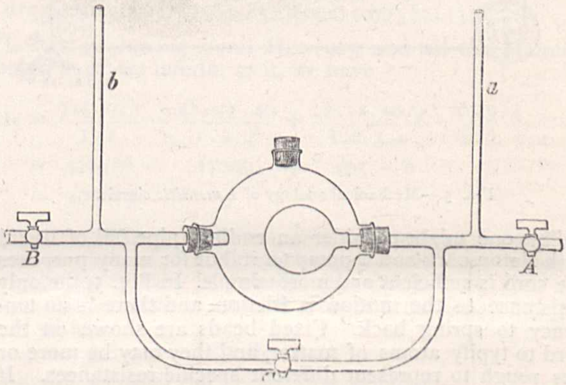


FIG. 10.—Skeleton diagram of hydraulic model of a Leyden jar.

Now open B for an instant, the pressure is relieved, and both gauges at once fall, apparently both to zero. Repeat the whole operation several times however, and it will be found that whereas *b* always falls to zero, *a* falls short of zero each time by a larger amount, and the bag is gradually becoming distended. This is *charge by alternate contact.* It may be repeated exactly with the real jar: a spark put in to the inner coating, and an equal spark withdrawn from the outer coating each time; and unless this outer spark is so withdrawn, the jar declines to charge: water (and electricity) being incompressible.

If B is left permanently open, the pump can be steadily worked, so as to distend the bag and raise the gauge *a* to its full height, *b* remaining at zero all the time, save for oscillatory disturbances.

Having got the jar charged, shut A, and remove the pump, connecting the end of A with the tank directly.

Now of course by the use of the discharger C the fluid can be transferred from inner to outer coat, the strain relieved, and the gauges equalized. But if this operation be performed while the jar is insulated, *i.e.* while A and B are both shut, the common level of the gauges after discharge is not zero, but a half-way level; and the effect of this is very noticeable if you touch an insulated Leyden jar after it has been discharged.

Instead of using the discharger C, however, we can proceed to discharge by alternate contact, and the operation is very instructive.

Start with the gauge *b* at zero, and the gauge *a* at high pressure. Open stop cock A; some water is squeezed out of inner coating, and the *a* gauge falls to zero, but the suck of the contracting bag on the outer coat pulls down

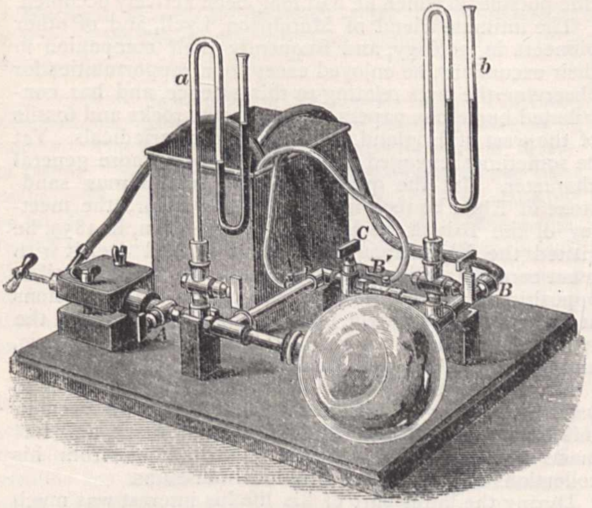


FIG. 11.—First actually constructed model Leyden jar, with mercury gauges for electrometers; the whole rigged up with things purchasable at a plumber's, except the pump.

the gauge *b below* zero, the descent of the two gauges being nearly equal.

Next shut A and open B; a little water flows in from

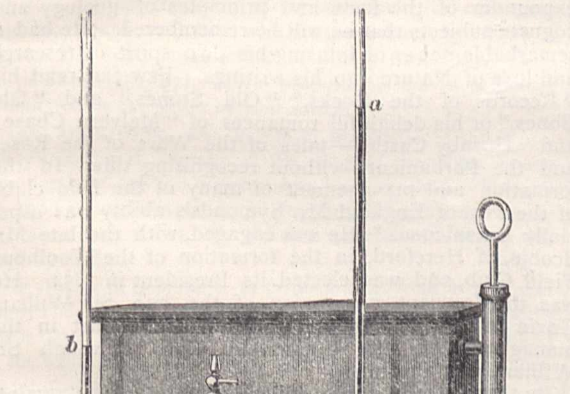


FIG. 12.—Latest form of hydraulic model of a Leyden jar with water gauges, the whole arranged vertically to be more conspicuous. The pump is a force-pump with a communication between top of barrel and tank to get rid of stray water.

the tank to still further relieve the strain of the bag, and both gauges rise; *b* to zero, *a* to something just short of its old position.

Now shut B and open A again: again the two gauges descend. Reverse the taps, and again they both rise; and so on until the bag has recovered its normal size. This is discharge by alternate contact, and exactly imitates the behaviour of an insulated charged Leyden jar whose inner and outer coats are alternately touched to earth. Its pith balls alternately rise with positive and with negative electricity, indicating potentials above and below zero.

Figs. 11 and 12 are taken from photographs of apparatus I have made to use as just described. The glass globe with the partially distended bag inside it, the pump, the tank, the gauges *a* and *b*, the stop-cocks A B C, will be easily recognized. Two extra stop-cocks, A′ and B′, leading direct to tank, are extra, and are to save having to disconnect pump and connect A direct, when exhibiting the effect of "discharge by alternate contact." But the tank is not sufficiently tall in Fig. 12; I have doubled its height since. The full height of the gauge-tubes is barely shown.

In any form of apparatus it is essential to fill the whole with water—pipes, globe, everything—before commencing to draw any moral from its behaviour. It is rather difficult to get rid of a large bubble of air from the top of the globe of Fig. 11, and though it is not of very much consequence in this place, the stop-cock in Fig. 12 is added to make its removal easy. The gauges in Fig. 11 may be replaced by others arranged as a lantern-slide, and connected by flexible tubing full of air.

I have explained thus fully the hydraulic illustration of Leyden jar phenomena, because these constitute the key to a great part of electrostatics. The illustration is not indeed a complete or perfect one by any means, but by combining with it a consideration of the endless cord models, and of what I have endeavoured to explain concerning conduction and insulation in general, a distinct step may be gained.

Think of electrical phenomena as produced by an all-permeating liquid embedded in a jelly; think of conductors as holes and pipes in this jelly, of an electrical machine as a pump, of charge as excess or defect, of attraction as due to strain, of discharge as bursting, of the discharge of a Leyden jar as a springing back or recoil oscillating till its energy has gone.

By thus thinking you will get a more real grasp of the subject and insight into the actual processes occurring in Nature—unknown though these may still strictly be—than if you employed the old ideas of action at a distance, or contented yourselves with no theory at all on which to link the facts. You will have made a step in the direction of the truth, but I must beg you to understand that it is only a step, that what modifications and additions will have to be made to it before it becomes a complete theory of electricity I am wholly unable to tell you. I am convinced they will be many, but I am also convinced that it is unwise to drift along among a host of complicated phenomena without guide other than that afforded by hard and rigid mathematical equations.

The mathematical theory of potential and the like has insured safe and certain progress, and enables mathematicians to dispense for the time being with theories of electricity and with mental imagery. Few, however, are the minds strong enough thus to dispense with all but the most formal and severe of mental aids: and none, I believe, to whom some mental picture of the actual processes would not be a help if it were safely available.

Such a representation I have endeavoured partially to lay before you to-night, and I hope, if I have succeeded in making myself at all intelligible, that those students of electricity who may be present will find it of some use and service. O. J. LODGE.

(*To be continued.*)

NEW FORM OF CONSTRUCTION OF OBJECT-GLASSES INTENDED FOR STELLAR PHOTOGRAPHY.

THE interest now generally taken in stellar photography will probably make it desirable that the object-glasses of telescopes ordinarily used for visual purposes should be so constructed as to be readily adapted to photographic use. As now commonly made, the correction for chromatic aberration by means of the flint-glass lens of a refracting telescope is too great to give satisfactory photographic images. The method of adapting such a telescope to photographic purposes which was employed by Mr. Rutherford, and more recently in the case of the great telescope of the Lick Observatory, is to provide an additional convex lens of long focus which may be mounted when photographs are to be taken, and removed when direct observation is desired. The objections to this method are the expense of the additional lens and the introduction of two more surfaces.

Another way of removing the excessive correction for chromatic aberration is to separate the flint- and crown-glass lenses, and to place the flint nearer the eye-piece. But when this is done, while the correction for colour becomes satisfactory, the spherical aberration is only partially corrected, the focal length of the central part of the object-glass being greater than that of the surrounding portions. This difficulty, however, may be surmounted by giving different curves to the two surfaces of the crown-glass lens, and reversing it when the lenses are separated.

In an object-glass of this construction, when used for direct observation, the two lenses are in contact, with the more convex side of the crown lens next the flint. For photographic use, the lenses are separated, and the more convex side of the crown-glass lens is turned outwards. In order to determine whether this principle of construction should be adopted in the case of a large object-glass to be made for experimental work undertaken with the aid of the Boyden Fund, recently transferred to the Observatory of Harvard College, for the purpose of obtaining astronomical observations at elevated stations, a small object-glass was made upon the new plan by Messrs. Alvan Clark and Sons. As this object-glass proved to be well adapted to its purpose, the larger object-glass above mentioned has been similarly constructed by the same makers; its aperture is 13 inches, and its focal length about 180 inches. Upon trial, it is found that the images formed by this object-glass are excellent when the instrument is used for direct observation, and that the photographic images are equally good when the lenses are separated 3 inches and the crown-glass reversed.

The curvature given to the surfaces of such an object-glass will depend upon the quality of the glass employed; in this particular instrument the radius of curvature for the less convex side of the crown-glass is 86 inches; for the more convex side, 77 inches; for the concave side of the flint, 73·8 inches; the side of the flint-glass which is turned towards the eye-piece is convex, and its radius of curvature is 1020 inches.

EDWARD C. PICKERING.

Harvard College Observatory, Cambridge, U.S., September 29.

WILLIAM S. SYMONDS.

WE have already announced the death, on September 15, at Cheltenham, of the Rev. William S. Symonds, Rector of Pendock, F.G.S., and a J.P. for the county of Worcestershire. Mr. Symonds, the eldest son of Mr. William Symonds, of Elsdon, Hereford, was born in Hereford in 1818, took his degree at Christ's College, Cambridge, in 1842, and in 1868 was presented to the Rectory of Pendock.

For several years past Mr. Symonds had suffered from heart-disease, and was compelled to withdraw from his parish duties, as well as from participation in those scientific pursuits in which he had long been actively occupied.

The intimate friend of Murchison, Lyell, and of other pioneers in geology, and frequently their companion in their excursions, he enjoyed exceptional opportunities for observing the facts relating to this science, and has contributed numerous papers, chiefly on the rocks and fossils of the west of England, to the scientific periodicals. Yet he sometimes engaged in discussions of a more general character. In the question of the reptiliferous sandstone of Elgin he took much interest. Before the meeting of the British Association at Aberdeen, in 1859, he visited the Elgin area, and, having worked over it with great care, was led to accept the views of Sir C. Lyell in opposition to those of Murchison; and in the discussions at the meeting strongly insisted on the view that the reptiliferous sandstones are of the New Red or Triassic, and not of the Old Red Sandstone age.

Mr. Symonds did not devote as much attention to palæontology as to physical geology, although even in this branch of the science he has left his mark, and has made numerous and valuable contributions from his collections of fossils to several local museums.

During the latter part of his life his interest was much concentrated on the phenomena of the glacial drifts, and the question of the antiquity of prehistoric man. In 1871 he communicated to the *Geological Magazine* (p. 433) a paper on the great Doward Caves, and in his "Severn Straits, or, Notes on Glacial Drifts," he gives his conclusions on this subject.

But it is perhaps chiefly as an earnest and eloquent expounder of the facts and principles of geology and cognate subjects that he will be remembered. He had a remarkable power of infusing his own spirit of research and love of Nature into his writings. Few can read his "Records of the Rocks," "Old Stones," and "Old Bones," or his delightful romances of "Malvern Chase" and "Hornby Castle"—tales of the Wars of the Roses and the Parliament—without recognizing this. In the formation and management of many of the field clubs of the west of England Mr. Symonds's ability was especially conspicuous. He was engaged, with the late Mr. Scobie, of Hereford, in the formation of the Woolhope Field Club, and was elected its President in 1854. He was the frequent companion of the late Sir William Govin in his travels, and took an active part in the management of the Cotteswold Club, of which Sir William was President.

By those who had the privilege of an intimate acquaintance with Mr. Symonds, he will ever be thought of and respected as an earnest and most uncompromising seeker after truth for its own sake. He considered that man is performing a most religious duty when he sits as a humble student at the feet of Nature to learn, as far as may be, the lessons which Nature's Creator would teach him. It was a faith, too, which, throughout the trying and painful complaint that clouded the last days of his life, never failed him, and which enabled him to look forward to, and speak of, the great change which was before him, with cheerful hope.

The number of papers which Mr. Symonds has from time to time contributed to various scientific journals appears to have been over forty.

NOTES.

WE reprint to-day from the *Times* an admirable letter by Mr. Samuel Smith on education in Germany. Mr. Smith gives a clear account of some important elements of the educational system which the Germans are gradually bringing to perfection;

and no one who reads what he has to say will be surprised that in many departments of industry our manufacturers are being surpassed by their Teutonic rivals. The letter contains nothing new; but the essential facts connected with this vital subject cannot be too often pressed on the attention of the public.

WE regret to announce the death of Mr. Joseph Baxendell, F.R.S., of the Observatory, Birkdale, Southport. He died at the age of seventy-two.

ACCORDING to a report which appears in the *Mouvement Géographique*, Kilimanjaro has at last been ascended to its summit. This has been done by a German traveller, M. Meyer, of Leipzig. We know that the mountain presents two great peaks:—Kimawenzi, 4973 metres in height, and Kibo, estimated by Mr. H. H. Johnston at 5745 metres. Mr. Johnston succeeded in ascending the latter to a height of 4950 metres. M. Meyer, it is stated, has succeeded in reaching the crater summit of Kibo, which he estimates at 6000 metres. Before giving absolute credence to these statements, it will be well to await the publication of details by M. Meyer.

IN an interesting article in the *Times* on Monday, on "The British Race-Types of To-day," it was stated that "for a generation or more the advocates of the view that the English are almost unmixed Teutons pressed their ideas upon the scientific and literary world with a persistence and learning which went far to produce conviction." Prof. Huxley, writing to the *Times* about this statement, maintains that, whatever may have been the case with "the literary world," scientific anthropologists were never misled by the "persistence and learning" of those who contended that the English are of almost purely Teutonic origin. "A score of years ago," says Prof. Huxley, "this question was hotly debated; and I do not think that, at that time, any of my anthropological colleagues would have found much fault with the propositions laid down in a paper 'On some Fixed Points of British Ethnology,' which was published in 1871, which propositions are in substance corroborated by the writer of your article."

CAPT. DICKINSON, who has been in charge of the Royal Society's boring at Zagazig, in the delta of the Nile, reports that a depth of 308 feet 6 inches has been reached. The soil from 190 feet has been sand, varying in coarseness, and sometimes mixed with stones. At 308 feet, 4 inches of blue clay was passed through.

THE *Nation* of September 22 prints a letter from Miss Mabel Loomis Todd on the Eclipse Expedition in Japan. Miss Todd's letter is dated Shirakawa, Japan, August 20. We regret to find that the weather was not more favourable for observers in Japan than for observers in Russia and Germany.

WE have received the fourth volume of the Proceedings and Transactions of the Royal Society of Canada. It contains the Proceedings and Transactions during the year 1886. Most of the papers are in English, but some are in French. Among the more important papers we may note "The Right Hand and Left-handedness," and "The Lost Atlantis," by Dr. Daniel Wilson; "The Genetic History of Crystalline Rocks," and "Supplement to 'A Natural System in Mineralogy,' &c.," by Dr. T. Sterry Hunt; "Some Points in which American Geological Science is indebted to Canada," and "On the Fossil Plants of the Laramie Formation of Canada," by Sir J. William Dawson; and "On certain Borings in Manitoba and the North-West Territory," by Dr. Geo. M. Dawson.

The October Bulletin of Miscellaneous Information, issued from the Royal Gardens, Kew, presents the results of a careful inquiry made by Mr. Arthur Shipley, under the auspices of the Royal Gardens, into a disease affecting the onion crop at the Bermudas. Mr. Shipley shows that the disease is caused by a fungus, *Peronospora Schleideniana*, which lives parasitically upon the leaf of the onion plant; and that the atmospheric conditions which favour the progress of the disease are heavy dews or rains, followed by warm, moist, calm weather, and the absence of direct sunshine and cold winds. In favourable weather the progress of the disease is very rapid. The fungus lives in the tissues of the leaf, choking up the air-passages and absorbing the nutritive fluid formed in the cells. Its stem protrudes through the stomata of the leaf into the air. Its branches bear spores at their tips. The reproduction of the fungus is effected by means of these spores, which float about through the air, and also by means of certain special cells formed by the fungus and known as resting-spores. These pass the winter in the earth, and are capable of retaining the power of germination for two or three years. It is by their means that the disease is carried on from one season to another. Mr. Shipley offers various practical suggestions, which will no doubt be of considerable service to cultivators.

DR. SCHWEINFURTH, in co-operation with Prof. Ratzel, is about to publish through Brockhaus, of Leipzig, a collection of all the letters and other writings of Emin Pasha. Dr. Junker also, in association with M. Richard Buchta, who visited the Upper Nile region some years ago, is about to issue a work dealing with the events of recent years in the Soudan. The volume will be illustrated with two maps, and have portraits of Gordon, Emin, Gessi, Lupton, and Slattin. Dr. Junker has just finished his work of preparing at Gotha the great map of his explorations in the basin of the Wellé and the region of the Upper Nile. It has been drawn by Dr. Hassenstein in four sheets, which will appear in the beginning of next year in a supplemental part of *Petermann's Mitteilungen*.

AN elaborate work on palæontology ("Handbuch der Palæontologie") is being issued at Munich and Leipzig by R. Oldenbourg. The editor is Prof. Karl A. Zittel, of Munich, who is aided by Dr. A. Schenck, of Leipzig, and Mr. S. H. Scudder, of Boston. The work is divided into two parts, in the first of which palæontology is dealt with; in the second, palæophytology. The first part, when completed, will occupy three volumes; the second, one. The first two volumes have been published, and we have just received the first "Lieferung" of the third volume. The subject of this "Lieferung" (illustrated by 266 woodcuts) is "Vertebrata: Pisces." The subjects of the later "Lieferungen" of the same volume will be "Vertebrata: Amphibia, Reptilia, Aves, Mammalia." We may mention that a French translation, by Dr. Charles Barrois, is issued simultaneously with the original German work.

A WORK on "The Cultivated Oranges and Lemons, &c., of India and Ceylon," by Brigade-Surgeon E. Bonavia, M.D., of the Indian Medical Department, is about to be issued. The writer's object is mainly practical and economical, but he deals also with some questions of purely scientific interest. His researches have brought him into contact with every variety of Citrus in India and Ceylon, and he claims that he has been able to dispose of, or at any rate to throw new light on, certain disputed points, both botanical and historical, in connexion with this genus. The book will be accompanied by an atlas in foolscap size, consisting of 259 plates of outline drawings of all the varieties of Citrus to be found in India and Ceylon.

MESSRS. DULAU AND CO. have now ready for publication "A Chapter in the History of Meteorites," by the late Dr. Walter Flight, F.R.S.

A THIRD edition of "Weather Charts and Storm Warnings," by Mr. R. H. Scott, F.R.S., has just been issued. The writer's object in preparing the work was to convey some idea of the state of weather knowledge, so that readers might understand what was to be learned from a careful study of the weather charts in the newspapers and of the remarks appended to them.

The second edition has long been out of print. In the present edition the entire text has been revised, and some new chapters have been added, mainly relating to changes and improvements in the Meteorological Office work since the year 1876.

MESSRS. DE LA RUE AND CO. will publish shortly the second volume of "A Treatise on Electricity and Magnetism (Methods of Measurement and Applications)," by E. Mascart, Professor in the Collège de France, and Director of the Central Meteorological Bureau, and J. Joubert, Professor in the Collège Rollin. The work is translated by Dr. E. Atkinson, Professor of Experimental Science in the Staff College.

MESSRS. MACMILLAN will shortly publish a new edition of Huxley and Martin's well-known "Manual of Elementary Biology," considerably revised and extended by Messrs. Howes and Scott, Assistant Professors in the Normal School of Science and Royal School of Mines. To the new volume Prof. Huxley will contribute a preface.

A NEW way of utilizing dynamite has been lately devised by a French military engineer, M. Bonnetond. He uses the expansive force to drive out, for a brief period, the water from portions of wet ground in which foundations are to be made. The method is now in practice in the construction of a fortified *enceinte* at Lyons. A hole is first bored 10 or 12 feet deep, and about 1½ inch wide, in the wet ground. Into this is passed a string of cartridges of dynamite, which is then exploded. The water is thus driven far out beyond the sides of the cavity, over a yard wide, which is produced, and it does not reappear till after half an hour at least. The workmen thus have time to clear the cavity and introduce quickly-setting concrete. When the water returns it cannot injure the foundation. A rapid rate of progress is realized by this method.

A RECENT number of *La Nature* (September 17) has an illustrated account of a steam tricycle contrived by MM. Roger de Montais and L'Héritier, which will go 16 to 18 kilometres an hour with one person, and 14 to 16 with two. In front is a small boiler heated by petroleum, which gives off, it is said, no smoke nor smell, nor unpleasant heat. Under the seat is the petroleum reservoir, holding ten litres, enough to last ten hours, and behind is a water reservoir which holds thirty-four litres, allowing a two and a half hours' run without fresh supply. This water reservoir has one compartment for cold water, and another for water constantly heated by escape of steam; the latter feeding the vertical engine behind, and the former having steam turned into it at will.

IN a new galvanic battery, described by Herr Friedrichs in *Wiedemann's Annalen* (No. 9), a series of inverted bottle-shaped vessels have their necks connected by means of a horizontal tube, into which the exciting liquid (say dilute sulphuric acid and bichromate of potash) flows through a flexible tube from the lower part of a jar, which is raised or lowered to fill or empty the vessels. The liquid can also be let off through a cock at the further end of the connecting tube.

THE various Transatlantic and British fish hatched out this year by the National Fish Culture Association have prospered remarkably well at the establishment at Delaford Park. Some of the Californian rainbow-trout have grown to the extent of 4 inches, and the *S. fontinalis* produced from ova taken from two-year-old fish in the ponds have thriven in a similar manner. The landlocked salmon (*S. sebago*), despite their partiality to deep waters, are also doing well. The whitefish (*Coregonus albus*) have attained a length of 4 inches, and appear to be thriving better this year in consequence of their habitat having been deepened to suit their natural necessities. The cultivation of coarse fish is proceeding, a large quantity of fry bred from German carp being now in the ponds, besides other species.

AT the request of the Austrian Minister for Agriculture, Herr Putik has recently investigated the hydrography of Central Carniola, and given special attention to the Zirknitzer Lake. The phenomena of the periodical emptying and filling of this lake are very extraordinary; a gigantic cave, called Gilovca or Karlovca by the natives, and situated at the north-west corner of the lake, near Niederndorf, forms an outlet for the overflow. This cave lies at the foot of perpendicular rocks, and leads to a number of subterranean lakes, five of which Herr Putik has crossed. He is convinced that there are a great many more of these lakes.

IN the spring of 1885 a Society was founded in Hamburg for the establishment of plantations in Cameroon. Some 30,000 cocoa shrubs were planted, which are now 3½ to 4 feet high, and this year 40,000 more have been added.

ON Monday evenings in Michaelmas Term a course of lectures on "Climate and Weather" will be delivered by Mr. A. W. Clayden, at the City of London College, White Street, Moorfields, E.C. The lectures will be delivered in connection with the London Society for the Extension of University Teaching, and under the auspices of the Mitchell (City of London) Trustees.

A CORRESPONDENT of the *Indian Forester* communicates the following account of "a real weeping tree" to that periodical:—"On my way to and from the Mussoorie Library I have noticed for some days a small pool of water in the middle of the road just above 'Auchnagie.' It struck me as being something singular; and to-day when passing I noticed several drops of water fall into it; on looking up I saw that it was the sap from a branch high up on a tree that was falling into it; the drops were large and were falling at the rate of one a second. I afterwards noticed several other trees of the same kind on the roadside dropping sap from their branches in the same way. The tree is a large one, called by the natives Kágashi (*Cornus macrophylla ?*). In the spring, if the bark of this tree is wounded by an axe, the sap runs out of the wound in a great stream; some of it solidifies into a thick mucilage of a bright orange colour; it was from a broken branch that the sap was coming, broken most likely by the heavy fall of snow we had at the end of January. These trees are just bursting into leaf, but they have been weeping for the last ten days at least."

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus* ♀) from India, presented by Mr. H. R. Sherren; a Leopard (*Felis pardus*) from Ceylon, presented by Mr. W. Mauger; a Guilding's Amazon (*Chrysotis guildingi*) from St. Vincent, West Indies, presented by Mrs. Ellice; a Pheasant (*Phasianus colchicus*), British, presented by Mr. A. L. Sawer; a Common Toad (*Bufo vulgaris*) from Gloucestershire, presented by Mr. John Scovell; a Chinchilla (*Chinchilla lanigera*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

PROPER MOTION OF LL 26481.—Mr. John Tebbutt (*Observatory*, 1887, October, p. 360), having found a considerable discordance between the places given for this star by Lalande and Lamont, asked Mr. Lenehan, the acting Government Astronomer at Sydney, to observe the star with the transit-circle of that Observatory. The result of his observations, as will be seen, shows that the star has a large proper motion in both elements:—

		Mean R.A. 1886·0.		Mean N.P.D. 1886·0.
		h. m. s.		° ′ ″
Lalande 1800	...	14 25 1·06	...	105 6 33·4
Lamont 1850	...	14 25 2·17	...	105 6 56·6
Lenehan 1887	...	14 25 2·67	...	105 7 14·2

THE WASHBURN OBSERVATORY.—The fifth volume of the Publications of the Washburn Observatory of the University of

Wisconsin, containing the record of the work done during the year and quarter ending April 1887, has recently been published. Pending the appointment of a successor to Prof. Holden, who resigned his position as Director of the Observatory in the winter of 1885, to assume the direction of the Lick Observatory, Dr. Davies, Professor of Physics in the University of Wisconsin, has had general charge of the Observatory, to which of course he has been able to devote only a limited amount of time and attention. It is no doubt owing to this circumstance that no very definite programme of work has been carried out since the completion of the observations and reductions necessary for clearing off the list of 303 fundamental stars undertaken by Prof. Holden for the *Astronomische Gesellschaft*. The assistants, Mr. Updegraff and Miss Lamb, have been principally employed in observations of fundamental stars for determination of latitude and discussion of the instrumental errors of the meridian-circle and of refraction. The large equatorial has been used for measures of double stars, observations of Sappho and of Comet *b* 1887 (Brooks). A considerable portion of the volume is devoted to an index of the stars occurring in Airy's Greenwich Catalogues, not found in Flamsteed, which has been prepared by Miss Lamb. This index, which will be very useful to practical astronomers, has been prepared according to the general plan suggested by Argelander in his review of the Greenwich second seven-year Catalogue (*Vierteljahrsschrift*, Bd. vi. Heft 2), and contains some 3000 entries. The computer is thus saved the labour of looking through all six catalogues when searching for a star which is tolerably sure to be in one of them, and as the catalogues are reduced to six different epochs, the labour attending such a search would be considerable. The star places in Miss Lamb's index are reduced to 1875·0.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 *OCTOBER* 16–22.

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

At Greenwich on October 16

Sun rises, 6h. 27m.; souths, 11h. 45m. 39·0s.; sets, 17h. 4m.; decl. on meridian, 8° 52′ S.: Sidereal Time at Sunset, 18h. 44m.

Moon (New on October 16, 23h.) rises, 5h. 22m.; souths, 11h. 27m.; sets, 17h. 21m.; decl. on meridian, 2° 20′ S.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Decl. on meridian. ° ′
Mercury ...	8 41 ...	13 7 ...	17 33 ...	18 17 S.
Venus	3 37 ...	9 40 ...	15 43 ...	0 9 S.
Mars	1 28 ...	8 36 ...	15 44 ...	12 24 N.
Jupiter... ...	8 8 ...	12 57 ...	17 46 ...	14 21 S.
Saturn... ...	23 6* ...	6 54 ...	14 42 ...	19 10 N.

* Indicates that the rising is that of the preceding evening.

Oct.	h.	
18 ...	1 ...	Jupiter in conjunction with and 4° 19′ south of the Moon.
18 ...	9 ...	Mercury in conjunction with and 7° 39′ south of the Moon.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·3 ...	81 16 N. ..	Oct. 18,	4 11	*m*
Algol	3 0·8 ...	40 31 N. ...	,, 21,	5 43	*m*
ζ Geminorum ...	6 57·4 ...	20 44 N. ...	,, 20,	0 0	*M*
U Monocerotis ...	7 25·4 ...	9 33 S. ...	,, 16,		*m*
U Coronæ	15 13·6 ...	32 4 N. ...	,, 17,	4 15	*m*
R Scorpii	16 10·9 ...	22 40 S. ...	,, 20,		*M*
U Ophiuchi... ...	17 10·8 ...	1 20 N. ...	,, 17,	3 57	*m*
		and at intervals of		20 8	
X Sagittarii... ...	17 40·5 ...	27 47 S. ..	Oct. 20,	0 0	*m*
W Sagittarii ...	17 57·8 ...	29 35 S. ...	,, 17,	0 0	*m*
T Herculis	18 4·8 ...	31 0 N. ...	,, 19,		*m*
β Lyræ...	18 45·9 ...	33 14 N. ...	,, 21,	0 0	m_2
R Lyræ	18 51·9 ...	43 48 N. ...	,, 16,		*m*
η Aquilæ	19 46·7 ...	0 43 N. ...	,, 20,	1 0	*m*
R Sagittæ	20 8·9 ...	16 23 N. ...	,, 16,		*m*
S Delphini	20 37·9 ...	16 41 N. ...	,, 17,		*m*
T Aquarii	20 44·0 ...	5 34 S. ...	,, 17,		*m*
δ Cephei	22 25·0 ...	57 50 N. ...	,, 18,	1 0	*m*

M signifies maximum; *m* minimum; m_2 secondary minimum.

Meteor-Showers.

	R.A. °	Decl. °	
Near ξ′ Ceti	31 ...	8 N. ...	Slow; with trains.
,, ν Orionis... ...	90 ...	15 N. ...	Swift; streaks.
,, δ Geminorum ...	108 ...	23 N. ...	Swift; streaks.
,, κ Cephei	308 ...	78 N. ...	Slow; faint.

METEOROLOGICAL NOTES.

WE have just received the "Results of Meteorological and Magnetical Observations" made at Stonyhurst College during 1886, which maintains well the high character of previous issues. Pressure, at a height of 381 feet, fell, on December 8, to 27·350 inches, being absolutely the lowest hitherto noted at Stonyhurst. On the other hand, no excessively high readings occurred during the year, the maximum of each month being in each case topped by higher readings in previous years. For eight of the months temperature was under the normal, the deficiency being, in February, 5°·2; December, 4°·4; January, 3°·4; and March, 2°·3; and for the year, 1°·5. In October, temperature was 2°·9 above the average of the month. The annual rainfall was 5·18 inches above the mean, a result largely due to the heavy rains of January and May; but in February and August the fall was much less than usual. The actual sunshine for the year was 30 per cent. of the possible sunshine, the highest monthly percentage being 40 in April, and the lowest 20 in January. The maximum sunshine for the day occurs from 10 a.m. to 3 p.m., the absolutely highest hour being from 1 to 2 p.m. Among the more special meteorological work undertaken by the College are observations of cirrus clouds, upper glows, and trees, shrubs, and flowering plants. For the fourth year an appendix is given, exhibiting with some fullness the results of the observations made at St. Ignatius's College, Malta, by the Rev. J. Scholes.

THE Meteorological Commission of Cape Colony have published their Report for the year 1886, containing summaries of observations taken at 28 stations, and rainfall observations at 268 stations, including 3 in Basutoland and 11 in Orange Free State. At the Royal Observatory the absolute maximum temperature in a Glaisher stand was 104°·0 in January, and the minimum 34°·5 in August. In a Stevenson screen the maximum was 101°·0, and the minimum 35°·0 (in July), plainly showing the effect of radiation on the former readings. The total rainfall measured on 77 days was 27·79 inches, of which 7·68 inches fell in June. Self-recording anemometers are erected at the Royal Observatory, Port Elizabeth, and East London, but no arrangements are made for reducing the curves. The Commission draw special attention to the interesting series of thirteen rainfall maps appended to the Report. These have been reduced from maps exhibited by Mr. Gamble at the Indian and Colonial Exhibition, and represent the average rainfall of the colony for each month and for the whole year.

IN the *Annalen der Hydrographie und maritimen Meteorologie* for September, Capt. D. Ruete gives the results of eighteen years' experience of the typhoons of the China seas, accompanied by rules for manœuvring in different cases, and by charts of the tracks of the typhoons in various seasons. The distinguishing features of the typhoon are its small diameter and its sharply-defined central calm, as compared with ordinary rotatory storms. They occur most frequently in August and September, less frequently in July and October, and more rarely still in May, June, and November. They do not extend into the higher regions of the atmosphere; Knipping assumed a height of four nautical miles for the severe September typhoon of 1878. Their form is generally oval, but dependent on the contour of the coasts. The author finds that they travel slower when south of 30° N. than they do when north of that position, and that the faster they travel and the greater the area of the storm field, the more severe the typhoons are, and that the duration of the fall of the barometer gives no clue to the magnitude of the area of the storm, and further, that an approaching typhoon is shown less by the amount of the fall than by the general behaviour of the instrument. The regions most frequented by the typhoons extend from lat. 10° N. to 38° N. in the China seas, and to 50° N. in the Japan seas, and may be divided into four different seasons and districts, which are separately discussed in the paper.

At the meeting of the International Meteorological Committee at Paris in 1885, Dr. H. Wild, of St. Petersburg, and Prof. E. Mascart, of Paris, were requested to take the initiative in the publication of a series of international meteorological tables, to allow of a uniform method of reduction of the observations being everywhere carried out, and a specimen has now been printed and issued for criticisms. The work contains (1) a description of the tables and of their use, in English, French, and German; (2) equivalents of various units, and general tables used by different countries for meteorology, magnetism and electricity. The volume will occupy nearly 440 pages quarto, and will cost about 30*s*. The Committee request each country to contribute to the expense of publication by subscribing for a certain number of copies.

We have received the results of meteorological observations made in New South Wales during 1885, under the direction of H. C. Russell, B.A., F.R.S., the Government Astronomer, forming a compact octavo volume of 360 pages, with plates of meteorological curves for each month. The great increase in the number of rainfall and river stations has made it necessary to publish these observations in a separate volume. Some important additions have been made to the information given in past years, and the barometric curves have been so arranged as to show the various changes through all the stations at one view. The tables show (1) the most important data for the whole colony; (2) the data for each station separately; (3) the barometric curves; and (4) the monthly abstracts published during the year. Considerable attention has been paid to the amount of evaporation in various parts of the colony, and the quantities for some districts are found to be much below what has often been stated, depending very much upon the state of the soil. The year 1885 was one of serious drought, although the total rainfall for the year was only 10 per cent. below the average, owing to heavy rainstorms at the end of January. The total rainfall at Sydney was 39·78 inches measured on 145 days. The greatest fall was in June, and the least in August. The mean temperature for the year was 63°·9. The maximum in the shade was 97°·6 on November 5, and the minimum 40°·6 on June 30. The mean temperature of the whole colony for 1885 was 63°·0, or 1°·7 in excess of the mean for 15 years. The absence of cloud, and the drought, have had a decided effect upon the temperature of the whole colony, showing apparently a direct relation between rainfall and temperature.

THE PROBLEM OF THE HOP PLANT LOUSE (PHORODON HUMULI, Schrank) *IN EUROPE AND AMERICA.*[1]

The author has been for several years carrying on investigations with a view of ascertaining the full annual life-history of *Phorodon humuli*, and especially with a view of settling the hitherto moot question as to its winter life. The importance of the inquiry, both from the economic and the scientific sides, is self-evident. The hop crop, in all parts of Europe where it is grown, and especially in England, annually suffers more or less from the ravages of this its worst insect enemy, and in some years is a total failure. The same is true in North America, at least east of the Rocky Mountains, and last year the injuries of this Phorodon in the hop-growing regions of the State of New York were so great that many hop yards were abandoned and have since been ploughed up; while but 10 per cent. of an average crop was harvested. From the purely scientific side, entomologists, notwithstanding the great interest attaching to the subject, have been divided in opinion as to the identity, or specific relationship, of the hop Phorodon and one that occurs on Prunus, while the complete annual cycle of the insect's life has remained a mystery. After full and satisfactory investigations I have satisfied myself that, contrary to the prevailing impression among hop growers and previous investigators, the hop plant louse does not hibernate underground on the roots of the hop, nor in, on, or about anything in the hop yard; but that, upon the advent of the first severe frosts, the hop plant and the hop yards are entirely cleared of the species in any form. I find that all statements to the contrary in America are based on misapprehension, or mistaken identity of species, and I believe (though admitting the possibility of variation in this respect in milder climates) that the same will be found to hold true in England, where hibernation on the hop root has been accepted by high authority. The positive statements made about eggs being laid in autumn, whether on roots or upon the vines left in cutting, or which are carted away, are based on conjecture, and have been blindly copied without credit by one writer from another, a practice too common among second-hand writers on economic entomology.

The conjectures of some of the best students of aphidology that *Phorodon humuli* had a form (*malaheb*, Fonsc.) living on Prunus, and that there was a consequent migration from one plant to the other, I have positively proved to be correct, by direct colonizing from Prunus to Humulus, and by continuous rearing from the original stem-mother hatched from the winter egg.

The observations have been made on growing plants and in vivaria at Washington, and checked by others made simultaneously in hop yards at Richfield Springs, N.Y. An incident may here be recorded as illustrating the effect of meteorological extremes upon Aphides. The extreme heat (over 100° F.) and dryness of July 17 and 18 killed every one of the insects under observation at Washington, entirely clearing the plants. The economic bearing of such exceptional phenomena, as also of the biological observations made, is readily understood.

The more important conclusions from the studies so far made are thus summed up in a paper which I had the honour to read before the American Association at its recent meeting in New York:—

(1) *Phorodon humuli* hibernates in the winter egg state, this egg being fastened to the twigs (generally the previous year's growth) of different varieties and species of Prunus, both wild and cultivated. The egg is difficult to detect, because it is covered with particles which resemble the bark in colour and appearance. It is usually laid singly, and when freed of disguising particles is seen to be ovoid and 0·04 mm. long.

(2) The annual life-cycle is begun upon Prunus by the stem-mother, which hatches from this winter egg. The stem-mother is stouter than the individuals of any of the other generations, with the legs, antennæ, and honey-tubes relatively shorter, while the cornicles between the antennæ are sub-obsolete. The colour is uniform pale green, with bright red eyes and faintly dusky tarsi.

(3) Three parthenogenetic generations are produced upon Prunus, the second at once distinguished by its more elongate form, much longer members, distinct cornicles and markings of darker green; while the third (or typical *malaheb* form) becomes winged, and instinctively abandons the plum and migrates to Humulus. The habit of moving from plant to plant after giving birth to an individual, and thus scattering the germs of infection on Humulus, is well marked in this winged generation.

(4) During the development of the three plum-feeding generations, the hop is always free, and subsequently, until the return migration, the plum becomes more or less fully free from infection by this species.

(5) A number of parthenogenetic wingless generations are produced on the hop (seven, or the tenth from the stem-mother on plum, having been traced up to August 5, and advices of the eleventh, up to August 19, have been received since my arrival in England); and, finally, there is a return migration of winged females to the plum in autumn. The wingless hop generations are not only incapable of migrating to the plum, but do not thrive upon it when artificially transferred thereto.

(6) Exact observations are not yet complete as to the full number of generations produced upon the hop before the winged return migrant appears, and another month's careful watching and experiment is needed to fill this hiatus in the annual cycle, as also to ascertain the exact number of generations produced in autumn on the plum. From knowledge extant and previous general observation, the facts will probably prove to be as follows:—

(7) The eleventh or twelfth generation will produce winged females (from the middle to the end of August), which will deposit their young upon the plum, and these will become the only sexed individuals of the year, the male winged and the female wingless, the latter after coition consigning a few impregnated or winter eggs to the twigs.

(8) Up to August 5 the first females on hop were still alive and breeding, having existed two months. There is, consequently, an increasing admixture of generations from the first

[1] Abstract of a Paper read before Section D of the British Association for the Advancement of Science, at Manchester, by Prof. C. V. Riley, on September 3.

on hop until frost overtakes the species in all conditions and sweeps from the hop yards all individuals alike, perpetuating in the egg state those only which reached the sexual condition on the plum.

(9) Each parthenogenetic female is capable of producing on an average 100 young (the stem-mother probably being more prolific) at the rate of one to six, or an average of three per day, under favourable conditions. Each generation begins to breed about the eighth day after birth, so that the issue from a single individual easily runs up, in the course of the summer, to trillions. The number of leaves (700 hills, each with two poles and two vines) to an acre of hops, as grown in the United States, will not, on the average, exceed a million before the period of blooming or burring; so that the issue from a single stem-mother may under favouring circumstances blight hundreds of acres in the course of two or three months.

(10) While meteorological conditions may materially affect the increase and power for injury of the species, these are far more truly predetermined and influenced by its natural enemies, many of which have been studied and will be described.

(11) The slight colorational differences, as also the structural differences, including the variation in the cornicles on head and basal joints of antennæ, whether upon plum or hop, are peculiarities of brood, and have no specific importance whatever.

(12) The exact knowledge thus gained simplifies the protection of the hop plant from Phorodon attack. Preventive measures should consist in destroying the insect on plum in early spring where the cultivation of this fruit is desired, and the extermination of the wild trees in the woods wherever the hop interest is paramount; also in avoiding the introduction of the pest into new hop countries in the egg state upon plum cuttings or scions. Direct treatment is simplified by the fact that the careful grower is independent of slovenly neighbours, infection from one hop yard to another not taking place.

Experiments still under way have shown that there are many effective remedies, and that the ordinary kerosene emulsion diluted with twenty-five parts of water and sprayed with the cyclone nozzle, or a soap made by boiling one pound of pure potash in three pints of fish oil and three gallons of water, and this dissolved in eight gallons of water, and sprayed in the same way, are thoroughly effectual remedies, and leave the plant uninjured. The former costs 75 cents, the latter 30 cents, per acre, plus the time of two men for three hours, plus appliances. The object of further experimentation now being carried on is to simplify and reduce the cost of these last to a minimum. As they consist, however, essentially of a portable tank and a force-pump with hose and spraying attachment, which, together, need not involve a greater first outlay than 5 dollars to 10 dollars, and as every American hop grower can afford to expend the larger sum for the protection of a single acre, there is no longer any excuse for allowing this pest to get the better of us.

It is not my purpose, however, to enter into aphidicide details in this communication, which I will conclude by brief reference to the bearings of these discoveries in America on the problem in Great Britain. The most comprehensive and satisfactory review of the knowledge possessed on the subject in England that has come to my notice, is that by my esteemed friend and correspondent, Miss Eleanor A. Ormerod, Consulting Entomologist of your Royal Agricultural Society, in her "Report of Observations of Injurious Insects," &c., made in 1885. So far as her own careful observations are concerned, they fully accord with the facts here set forth; but on the authority of others, and especially on the evidence of Mr. C. Whitehead, who reported finding young lice and large viviparous females on hop shoots as early as March 29, and that of Mr. A. Ward, who experimented with surface dressings near Hereford, Miss Ormerod concludes that attack on the hop begins in spring from wingless females which come up from the hop hills, and, as a corollary, that dressings to prevent such ascent are strongly to be recommended. It is quite within the range of possibility, and what is known of aphid life, that where the winters are mild, with scarcely any frost, this Phorodon may continue on the hop from one year to another in the parthenogenetic condition. If such is ever the case in England, you have a somewhat different set of facts to deal with here from what we have in America. But for the reasons already stated in abstract, from many other detailed observations which it would be tedious to record here, as well as from the ease with which erroneous conclusions are arrived at in entomological matters of this kind, where not checked and proved by the most competent and careful study, I shall be inclined to believe that the facts in England are essentially the same as I have found them in America, until convincing and trustworthy evidence to the contrary be forthcoming. Mr. Whitehead may have had another species under observation, and Mr. Ward's surface dressings may have acted by repelling the winged female migrating from Prunus, in the same way that buckwheat sown among the hops is believed to do with us.

EDUCATION IN GERMANY.

THE following letter appeared in the *Times* on the 10th inst.:—

SIR,—I should be glad if you could find space in your columns for some remarks on the state of education in Germany. I have just completed a short tour in this country, mainly to inquire into its educational system, especially with reference to primary and technical schools. England has at last roused herself to the necessity for technical education.

The Bill, which was unhappily crowded out last session, will be reproduced next year, and, I trust, expanded to larger dimensions. It will contain, I hope, a clause for the establishment of evening continuation schools, for which object I gave notice of an amendment last session. My trip to Germany has been chiefly taken to learn what is doing here in this direction, and what is the drift of educated German opinion. With your permission I will briefly summarize my impressions. I premise by observing that each State of the German Empire manages its own education, and that the laws and regulations differ somewhat, so that general statements referring to all Germany cannot be made without qualifications. I will not weary your readers, however, by going into details respecting each State, but place broadly before them the general features of German education.

The salient fact which strikes all observers is the universality of good education in this country. There is no such thing as an uneducated class; there are no such things, speaking broadly, as neglected and uncared-for children. All classes of the community are better educated than the corresponding ones in our country; and this applies quite as much to primary as to secondary education. Nothing struck me more than the general intelligence of the humbler working classes. Waiters, porters, guides, &c., have a knowledge of history, geography, and other subjects far beyond that possessed by corresponding classes in England, and the reason is not far to seek. The whole population has long been passed through a thorough and comprehensive system of instruction obligatory by law and far more extended than is given in our elementary schools. I went through several of these schools and observed the method of teaching, which was simply admirable. The children are not crammed, but are taught to reason from the earliest stages. The first object of the teacher is to make his pupils comprehend the meaning of everything they learn, and to carry them from stage to stage so as to keep up an eager interest.

I saw no signs of weariness or apathy among either teachers or scholars. The teaching was all *vivâ voce*, the teacher always standing beside the blackboard and illustrating his subject by object-lessons. The instruction was through the eye and hand as well as the ear, and question and answer succeeded so sharply as to keep the whole class on the *qui vive*. The teachers are, as a body, much better trained than in England, and seem to be enthusiasts in their calling, and the school holds a far higher position in the social economy of the country than it does with us. What I am saying here applies equally to Switzerland as to Germany, and for educational purposes Zurich will compare with any part of this empire. The main advantage, however, that primary education has in Germany over England lies in the regularity of attendance and the longer period of school life. There is none of the difficulty of getting children to school that exists in England; the laws are very rigid and permit no frivolous excuses, and, what is even more important, the people entirely acquiesce in the laws, and are inclined rather to increase than relax their rigour. It is well known that in London and all our great cities a large part of the population seek to avoid school attendance by every means in their power, and consequently the attendance is most irregular. There is very little of this in Germany; at least I have not found it so. Then in our country a great portion of our children are withdrawn altogether from school, after passing the fourth or fifth standard, at the age of eleven or twelve, whereas in Germany almost everywhere attendance is compulsory until fourteen for boys, though in some places girls are allowed to leave at thirteen.

This last point is the one I wish to emphasize. The great defect—I might almost call it the fatal defect—of our system is that it stops just at a time when real education should begin. It allows a child to leave school at an age when its learning is soon forgotten and its discipline effaced. It is hardly too much to say that the two years' additional training the German child receives in the elementary school, doubles its chance in life as compared with the English child.

But this is not all. The Germans are rapidly developing a system of evening continuation classes which carry on education for two or three years longer. In Saxony the boys who leave the primary school, if they do not go to the higher schools must attend for three years longer—say, until they are seventeen—continuation classes for at least five hours per week. But teaching is provided for them, and they are encouraged to attend, twelve hours per week. So complete is this system that even the waiters at the hotels up to the age of seventeen attend afternoon classes, and are taught one or two foreign languages. I take Saxony as one of the most advanced States; but the law is much the same in Würtemburg and Baden, and the system is found to work so well that it is in contemplation to extend it to all the States in the German Empire, and Austria will probably follow suit. This is confidently expected to happen in the course of 1888. I may state as an undoubted fact that in Germany and Switzerland, and I believe in some other Continental countries, the opinion is ripening into a conviction that the education, even of the poorest class, should be continued in some form or another to the age of sixteen or seventeen. They find by experience that wherever this is adopted it gives an enormous advantage to the people in the competition of life, and, above all, trains them to habits of industry and mental application. I believe it is owing to this system of thorough education that Germany has almost extinguished the pauper and semi-pauper class, which is the bane and disgrace of our country.

Wherever I have gone I have inquired how they deal with the ragged and squalid class of children, and I have been told in every city I visited—in Zurich, Stuttgart, Nuremberg, Chemnitz, Dresden, and Berlin—that such a class practically does not exist. I do not mean that there is not poverty and plenty of it in Germany. Wages are much lower than in England, and many have a hard struggle to live. But there does not seem to exist to any extent that mass of sunken, degraded beings who with us cast their children upon the streets, or throw them on the rates, or leave them to charity. Some half-a-million of children in the United Kingdom are dependent, more or less, on the alms or the rates of the community, and probably another half-million are miserably under-fed and under-clad. Nothing to correspond with this exists in Germany. The poorest people here would be ashamed to treat their children as multitudes do with us. Indeed, I have not seen since I left home a single case of a ragged or begging child. I repeat that the great cause of this both in Germany and Switzerland is the far greater care they have taken of the education of the children for at least two or three generations, whereas we have only taken the matter up seriously since 1870, when Mr. Forster's great Act was passed.

Let us contrast the general condition of our London children, for instance, at the age of fifteen or sixteen, with that of the same class in Berlin or Dresden or Chemnitz. With us nine-tenths of the children have long since left school, and a too large proportion of them are receiving no training but the coarse and brutalizing education of the streets. Most of them retain little of what they have learnt at school, except the power to read the "penny dreadful," which stuffs their minds with everything a child should not know. They are to a very large extent adepts in profane and obscene language, and are frequenters of the public-house, the "penny gaff," and such like amusements; a great many of them are learning no useful trade or calling, but are drifting helplessly into the class of wretched, ill-paid, casual labourers. Very many of them marry before they are twenty, and are soon the parents of a numerous progeny, half-starved and stunted both in body and mind. Compare, or rather contrast, this with Germany. At fifteeen or sixteen a great part of the children are still under excellent instruction. Exceedingly few are to be found roaming about the streets. They are prohibited, at least in some parts of Germany, from entering the public-houses (except with their parents) until the age of seventeen, and I am told are everywhere prohibited from smoking until sixteen. In fact, there are, both by law and public sentiment, barriers placed against the corruption of the young which do not exist in England.

No country has ever suffered more from the abuse of the idea of individual liberty than England has done. Owing to this overstrained idea we did not get compulsory education until long after the advanced nations of the Continent, and still we are far behind them in the care we take of our children. It is intolerable that this state of things should continue longer. Democratic government everywhere insists upon good education, and expects each citizen to fulfil his duties to the State.

Public opinion in our country will certainly insist, and that before long, that we shall not be for ever disgraced with a residuum of the most drunken, demoralized, and utterly incapable population to be found in any modern State. It will insist that some time be spared for the solution of this vital question from the wrangles of party politics and the party recriminations of party leaders. When one sees what a poor country like Germany has done to raise its people in spite of the conscription and three years' compulsory military service, in spite of frequent and exhausting wars from which our island home has been free, one has grave doubts whether our system of party government is not a failure.

Certainly we waste on barren conflicts and wordy strife far more time than other nations do in the conduct of their affairs. They direct their energies with business-like precision to supply the exact needs of the people, we fritter away our enormous political energy in fruitless party contests which every year degrade Parliament lower and lower, and make it less and less fit for the practical work of governing the nation.

One thing seems certain. Unless we can give more attention to the vital questions which concern the welfare of the masses our country must go down in the scale of nations. No honest observer can doubt that in many respects the Germans are already ahead of us, and they are making far more rapid progress than we are. They are applying technical science to every department of industry in a way that Englishmen have little idea of. Their polytechnics and their practical technical schools are far ahead of anything we possess in England, the leaders of industry are far better trained, the workmen are better educated and far more temperate and thrifty than ours are. Wherever the Germans and English are coming into competition upon equal terms the Germans are beating us. This is not because the Germans have greater natural power. I believe the British race is the more vigorous naturally. But they are organized, disciplined, and trained far better than we are. They bring science to bear upon every department of the national life, whereas we, up till lately, resented all State interference, and so exaggerated the doctrines of freedom as almost to glory in our abuses.

There is much more that I might say if space permitted; but it will not do to trespass further on your indulgence. I will only add in conclusion that England must wake up, and that immediately, to the necessity of a far more thorough and practical system of education, else she will lose the great place she has hitherto held in the world's history.

I am, Sir, yours faithfully,

Berlin, October 4. SAMUEL SMITH.

THE BRITISH ASSOCIATION.

SECTION B—CHEMICAL SCIENCE.

The Atomic Weight of Gold, by J. W. Mallet, F.R.S.—Attention is called to the importance of correct determinations of atomic weights by different experimenters, and especially the elimination of "constant errors." Considering the desirability that all such values should be connected as directly as possible with hydrogen, a method is described by which this may be done in the case of gold. A known weight of zinc is dissolved in dilute sulphuric acid, and the hydrogen evolved is measured. A solution of bromide or chloride of gold is then treated with zinc more than sufficient to precipitate the whole of the gold, the residual zinc being determined by the hydrogen evolved on treatment with sulphuric acid. The difference in volume of hydrogen obtained gives a direct means of calculating the atomic weight of gold. The author described various experimental precautions that had been taken in measuring the gas.

The Atomic Weight of Zirconium, by Dr. G. H. Bailey.—The previous determinations of the atomic weight of this element were made by Berzelius (89·25), Hermann (88·8), Marignac (90·54). The earlier results were doubtless vitiated by the presence of iron and of the cerite earths, whilst Marignac's determination is open to objection from the character of the salt (potassium zirconium fluoride) which he used. In the present determination zirconia was prepared from North Carolina zircons by three independent methods. It was dissolved in sulphuric acid, and the sulphate was crystallized out. This salt becomes normal and constant in weight by heating some hours at 400°, the temperature at which it begins to decompose being 470°. The relation of zirconium sulphate to zirconia gives a ratio from which the atomic weight is calculated, and, though the work is not complete enough to state the result with accuracy, the value obtained agrees more nearly with that of Marignac. The author proposes to make further determinations, using the tetrabromide.

Torsion Balances, by Dr. A. Springer.—Light frames are made and stiffened by wires or flat bands being tensioned over them. The beam is then firmly clamped to the bands in such a manner that its centre of gravity is above its point of support; this tends to tip the beam, thus equilibrating the torsional resistance of the fulcrums. We thus have the torsional resistance exerted to keep the beam horizontal, and the high centre of gravity tends to tip it out of the horizontal. The adjustment of the position of the centre of gravity is most easily made by having an adjustable poise placed immediately above the centre of the torsional wire. In order to do away with the necessity of alignment of support, a secondary beam is attached to the first in such a manner that both beams tending to tip in the same direction remain stationary owing to their having opposite and equal moments. On this principle scales are constructed which can be used on rolling ships, or in buildings where there is considerable jarring. In all the "torsion balances" there is permanence of adjustment, consequently repeated weighings will give like results. Various "torsion balances" were shown illustrating the principle involved, as well as to show how equal sensitiveness can be obtained with any load.

Integral Weights in Chemistry, by T. Sterry Hunt.—The author maintains the necessity for taking hydrogen as standard of specific gravity, not only for gases, but also for liquids and solids, and thinks that such considerations lead to a comprehension of the physical properties and chemical constitution of chemical substances.

Action of Light on the Hydracids of the Halogens in presence of Oxygen, by Dr. A. Richardson.—HCl and O were mixed in different proportions in bulbs, and exposed forty to sixty days in sunlight, at the end of which time their contents were examined. Free Cl was only noticeable when large excess of O was present, and when the gases had not been dried. Similar experiments were made in the cases of HBr and HI.

The Present Position of the Alkali Trade, by A. E. Fletcher.—The author, in presenting this report, remarked that no report on this subject had been presented to the Association since that of his predecessor in office, Dr. Angus Smith, in 1861. Tracing the general history of the alkali manufacture, he noticed the various improvements which have been carried out in the mechanical details and in the chemistry of the processes, with special reference to the recovery of by-products. The rapid growth of the alkali trade in Germany was shown by a reference to the exports and imports of the product. In Germany this advance is largely due to the adoption of the ammonia-soda process, a process which in this country has been taken up thus far by only three firms. It was pointed out, however, that the Leblanc process, with certain modifications, was not by any means a forlorn hope; and the improvements now being worked out by Messrs. Chance, Messrs. Parnell, and Messrs. Gaskell, Deacon, and Hurter were referred to.

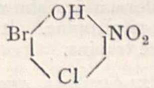
On the Constituents of the Light Oils of Blast-Furnace Coal Tar from the Gartsherrie Works, by Watson Smith.—These tars are recovered from the condensation of the gases evolved from a blast-furnace, condensed by means of the process of Messrs. Alexander and McCosh. The various constituents are described, amongst others toluene and xylene, the latter consisting of about 70 per cent. metaxylene. Considerable interest was manifested in a specimen of flannel dyed by xylidine scarlet prepared from this metaxylene, being the first dye product ever prepared from the by-products of the blast-furnace.

A New Apparatus for condensing Gases by contact with Liquids, by Prof. Lunge.—The apparatus described is of a construction of the "plate column" style, and consists, as the name implies, of a series of perforated plates arranged in column, and made of stoneware. The gases as they rise are thus brought into immediate contact with an extensive plane surface of the absorbing liquid. The cooling is not so rapid as with coke towers and similar arrangements, but it is to be borne in mind that the gases pass more slowly owing to the completeness of the contact with liquid. Comparative results were given showing the working relation between this apparatus and others.

The Extent to which Calico Printing and the Tinctorial Arts have been affected by the Introduction of Modern Colours, by Charles O'Neill.—The author reviewed the state of things in 1856, at which time Perkin's aniline mauve was discovered, and showed the effect of the introduction of alizarine colours. It was shown that the demand had not kept pace with the production, and this had much to do with the unremunerative condition of calico printing.

The Chemistry of Cotton Fibre, by F. H. Bowman.—It is shown that cotton, in common with all vegetable substances, has for its base cellulose. The opinion is here expressed that, judging from the results of combustion, it consists of a series of bodies not agreeing in all respects with one another. The mineral matter of cotton amounts to about 1 per cent., and this is considered to form an essential constituent.

Isomeric Change in the Phenol Series, by O. R. Ling.—The isomers



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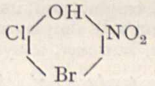

were stated to have been prepared. The melting-point of the former was found to be 125°, and its calcium salt contained 2½ molecules of water, whereas the melting-point of the latter was 117°, and its calcium salt contained 7 molecules of water.

On Methylene Blue and Methylene Red, by Prof. Bernthsen.—In this paper it was shown how from thiodiphenylamine, by respective nitration, reduction, and oxidation, Lauth's violet (thionine) was obtained. Methylene-blue was described as tetramethylthioninechloride.

On the Constitution of Azimido Compounds, by Drs. Noelting and Abt.—The formulæ given by Griess and by Kekulé for the azimido compounds were explained and discussed, and it was shown that the evidence was in favour of the formula of Kekulé.

Velocity of Formation of Acetic Ether by Prof. Menschutkin.—In these experiments acetic anhydride was used instead of the acid by which in his previous work the process of etherification had been effected. It was found that the velocity of the reaction was greater with the primary than with the secondary alcohols, and that it was much slower in the higher members of an homologous series than in the lower. A distinct and marked difference occurs between isomers as shown by the examination of butyl and isobutyl alcohols. By working in solution the reaction proceeds more regularly, and the results agree better amongst themselves. The author finds that the nature of the solvent affects the course of the reaction in such a manner as to throw some doubts on the hypothesis of Guldberg and Waage.

The Relation of Geometrical Structures to Chemical Properties, by Prof. Wislicenus.—This memoir—probably the most important contribution that has yet been made to the question of the constitution of unsaturated organic compounds—cannot readily be understood without the accompanying diagrams. The results have already been published in the Transactions of the Royal Saxon Academy.

Note on Valency, by Prof. Armstrong.—An attempt to explain the phenomena of valency according to the views expressed by Helmholtz as to the unit charge of the elements and its distribution.

The Solubility of Isomeric Organic Compounds, by Prof. Carnelley.

(1) For any series of isomeric organic compounds the order of solubility is the same as the order of fusibility, *i.e.* the most fusible compound is also the most soluble. This is shown to hold true in a very large number of cases, whilst there are very few exceptions, and those of a doubtful character.

(2) The order of solubility of two or more isomeric compounds is independent of the nature of the solvent. This has been experimentally proved, more particularly in the case of meta- and para-nitraniline, the solubility of each of which in thirteen different solvents has been determined. Also by a considerable number of cases taken from literature.

(3) The ratio of the solubilities of two isomers in a given solvent is constant, and is therefore independent of the nature of the solvent. So that—

$$\frac{\text{Solubility of A in any solvent}}{\text{Solubility of B in the same solvent}} = \text{constant.}$$

This has been proved for meta- and para-nitraniline in respect of thirteen different and very varied solvents.

Alcohol and Water Combinations, by Prof. Mendeléef.—The author looks upon solution as implying a definite chemical combination liable to alteration and to decomposition at ordinary temperatures. He has also examined the phenomena at low temperatures where cryohydrates are formed, and finds the same agreement with his adopted formula. At low temperatures he has obtained solid compounds of alcohol and water containing 17·56, 46·04, and 88·46 per cent. of alcohol respectively. The investigations have been extended to various mineral acids and salts without discovering any exception to the generalized expression given by him.

On the Constitution of Atropine, by Prof. Ladenburg.—This body is shown to belong to the class of bodies known as alkines. The reactions of tropine and its transformations show that it stands in a direct and simple relation to atropine. It has not yet been possible, however, to synthesize tropine.

The Reduction-products of the Nitro-paraffins and Alkyl Nitrites, by Prof. Dunstan and T. S. Dymond.—The authors have studied the reduction of ethyl nitrite, using ferrous hydroxide as the reducing agent. More than two-thirds of the nitrogen of the ethyl nitrite is liberated in the form of gas, either nitrous oxide or nitrogen; the remainder appears partly as ammonia and partly as ethylamine. If potassium hydroxide is mixed with the ferrous compound a considerable quantity of potassium hyponitrite is formed. It is also probable that ethyl hyponitrite, a compound that has not yet been prepared, may also be formed as an intermediate compound. The authors are further investigating the change with the object of isolating this compound and of discovering the mode of formation of the ethylamine. The reducing action of ferrous hydroxide on the nitro-paraffins was also partially investigated with interesting results.

On a Partial Separation of the Constituents of a Solution during Expansion by Rise of Temperature, by J. W. Mallet, F.R.S.—When solutions of colloid substances—some alcoholic, some aqueous—are exposed to cold, and afterwards to a gradually increasing temperature, the expansion in the liquid has been noticed to take place with a partial or entire separation of the substance dissolved in the upper layer, without any deposition of solid matter.

A New Method for Determining Micro-Organisms in Air, by Prof. Carnelley and Thos. Wilson, University College, Dundee.—This is a modification of Hesse's well-known process. It consists essentially in the substitution of a flat-bottomed conical flask for a Hesse's tube. Its chief advantages are: (1) much smaller cost of flask and fittings as compared with Hesse's tubes; (2) very much fewer breakages during sterilization; (3) great economy in jelly; (4) freedom from leakage during sterilization; (5) results not vitiated by aërial currents.

The Absorption-Spectra of Rare Earths, by Dr. G. H. Bailey.—This paper is an examination of the conditions of observation of absorption-spectra with a special view to the recent announcement of the twenty new elements of Krüss and Nilson. The author finds that the strengths of the absorption-bands do not diminish equally in all parts of the spectrum when the liquid is diluted. The presence of nitric acid also effects not only a displacement of the bands, but also an alteration in their relative intensity. It is further pointed out that a record of the strength of the bands in mixtures containing, in some cases, large quantities of samaria and erbia, and in others none, cannot be used as a means of comparison, and deductions drawn from variations of intensity are untrustworthy. Whilst acknowledging that, with due allowance for such factors, some assistance may be gained towards the course of fractionation, the author considers the announcement of new elements quite premature, and only calculated to throw further confusion into this already difficult field of work.

The Absorption-Spectra of the Haloid Salts of Didymium, by Dr. G. H. Bailey.—Bunsen has described certain variations that occur in the absorption-spectra given by crystals of the didymium salts. In this paper are detailed the variations produced in the absorption-spectra of crystalline salts of didymium when examined in polarized light. A comparison of the chloride, bromide, and iodide of didymium has also been made, from which it appears that in the bromide the bands are situated 5λ further towards the red end of the spectrum than in the chloride, whilst the displacement for the iodide is 14λ towards the violet. In the solution of the chloride (or nitrate) the bands have almost the same position as in the crystals of the iodide, whilst the addition of nitric acid causes a displacement of 12λ towards the red. It is proposed to determine how far this displacement of bands is due to the dispersion equivalent of the menstruum, and whether it gives evidence of dissociation in the liquid.

On Solution, by W. Durham.—The theory of solution adopted by the author of this paper was published by him before the Royal Society of Edinburgh in 1878. According to these views solution is due to the chemical affinity of the elements of the substance dissolved for the elements of the solvent.

Thermal Phenomena of Neutralization, and their bearing on the Nature of Solution, by W. W. J. Nicol.—A consideration of the general relationship existing between the heats of formation of various salts in dilute aqueous solutions.

Notes on some peculiar Voltaic Combinations, by C. R. A. Wright, F.R.S., and C. Thompson.—The combinations consist of a class of cells in which one or both of the "plates" is a film of gas condensed on the surface of an electrically conducting solid, which is itself not appreciably acted on. In Grove's gas battery both plates are gas films. Mercury and silver in dilute sulphuric acid opposed to aëration plates of platinum sponge form sulphates, whilst gold dissolves in potassium cyanide under the same conditions. If an acid and alkaline solution be united by means of a wick a considerable current is producible for a short time in the external circuit, but this falls off rapidly in consequence of the development of free hydrogen on the surface of the plate in the acid fluid and of oxygen on the other plate. No direct quantitative proof of this has, however, been given, and there are given in this paper a number of experiments showing that for every milligramme equivalent of silver deposited 11·2 cc. of hydrogen are evolved.

The Present Aspect of the Question of the Sources of Nitrogen in Vegetation, by Sir J. Lawes, F.R.S., and Dr. Gilbert, F.R.S.—An outline of the work of various experimenters in this line of research was given, indicating that, whereas in accordance with the original observations of Boussingault the authors had found that nitrogen was assimilated in part from the atmosphere directly, the results of Berthelot, Frank, and others derived all nitrogen from the soil. These results were criticised, and it was pointed out that the methods pursued failed in that they did not represent normal conditions of growth of vegetation.

Dispersion Equivalents and Constitutional Formulæ, by Dr. J. H. Gladstone.—The difference between the refraction equivalent, as observed for the line "A" and for the line "H" in the spectrum, is called the dispersion equivalent. The refraction equivalent of a compound is in general the sum of the refraction equivalents of the elements of which it is composed, but varies according to the constitution. The same holds for the dispersion equivalent, and it is shown that in some cases differences are observable in this respect where they are not indicated by constitutional formulæ, as, for instance, in the allyl compounds, and in naphthalene derivatives.

On Organic Vanadates, by J. A. Hall.—A series of organic vanadates are described, which can be distilled under reduced pressure without decomposition. They are obtained by the action of an alkyl bromide on silver orthovanadate.

On some New Cinnamic Acids, by Dr. Cohen and Prof Perkin.—A description of a method of obtaining certain substituted cinnamic acids from aromatic aldehydes in cases where, from the nature of the aldehyde, Perkin's reaction cannot be employed. The aldehydo-salicylic acids are converted into ethereal salts, and these are heated with sodium alcoholate, and finally with sodium acetate and acetic anhydride.

The Antiseptic Properties of Metallic Salts, by Prof. Carnelley. —This paper consisted of a description of experiments performed by the author illustrative of further relations between the chemical composition of a substance and its antiseptic properties.

Antiseptic Properties of some Fluorine Compounds, by W. Thomson.—The author describes in this paper the antiseptic properties of sodium fluosilicate. The body is not poisonous, and possesses no smell. Its superiority over chloride of mercury for surgical purposes is claimed.

On the Composition of Water by Volume, by A. Scott.—From various preliminary experiments the author was led to conclude that the relation of oxygen to hydrogen in water was not accurately represented by the numbers 1 : 2. Subsequent experiments gave the ratio 1 : 1·997 with small variation.

On some Vapour Densities at High Temperature, by A. Scott. —A number of vapour densities of inorganic salts of certain elements have been determined by means of the well-known method of Victor Meyer, at a temperature above the melting-point of cast iron. A breaking up of the molecule is shown to occur in the case of iodine, cadmium iodide, mercuric sulphide, mercurous chloride, and mercuric chloride.

On the Estimation of the Halogens and Sulphur in Organic Compounds, by R. T. Plimpton.—The method suggested as a substitute for those already in use is that of introducing the substance into the flame of a Bunsen burner, or into a jet of hydrogen, the products of the combustion being aspirated through an absorbent liquid. In this solution the amount of the halogens or of sulphur can afterwards be estimated.

On the Derivatives and Constitution of the Pyrocresols, by W. Bott and Prof. Schwarz.—The authors describe some derivatives of these bodies, and are led to conclude that the α-pyrocresol and its isomers are anhydrides similar in constitution to diphenyl ether.

Section C—Geology.

On the Mineralogical Constitution of Calcareous Organisms, by Vaughan Cornish and Percy F. Kendall.—In Dr. Sorby's presidential address to the Geological Society in 1879 it was stated that both calcite and aragonite occur in organic structures, and that aragonite fossils are less stable than those of calcite. It appeared probable that carbonic acid has been the agent which effected the removal of the aragonite, but there are no published experimental data to show that it would remove aragonite more readily than calcite. The authors gave an account of the experimental evidence obtained as to the cause of the inferior stability of aragonite fossils as compared with those formed of calcite, with observations on the geological conditions favourable to the removal of aragonite fossils. They then described the work done in following out these observations, and in the examination of certain organisms belonging to groups not yet classified according to their mineralogical constitution.

The Matrix of the Diamond, by Prof. H. Carvill Lewis.—A microscopical study of the remarkable porphyritic peridotite which contains the diamonds in South Africa demonstrates several interesting and peculiar features which are described in detail. It is one of the most basic rocks known, and has a composition which by calculation would belong to a rock composed of equal parts of olivine and serpentine, impregnated by calcite. It is a volcanic breccia, but not an ash or tuff, the peculiar structure being apparently due to successive paroxysmal eruptions. A similar structure is known in *meteorites*, with which bodies this rock has several analogies. The microscopical examination supports the geological data in testifying to the igneous and eruptive character of the peridotite, which lies in the neck or vent of an old volcano. While belonging to the family of peridotites, this rock is quite distinct in structure and composition from any member of that group heretofore named. It is more basic than the picrite porphyrites, and is not holocrystalline like dunite or saxonite. It is clearly a new rock-type, worthy of a distinctive name. The name *Kimberlite*, from the famous locality where it was first observed, is therefore proposed. Kimberlite probably occurs in several places in Europe, certain garnetiferous serpentines belonging here. It is already known at two places in the United States: at Elliott County, Kentucky, and at Syracuse, New York; at both of which places it is eruptive and post-Carboniferous, similar in structure and composition to the Kimberley rock. At the diamond localities in other parts of the world diamonds are found either in diluvial gravels or in conglomerates of secondary origin, and the original matrix is difficult to discover. Thus, in India and Brazil the diamonds lie in a conglomerate with other pebbles, and their matrix has not been discovered. Recent observations in Brazil have proved that it is a mistake to suppose that diamonds occur in itacolumite, specimens supposed to show this association being artificially manufactured. But at other diamond localities, where the geology of the region is better known than in India or Brazil, the matrix of the diamond may be inferred with some degree of certainty. Thus, in Borneo, diamonds and platinum occur only in those rivers which drain a serpentine district, and in Timor Laut they also lie in serpentine. In New South Wales, near each locality where diamonds occur, serpentine also occurs, and is sometimes in contact with carboniferous shales. Platinum, also derived from eruptive serpentine, occurs here with the diamonds. In the Urals, diamonds have been reported from four widely separated localities, and at each of these, as shown on Murchison's map, serpentine occurs. At one of the localities the serpentine has been shown to be an altered peridotite. A diamond has been found in Bohemia in a sand containing pyropes, and these pyropes are now known to have been derived from a serpentine altered from a peridotite. In North Carolina a number of diamonds and some platinum have been found in river sands, and that State is distinguished from all others in Eastern America by its great beds of peridotite and its abundant serpentine. Finally, in Northern California, where diamonds occur plentifully and are associated with platinum, there are great outbursts of post-Carboniferous eruptive serpentine, the serpentine being more abundant than elsewhere in North America. At all the localities mentioned chromic and titanic iron-ore occur in the diamond-bearing sand, and both of these minerals are characteristic constituents of serpentine. All the facts thus far collected indicate *serpentine*, in the form of a decomposed eruptive peridotite, as the original matrix of the diamond.

On the Discovery of Carboniferous Fossils in a Conglomerate at Moughton Fell, near Settle, Yorkshire, by Robert Law and James Horsfall.—After briefly noting the various exposures of the conglomerate, its unconformability with the Silurian rocks, its nature, probable age, and the circumstances which led to the discovery of fossils in it; the authors described the following section exhibited on the south-west side of the Moughton Fell.

	Feet.
a. Scar limestone, of light grey colour and well jointed; layers very distinct in lower parts and almost horizontal, the genus *Bellerophon* being the commonest fossil in the lowest bed of this rock	300 to 500
b. Conglomerate.—Of a bluish-grey colour when newly fractured, and becoming reddish on exposure to the air. The fragments consist of slate, grit, flagstone, and vein-quartz, all apparently derived from Silurian rocks. Fossil shells and corals are common throughout the bed. *Bellerophon*, *Euomphalus*, *Syringopora*, and *Lithostrotion* are the prevailing genera...	1 to 12
c. Lower Silurian slates, of great thickness, having a north-east strike, and a dip of about 65°. The dip and cleavage appear to be on the same plane in this locality.	

The nature and the origin of the stones in the conglomerate were next pointed out; also it was shown that the portion of the bed in which fossils had been found was not more than 200 yards in length, and that it was thickest in the middle, thinning out to the east and west, and at one point could be seen merging into the overlying limestone. Twenty species of fossils were collected from the conglomerate.

Places of Geological Interest on the Banks of the Saskatchewan by Prof. J. Hoyes Panton.—The writer, after referring to some of the marked geological features which characterize the three great prairie steppes of the North-west of Canada, proceeds to describe two localities more particularly, viz. the vicinity of Medicine Hat, situated on the banks of the Saskatchewan, 660 miles west of Winnipeg, and a locality near Irvine Station, 20 miles east of Medicine Hat.

The History and Cause of the Subsidences at Northwich and its Neighbourhood, in the Salt District of Cheshire, by Thos. Ward.—The frequent occurrence of subsidences in the neighbourhood of Northwich makes it desirable to learn their history and cause. Northwich overlies extensive beds of salt. These occupy about three square miles. The first, or "top" rock-salt, lies at a depth of about 50 yards from the surface, and is covered by Keuper marls, and these by the drift-sands and marls. Between the two beds of salt there are 30 feet of indurated Keuper marl. The second, or "bottom" rock-salt, is over 30 yards in thickness. The subsidences which are so destructive in the town of Northwich and the neighbourhood are entirely caused by the pumping of brine for the manufacture of white salt. It was only about 1770, or shortly afterwards, that the first sinking was noticed; since that date, subsidence has gone on very rapidly, and much destruction of property has resulted. Large lakes or "flashes," one of more than 100 acres in area, and of all depths up to 45 feet, have been and are being formed. This peculiar phenomenon of subsidence in the salt-districts is worthy of more consideration than it has hitherto received from scientific men.

The Sonora Earthquake of May 3, 1887, by Dr. T. Sterry Hunt, F.R.S., and James Douglas.—On the afternoon of May 3, 1887, at 2.12 Pacific time (= 120° W. of Greenwich), the first of a series of earthquake movements was felt in the State of Sonora and the adjacent parts of Mexico and the United States, over an area extending from El Paso in Texas on the east to the River Colorado and the Gulf of California on the west, and from the State of Sinoloa on the south as far north as Albuquerque in New Mexico; the extremes in both directions being over 500 miles. It was the fortune of the writers to be at the time at the great copper-mining camp of Bisbee in Arizona, in a narrow gorge of the Mule Pass Mountains, about 5300 feet above the sea, and near the border of Sonora. A violent tremor of the earth, including two sharp shocks, and lasting over ninety seconds, was succeeded at frequent intervals by many minor movements in the next three days, and, less frequently, at least up to May 29. In this part of Arizona solid house-walls, of *adobe* or unburned brick, were cracked or overturned, while huge rocks in the steep mountain gorges rolled down, causing much damage. Fires, perhaps kindled by these in their course, appeared immediately afterwards in various wooded regions in Sonora and Arizona, giving rise to many false rumours of volcanic eruptions. The movement here seemed from south to north. The small town of Bavispe in the Sierra Madre in Sonora was nearly destroyed, many people being wounded and forty-two killed. Opoto suffered in a similar way, and Fronteras to a less extent. The district chiefly affected by the earthquake is, however, for the most part a desert, with some cattle ranches and mining stations. Interesting studies were made by the authors in the valleys, or *mesas*, between the parallel mountain ridges in this region, both in the San Pedro and Sulphur Spring Valleys. The latter, to the east of Bisbee, and stretching north and south about 100 miles, is often 8 or 10 miles wide, and has its lower portion in Sonora. Though without a visible watercourse, water is there generally found at depths of from 10 to 40 feet in the numerous wells sunk at intervals to supply the needs of large herds of cattle. As described by many observers, the surface of this plain was visibly agitated by the first earthquake shock, so that persons were in some places thrown down by the heaving of the soil, which burst open with discharges of water, while the wells overflowed and were partially filled with sand. In the southern part of this valley, for about 7 miles south from the Mexican frontier, the authors found the results of the undulatory movement of the soil apparent in great numbers of cracks and dislocations. For distances of several hundred feet, along some lines with a generally north and south course, vertical downthrows on one side of from 1 foot to 2 feet and more were seen, the depressed portion rising either gradually or by a vertical step to the original level. Branching, and in some cases intersecting, cracks were observed. These depressions were evidently connected with outbursts of sand and water, which, along cracks, marked by depressions on both sides, sometimes covered areas of many hundred square feet with layers a foot or more in depth, marked here and there by craters 2 feet or more in diameter, through which water had risen during the outburst of these mud volcanoes. While the earthquake movements in the adjacent hills of Palæozoic strata had left no marks, the dislocations over many square miles in the valley would have sufficed to throw down buildings and to cause great loss of life in an inhabited region. There are believed to be no evidences of previous earthquake disturbances in this region since its discovery by the Spaniards centuries ago. From the published reports of commissioners named by the State of Sonora, it appears that the regions injured by the earthquake are in two nearly parallel north and south valleys in the district of Moctezuma, along the River Bavispe, a tributary of the Yaqui. In both regions are noticed the opening, in the arable lands, of numerous fissures, generally north or north-east in direction, from many of which water flowed abundantly. The river thus supplied in a time of excessive drought swelled to the volume usual in the rainy season of summer, a condition which lasted up to the time of the report of Señor Liborio Vasquez, dated at Bavispe, May 29, 1887. The fields had become green and the air moist with prevailing fogs. A report concerning the region of Opoto mentions not less than seven volcanoes in the vicinity, which were seen burning for two days, but without any flow of lava; while that for the Bavispe region declares that no volcano had there been discovered. The authors incline to the belief that, as was the case in the San José Mountains, and others examined by them along the borders of Arizona, the appearances of volcanoes near Opoto were due to forest fires.

The Disaster at Zug on July 5, 1887, by the Rev. E. Hill.—On July 5, 1887, at the town of Zug, in Switzerland, a portion of the shore gave way and sank into the lake. About three hours later another much larger adjacent area also suddenly subsided, so that in all an area considerably over two acres, with half of one of the principal streets, was submerged to a depth of about 20 feet. It can be seen that the subsoil consists of coarse gravel and sand, followed after a few feet by soft wet sand and fine mud. According to Prof. Heim, this fine mud or sludge reaches to a depth of nearly 200 feet, and the disaster is shown to be due to a flowing out into the lake of this mobile sludge from under the superincumbent weight of buildings and firmer ground. The buildings collapsed as they sank. The catastrophe must have been long impending; the exact cause which precipitated it is indeterminate, but a low level of the lake and tremors from pile-driving for new quays are suggested as contributories. On the English coast the incessant changes of pressure from tides probably render impossible such instability of equilibrium.

The Triassic Rocks of West Somerset, by W. A. E. Ussher.—This paper is the result of investigations made in the years 1878 and 1879. The constitution, extent, and general relations of the Lower, Middle, and Upper Triassic rocks of the area are briefly described, with the following general results:—The Lower Trias consists of breccia and breccio-conglomerate upon sands and brecciated sand and loam; it is faulted against Keuper basement beds, and is conformably overlapped by Middle Trias marls upon the margin of the older rocks. The Middle Trias consists of marls with sandstones in places at their base; it is faulted against the successive divisions of the Keuper on the east, and terminates northward in the angle made by converging faults at Bicknoller. The Middle Trias marls rest on the older rocks near Yellow Wood Farm, and finally disappear near Orchard Wyndham, south of Williton, under Keuper breccias. The Keuper beds consist of marls, sandstones, and a locally varying series of conglomerates, gravels, and breccia in descending sequence. The sandstones are very calcareous south of Crowcombe; they form marginal deposits in places near Dunster. The coarser beds of the Keuper develop at the expense of the sandstones in the area west of Williton. It is very probable that the Keuper basement beds of the Porlock valley may be marginal deposits formed during a progressive subsidence, and therefore may belong to a higher horizon than the Lower Keuper beds south of Williton.

The Devonian Rocks of West Somerset on the Borders of the Trias, by W. A. E. Ussher.—The composition of the Quantocks is first briefly described, and the faulted relations of Middle Devonian grits, slates, and limestones of which they consist alluded to. From the constitution of the Palæozoic districts on the east and west of the Triassic rocks of Crowcombe and Stogumber, the author considered the beds eroded in the intervening valley would amply account for the variability of the Triassic strata derived from them. From Withycombe to Porlock the faulted relations of the Middle and Lower Devonian grits are then briefly described. The author considered that the elevation of the Quantocks, the Brendon, and the Dunkery ranges was pr

Triassic, accompanied by faulting on an extensive scale; that many lesser faults were produced in post-Triassic times, and that further movements took place along the old lines of fracture. He did not believe that the Devonian highlands were ever covered by Secondary sediments, but was of opinion that the Triassic rocks never extended far beyond their present boundaries, except in old valleys from which they had subsequently been almost entirely removed by denuding agencies.

Observations on the Rounding of Pebbles by Alpine Rivers, with a Note on their Bearing upon the Origin of Bunter Conglomerate, by Prof. T. G. Bonney, F.R.S.—The author describes the result of his observations of the rounding of pebbles in various torrents and rivers in the Tyrol and Dauphiné, and of the gravels of the Piedmontese and Lombard plains. These lead to the following conclusions, among others: (*a*) that pebbles are rounded with comparative rapidity when the descent of the stream is rapid, and they are dashed down rocky slopes by a roaring torrent capable of sweeping along blocks of much greater volume; (*b*) that pebbles are rounded with comparative slowness when the descent is gentle and the average pace of the river is about adequate to push them along its bed. The rocks observed were in some cases limestone and not very hard grits; in others various crystalline rocks, such as granite, gneiss, or mica-schist. Hence, as the majority of the pebbles in the Bunter are of harder material, and are generally better rounded than those which the author observed, he concludes that it is impossible to suppose them mainly derived from any tract of land which, in Triassic times, can have existed in either Central or Eastern England, for they must have been formed by rivers no less important, with courses either longer or steeper than those of Central Europe. Thus these observations are very favourable to the view which ascribes to them a Scotch origin, where alone rocks exactly like them are known to occur.

The Terminal Moraines of the Great Glaciers of England, by Prof. H. Carvill Lewis.—The investigation here recorded is based upon the important principle that *every glacier at the time of its greatest extension is bounded and limited by a terminal moraine*. The great ice-sheet which once covered Northern England was found to be composed of a number of glaciers, each of which was bounded by its own lateral and terminal moraines. These glaciers were studied in detail, beginning with the east of England; the North Sea glacier, the Wensleydale glacier, the Stainmoor glacier, the Aire glacier, the Irish Sea glacier, and the separate Welsh glaciers were each found to be distinguished by characteristic boulders, and to be defined by well-marked moraines. The terminal moraine of the North Sea glacier, filled with Norwegian boulders, may be seen in Holderness, extending from the mouth of the Humber to Flamborough Head, and consists of a series of conical hills inclosing meres. The Irish Sea glacier, the most important glacier of England, came down from Scotland, and, being reinforced by local ice-streams, and flowing southward until it abutted against the mountains of Wales, it was divided into two tongues, one of which flowed to Wellington and Shrewsbury, while the other went south-west across Anglesey into the Irish Sea. This great glacier and its branches are all outlined by terminal moraines, described in detail. A small tongue from it, the Aire glacier, was forced eastward at Skipton, and has its own distinctive moraine. In the neighbourhood of Manchester the great moraine of this Irish Sea glacier may be followed through Bacup, Hey, Staleybridge, Stockport, and Macclesfield, being as finely developed as the moraines of Switzerland and America. South of Manchester it contains flints and shell-fragments, brought by the glacier from the sea-bottom over which it passed. At Manchester the ice was at least 1400 feet thick, being as thick as the Rhone glacier. The great terminal moraine now described of the united glaciers of England, is a very sinuous line, 550 miles in length, extending from the mouth of the Humber to the farthest extremity of Carnarvonshire, and, except where it separates the Welsh glaciers from the North Sea glacier, it everywhere marks the extreme limit of glaciation in England, and is an important feature which might well hereafter be marked on the geological map of England.

In a separate paper, read at a subsequent meeting, the author described more in detail the moraine near Manchester.

On some Important Extra-Morainic Lakes in Central England, North America, and elsewhere, during the Period of Maximum Glaciation, and on the Origin of Extra-Morainic Boulder-Clay, by Prof. H. Carvill Lewis.—The lakes so characteristic of all glaciated regions are due to several causes. Some few are due to an actual glacier scooping-out of the rock-floor, many to an irregular deposition of the drift by which former watercourses are obstructed, and still others to the terminal moraine or to the glacier itself. These latter, known as *morainic lakes*, may be divided into *inter-morainic lakes*, *moraine meres*, and *extra-morainic lakes*, according to their position—back of, in, or outside of the moraine. Extra-morainic lakes, if dammed up by the ice front, are temporary in character, disappearing with the retreat of the glacier; but, as they may be of enormous extent if the glacier is large, they may produce deposits of much geological importance. Instances of such lakes occur in Switzerland, and ancient examples occur as well in Northern Germany, Asia, North America, and Central England. They are to be expected wherever a glacier advances against or across the drainage of a country. Mr. Belt supposed that Northern Asia was covered by a lake of this character, caused by the Polar glacier obstructing the rivers flowing north. In North America, where the terminal moraine has been accurately mapped for thousands of miles, deposits of boulder-clay and erratics occur outside of the moraine, and have been supposed to be due to an older glacier in the first Glacial epoch. But the entire absence of striæ or of glacial erosion or moraines in this district prove that a glacier was not the agent of deposition. Nor are there any traces of marine life in the deposits. This extra-morainic boulder-clay is narrow in Pennsylvania, where the author had called it "the Fringe," but west of the Missouri it is 70 miles wide; and in British America, between the great moraine called the "Missouri Coteau" and the Rocky Mountains, it is 450 miles wide and over 1000 miles long. It only occurs where rivers had flowed *towards* the glacier, and is explained as the deposit of great temporary fresh-water lakes dammed up by the ice front, the erratics having been dropped by icebergs. Similar deposits occur in England outside of the terminal moraine, and have been the subject of much discussion; being held by some to be a proof of marine submergence, by others to be the ground-moraine of a glacier. The "great chalky boulder-clay" is the best known of these deposits. There are serious objections to the two theories heretofore advanced to explain this, whilst the hypothesis of extra-morainic fresh-water lakes, dammed up by the glaciers, is sustained by all observed facts. The most important of these lakes was one caused by the obstruction of the mouth of the Humber by the North Sea glacier, whose terminal moraine crosses that river at its mouth. This large lake reached up to the 400-feet contour line, and extended southward nearly to London, and westward in finger-like projections into the many valleys of the Pennine Chain. It deposited the "great chalky boulder-clay," and erratics were floated in all directions by icebergs. The conclusion that the glacial phenomena of England are due neither to a universal ice-cap nor to a marine submergence, but to a number of glaciers bordered by temporary fresh-water lakes, is in accordance with all the observations of the author in England and elsewhere.

On the Extension of the Scandinavian Ice to Eastern England in the Glacial Period, by Prof. Otto Torell.—The author described the glacial deposits of Eastern England, particularly those of Holderness and Cromer, the latter having been examined by him on several occasions during the last twenty years. Applying his experience gained during winters spent within the Arctic Circle, the author showed that the boulder-clay of Holderness and Cromer is a true ground moraine formed near the southerly limit of the Scandinavian ice-sheet. The Cromer tills were formed by an extension of the Baltic ice; Swedish boulders brought by this ice can be traced across the German plain, and are found at Cromer. The till of Holderness was formed by an extension of the Skagerack, as is proved by characteristic Norwegian boulders. The Baltic ice retreated first, and the Skagerack ice, still moving onward, ploughed into and contorted the Cromer till. The distribution of the boulder is described in detail, as also is the succession of the beds as worked out by Mr. Clement Reid, whose facts and conclusions fit well with the opinions advanced by the author.

A Comparative Study of the Till or Lower Boulder-Clay in several of the Glaciated Countries of Europe—Britain, Scandinavia, Germany, Switzerland, and the Pyrenees, by Hugh Miller.—The sections of foreign till examined by the author occur chiefly in the neighbourhood of the Trondhjem Fjord in Norway, at Berlin and Leipzig in Germany, near the Lake of Geneva in Switzerland, and in the valleys of the Pyrenees directly south from Pau in Southern France. In these countries and in Britain the till bears an identical character. It is not more variable throughout Europe than the author has found it to be in Scotland and Northern England. On the basement-gneiss at Christiansund, in South-Western Norway, it is the same as on the basement-gneiss of Sutherlandshire; in the great limestone valley of Eaux Chauds, in the Pyrenees, it is scarcely to be distinguished from the till of the limestone valleys of Yorkshire. In all the places mentioned (more doubtfully at Berlin and Leipzig) it bears the unmistakable character of a ground-moraine accreted under the direct weight of glacier-ice; its essential character is that of a rude pavement of glaciated debris ground from the rocks over which the glaciers have passed, with its larger boulders firmly glaciated *in situ* on their upper sides in the direction of ice-movement, and with a tendency to the production of fluxion structure here and there in the matrix, due to the onward drag of the super-incumbent ice. In mere indiscriminateness of composition (which is a character much emphasized by glacialists) the till is not to be distinguished from boulder-clays formed under berg- or raft-ice, such as the highest marine clays of the Norwegian coasts, which are stuck promiscuously through with boulders derived from the glaciers of the interior. The glaciation of boulders *in situ* the author finds to be a crucial distinction; he readily detected this "*striated-pavement*" character in the tills of all the districts above mentioned except Leipzig and Berlin, where the boulder clays more resemble the upper boulder-clay (Hessle clay) of the eastern seaboard of England and Scotland, and in the sections examined by him contained no large blocks.

Note on a few of the many Remarkable Boulder-stones to be found along the Eastern Margin of the Wicklow Mountains, by Prof. Edward Hull, F.R.S.—Amongst the evidences of the former existence of an extensive sheet of ice descending from the Wicklow Mountains towards the shores of the Irish Sea is the occurrence of boulder-stones, chiefly formed of granite or granitoid gneiss, derived from the mountainous range to the westward, of a size seldom equalled—probably not surpassed—amongst the British Isles. (1) The Mottha Stone is perched on the summit of Cronhane Hill, above Castle Howard, and is a conspicuous object for all directions. It consists of grey granite, and rests upon Lower Silurian slate; its weight would be about seventy tons. It lies at a level of 816 feet above the sea, and is about 10 or 12 miles from the flanks of Lugnaquilla, whence, as we may suppose, the granite block started on its journey. (2) In the valley between Castle Kevin and Moneystown, where large boulders are numerous, there lies a block of granite about 100 tons in weight. The birth-place of this boulder was probably the mountainous district about Mullaghcleevann, 2783 feet in height, lying at the head of the valley in which is situated the deep waters of Lough Dan, and it probably travelled a distance of 8 or 9 miles in an east-south-east direction. (3) The last boulder-stone is perhaps the largest in the British Islands. It stands behind a cottage by the roadside, near Roundwood Church, and is quite as large as the cottage itself, to which it forms a good protection from the storms descending from the mountains behind. This boulder consists of granitoid gneiss, resting on Lower Silurian slate and grit, and is about 240 tons in weight. The source of this block, which lies at an elevation of about 800 feet above the sea, was probably in the same locality with that of the Castle Kevin boulder, and the distance travelled was about 6 or 7 miles. The blocks above noticed, with many others of smaller size, do not belong to any of the local glaciers which once filled the valleys towards the close of the Glacial epoch, and which have left numerous well-formed moraines in nearly all the principal valleys descending from the Wicklow range. They are to be referred, in all probability, to the earlier stage of intense glaciation, in which the whole district was covered with perennial snows and ice, moving eastward into the hollow now occupied by the waters of the Irish Sea.

On New Facts relating to Eozoon Canadense, by Sir J. William Dawson, F.R.S.—For several years no new facts respecting the Canadian Eozoon have been published, though there has been some discussion on the subject abroad. In so far as the author is concerned, this has arisen from the circumstance that the late Dr. Carpenter had in preparation an exhaustive memoir, for which Canadian material was being supplied, but which was unfortunately left unfinished at his death. The material collected for this has now been placed at the disposal of Prof. T. Rupert Jones, F.R.S., and in the meantime the present note is intended merely to direct attention to some new facts recently obtained. The form of Eozoon has been definitely ascertained to be normally inverted conical or broadly turbinate, except where several specimens have become confluent, or when rounded masses have been based on some foreign body. The larger specimens are traversed by cylindrical or long conical vertical openings (pores or oscula), around which the laminæ, becoming confluent, form an imperfect wall. Some other points of detail were mentioned, and facts were referred to indicating the continuity and definitely stratified character of the beds in the Middle and Upper Laurentian of Canada. A variety of laminated rocks and minerals which had been mistaken for Eozoon were referred to. Their description in more detail will be found in forthcoming memoirs of the Peter Redpath Museum.

Elements of Primary Geology, by T. Sterry Hunt, F.R.S.—The author, after recalling his classification of original or non-clastic rocks into Indigenous, Endogenous, and Exotic masses, based on their geognostic relations, gives in a concise form his theory of the genesis of these various groups of rocks, as taught more at length in his recent volume entitled "Mineral Physiology and Physiography." The superficial portion of a cooling globe, consolidating from the centre from a condition of igneous fusion, he conceives to have been the protoplasmic mineral matter, which, as transformed by the agencies of air, water, and internal heat, presents a history of mineralogical evolution as regular, as constant, and as definite in its results as that seen in the organic kingdoms. This great transformation involves a series of processes, which include: (1) the removal from the protoplasmic mass, through permeating waters, heated from beneath, of the chief elements of the great groups of indigenous crystalline and colloidal rocks, by what he has called the crenitic process; (2) the modification of the residual portion by this lixiviation, which removes silica, alumina, and potash, and, by the intervention of saline waters, brings in additional portions of lime, magnesia, and soda; (3) the partial differentiation, by crystallization and eliquation, of portions of this more or less modified residue, giving rise to the various types of plutonic rocks. The direct and indirect results of subaërial decay through atmospheric agencies, and those of the products of organic life, are also considered. From the operation of all these processes result progresssive changes in the composition alike of plutonic and of indigenous rocks. The endogenous rocks or veinstones are, like the last, of crenitic origin, and may be granitic, quartzose, or calcareous in their characters.

The author next considers the conditions of softening and displacement of indigenous rocks which permit them to assume in many cases the relations of exotic rocks, and to become extruded after the manner of lavas, as seen in the case of trachytes and many granite-like rocks. Such masses he designates pseudoplutonic. With these are often confounded the endogenous granitic veinstones, which were formed under similar chemical conditions to the indigenous granites. Masses alike of indigenous, endogenous, and exotic rocks may also become displaced, not through softening, but by being forced while in a rigid state, through movements in the earth's crust, among masses softer and more yielding than they.

The author also considers the fluxional structure seen in plutonic and pseudoplutonic eruptive masses, which has led some theorists to regard these as of aqueous origin, and others to maintain that the crenitic stratiform masses themselves are of plutonic origin—two opposite errors which vitiate much of our geological literature. The crenitic process, by removing (from beneath what was the original surface of deposition) the vast amount of material which forms alike the indigenous, the endogenous, and the pseudoplutonic rocks, has effected a great diminution in volume in the protoplasmic mass, besides that due in later times to extrusion of plutonic matter itself. This decrease in bulk of the underlying stratum was a potent agent in producing the universal corrugation of the earlier crenitic rocks, and the frequent discordances observed among them.

The author considers further the gradual diminution of the crenitic process seen in the later periods of Archæan time, and its feebler manifestations in Palæozoic and more recent ages down to the present. He notes moreover, that, as the result of geographical changes, erosion and partial deposition alike disturbed the succession of the later groups of crenitic rocks, none of which can claim that universality and uniformity which belong to the oldest known group, the fundamental granitoid gneiss.

The author concludes with a brief sketch of the great divisions of the indigenous crenitic rocks recognized by him, from the most ancient granitic substratum to the Taconian series, which appears to be the last of the characteristically crystalline indigenous groups, it being, so far as known, succeeded directly by the uncrystalline Cambrian, or the equally uncrystalline Keweenian, which may not, improbably, be itself included in the lower part of the Cambrian series.

Gastaldi on Italian Geology and the Crystalline Rocks, by T. Sterry Hunt, F.R.S.—The author recalled the fact that, in discussing in 1883 the geological relations of serpentines, he had maintained that, although not confined to Archæan rocks (in which they are found at various horizons), those of Italy, believed by some geologists to be in part of Tertiary age, are, so far as his studies go, wholly Archæan, in accordance with the views set forth by Gastaldi. The serpentines and other rocks of the ophiolitic group existed in their present condition in the seas in which were deposited the Eocene strata, which latter, by subsequent terrestrial movements, had been disturbed, broken, and even inverted, so as to seem to pass beneath the ophiolites. The indigenous and neptunian character of serpentines is maintained, while the plutonic hypothesis of their origin has been so far modified by its modern Italian advocates that they now suppose the serpentines to be due to submarine eruptions of a hydrous magnesian mud, which subsequently consolidated into serpentine and even into chrysolite. It is difficult to admit any other than a neptunian origin for the stratiform ophicalcites into which the massive serpentines often graduate. In a letter written in July 1878 to the author, but until recently mislaid, Gastaldi showed that the ophiolites of the Ligurian Apennines and of those of Prato were, like those elsewhere examined by him, protruding portions of the ancient *pietre verdi* zone, identical with that of the Alps, from which the Apennines cannot be distinguished either geologically or geographically. The vast series designated by him as the *pietre verdi* zone, according to Gastaldi, overlies the ancient central or primary gneiss (generally granitoid, but including quartzites and crystalline limestones with graphite, &c.), and has a thickness of many thousand metres, embracing three subdivisions. The lowest of these, sometimes called by him the *pietre verdi proper*, includes serpentines, diorites, euphotides, chloritic schists, &c.; the second is designated by him recent gneiss and granite with mica-schists and hornblendic rocks; while the third consists in great part of soft argillaceous or lustrous schists, with included quartzites, marbles, statuary, and banded dolomites and occasionally also serpentines, the presence of which led Gastaldi to include it with the two preceding subdivisions in his great *pietri verdi* zone; a name which the present writer, with Neri and others would restrict to the lower subdivision, regarded by him as the equivalent of the Huronian of North America; the underlying or central gneiss being the Laurentian; the recent gneiss and mica-schist, the Montalban or White Mountain series, and the upper subdivision, the Taconian or Lower Taconic of North America; the wholly distinct Upper Taconic being an uncrystalline series of fossiliferous Cambrian strata. The writer in this connexion recalled the work of Neri, Gerlach, and others in the western Alps, and that of Von Hauer and his associates in the Lombardo-Venetian Alps, where the same distinction of the true *pietre verdi* zone between the ancient gneiss below and the recent gneiss above had, unknown to him, been pointed out by the Austrian Geological Survey two years before the present writer in 1870 defined and named the younger gneissic series in North America. The absence of the true *pietre verdi* series in some localities, alike in the Alps and in North America, between the older and younger gneisses was noted, as well as the existence of apparent discordances between each one of the four great divisions of Archæan or pre-Cambrian crystalline rocks above named.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. A. E. Shipley, of Christ's College, has been appointed Demonstrator of Comparative Anatomy; Mr. H. F. Newall, of Trinity College, Demonstrator of Experimental Physics; and Messrs. L. R. Wilberforce and H. L. Callendar, both of Trinity College, Assistant-Demonstrators of Experimental Physics.

Dr. Peile has been elected Master of Christ's College, an election which all classes of University men, and reformers in particular, rejoice in.

A novelty is to be introduced in the education lectures next term, Dr. Francis Warner, of the London Hospital, having consented to give a course of six lectures on the physical and physiological study of children.

The next examination for Entrance Scholarships and Exhibitions at Gonville and Caius College will begin on December 10. Candidates must be under nineteen on that day.

Two scholarships of £80, and four others of £60 to £40, will be offered, with exhibitions. Candidates for Natural Science Scholarships may be examined in any of the following subjects: physics, chemistry, biology, and animal physiology, and will be expected to show proficiency in two of them, of which chemistry must be one. The tutors will forward full particulars on application.

We cannot find space for the long list of lectures in natural science now being given at Cambridge. Prof. Liveing gives a general course of principles of chemistry, and Prof. Dewar lectures on dissociation and thermal chemistry. Prof. Thomson lectures on electricity and magnetism, and on the applications of dynamical principles to physical phenomena. One of the courses of demonstrations at the Cavendish Laboratory is an advanced one on the properties of matter, and on sound. Prof. Lewis lectures on mineralogy, Prof. Stuart on mechanism. Mr. Marr lectures on principles of geology, Mr. Roberts on the palæontology of Echinoidea.

Dr. Vines lectures on the physiology of plants (advanced), Mr. Potter on the geographical distribution of plants.

Prof. Newton lectures on evolution in the animal kingdom; Mr. Gadow on the morphology of Ichthyopsida (recent and extinct); the Curator in Zoology, Mr. Cooke, on the geographical distribution of recent Mollusca.

Prof. Foster's, Dr. Lea's, and Mr. Langley's physiological courses are as usual. Prof. Macalister gives demonstrations on topographical human anatomy, as well as an elementary course.

Prof. Cayley's lectures this term are on quaternions and other non-commutative algebras; Prof. Darwin's on the orbits and perturbations of planets. Mr. Glazebrook lectures on hydrodynamics (waves and sound); Mr. Hobson on spherical and cylindrical harmonics; Mr. Larmor on electrostatics; Mr. Forsyth on modern algebra (binary forms); Dr. Besant on theory of equations and differential and integral calculus; Mr. H. M. Taylor on higher plane curves; Mr. Pendlebury on theory of numbers; Dr. Glaisher on elliptic functions; and Mr. Stearn on elastic solids.

SCIENTIFIC SERIALS.

American Journal of Science, September.—Notes on the geology of Florida, by William H. Dall. In this paper the results are given of two excursions to Southern and Central Florida undertaken in 1885 and 1887 by instruction of the Director of the United States Geological Survey. Special attention is devoted to the process of contemporaneous rock-formation now going on along the Gulf shores of West Florida, and to the Tertiary rocks which prevail so largely throughout the Peninsula. No coral or coral-reef formation was anywhere observed, and it is evident from these further researches that the hypothesis of Agassiz regarding the geological origin of this region can no longer be maintained.—Notes on the deposition of scorodite from arsenical waters in the Yellowstone National Park, by Arnold Hague. The occurrence of this comparatively rare mineral as a deposition from thermal mineral springs is here noticed for the first time. It is found in several localities in the Yellowstone Park as an incrustation deposited from the waters of several hot springs and geysers, and is especially abundant at the Joseph's Coat Springs on Broad Creek, east of the Grand Cañon. The analysis—yielding Fe_2O_3 34·94, As_2O_5 48·79, and H_2O 16·27—shows this mineral to be true scorodite, a hydrous arsenate of iron, the layers varying from a mere coating to an eighth of an inch in thickness. Wherever observed it occurs as an amorphous deposit, and when pure, leek green in colour.—The effects of magnetization on the viscosity and the rigidity of iron and steel, by C. Barus. An attempt is made in this memoir to verify by a static method the results recently communicated by Mr. Herbert Tomlinson on the changes of viscosity and of elasticity produced by magnetizing iron. It is shown that the increment of rigidity due to magnetization increases at an accelerated rate as the soft, temporarily twisted wire becomes more nearly filamentary. A series of results is also given on the rigidity of magnetized steel temporarily strained and varying in temper from extreme hard to extreme soft. A main object of the paper is to show how the principles here established may be utilized for the construction of electric dynamometers.—Fauna of the "Upper Taconic" of Emmons, in Washington County, New York, by Charles D. Walcott. This paper deals specially with the fauna represented by *Atops trilineatus* and *Elliptocephala asaphoides* from the black Taconic slate near Bald Mountain, Washington County, as described by Dr. Emmons in his second memoir on the "Taconic System." The paper is accompanied by a plate illustrating nineteen specimens of this fauna.—On the amount of moisture remaining in a gas after drying by phosphorus pentoxide, by Edward W. Morley. This quantity is here determined by the method applied in the case of sulphuric acid, the process consisting in drying the gas with phosphorus pentoxide and then passing it through a weighed apparatus in which the gas is first slightly moistened, then much expanded, and lastly again dried by phosphorus pentoxide.—Is there a Huron group? by R. D. Irving. In this paper the author inquires whether there can be carved off from the upper part of the great complex of rocks ordinarily known as Archæan, a *Huronian* series, entitled to rank with such groups as the Cambrian, Siberian, &c. In this first part of the memoir it is shown that the series on the north shore of Lake Huron mapped by Logan on Plate iii. of the atlas to the geology of Canada (1863) is entitled to rank as a separate group by its intrinsic characters and its structural distinction from the older Archæan and younger Cambrian and pre-Cambrian rocks of that region.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 3.—M. Hervé Mangon in the chair.—On some properties relative to the action of crystalline plates on light, by M. Mascart. It is shown that a system of waves on the same plane traversing a crystalline plate with parallel faces is decomposed into two systems of polarized waves with unequal retardation which at the exit are reconstituted in a system of waves in a state of vibration different from the first. From this is deduced the theorem that the action on light of any group of crystalline plates, endowed or not with rotatory power, is equivalent to that of a single plate with axis parallel to the incident axis and perpendicular to the incident rays.—On an experiment with M. D. Colladon's artificial waterspout, by M. Mascart. The action of this ingenious apparatus, as well as that of M. Weyher, seems to show that there is undoubtedly an ascending movement in the central part of all cyclonic phenomena. With regard to the recent waterspout in Lake Geneva, it is pointed out that the ascending motion stated to have been witnessed by M. Dufour and other observers, could scarcely be an optical illusion, as maintained by M. Faye. Some of the water seen to ascend was afterwards precipitated as rain, drenching some men engaged on the railway.—Remarks on M. Colladon's recent experiment, by M. Faye. In reply to the foregoing, it is pointed out that in a series of remarkable experiments conducted under like conditions, M. von Bezold, Director of the Berlin Central Meteorological Observatory, has, on the contrary, produced a descending movement in the direction of the long axis. But M. Faye rejects both classes of experiments, holding that his theory is neither refuted by the first, nor confirmed by the second, as none of the apparatus in question really succeeds in reproducing a natural waterspout.—Experimental study of human locomotion, by MM. Marey and Demeny. In continuation of their previous communications on this subject, the authors here analyze, by means of the photochronographic process, the movements of the trunk in walking and running. The accompanying diagrams show the successive figures of a runner photographed from above at intervals of one-tenth of a second.—On the non-existence of spontaneous tetanus, by M. Verneuil. The existence is denied of spontaneous or medical as opposed to traumatical or surgical tetanus. It is shown, however, that besides the latter there also exists a variety of the disorder, for which the term tetanus by absorption is proposed.—Researches on the apparently spontaneous movements of contraction and relaxation which after death are continued in the muscles so long as the *rigor* lasts, by M. Brown-Séquard. The results are described of numerous experiments carried out on rabbits, dogs, and monkeys by means of the graphic process, showing that complex muscular action continues after death throughout the whole period of *rigor mortis;* that is, until putrefaction sets in, which may at times be deferred for several weeks. The action is mostly irregular, but occasionally almost rhythmical, and the more decided movements occur not in the early stages, but towards the end, sometimes in the second, third, and even fourth week. It is made clear that they cannot be attributed to changes of temperature, variations of humidity or ozone, barometric pressure, or other atmospheric influences, nor yet to magnetism or electricity, at least to any great extent. It will be shown in a future communication that they are due to the persistence of muscular irritability; that is, to the fundamental property of the living muscular tissue surviving till arrested by putrefaction.—General results of fresh studies on several series of fatty and aromatic monamines, by M. Malbot. These studies deal with the ethylamines, the propylamines, butylamines, amylamines, caprylamines, and aromatic amines. Their whole history is cleared up, and a general interpretation is arrived at of their formation. Whether occurring in the free state or in combination, they result from a conflict of energies between the rival affinities of ammonia and the amines for the ether and its acid. With regard to their formation, the author's experiments seem to favour the ethylene theory of Berthelot rather than that of ethyl advocated by Hofmann.—A memoir on the syphon barometer was presented by M. Govi, who credits Torricelli with the first idea, and Pascal with the practical execution and first employment of this instrument, the invention of which has been successively attributed to Robert Hooke, Robert Boyle, and Borelli. He shows that the principle was known to Torricelli in 1644, when he used it to explain to Ricci the theory of the cistern barometer; also that Pascal was acquainted with it in 1653, while Hooke mentions it for the first time in 1665, Boyle in 1666, and Borelli in 1667.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

The Student's Hand-book to the Microscope: A Quekett Club Man (Roper and Drowley).—Weather: Hon. Ralph Abercromby (Kegan Paul).—Our New Zealand Cousins: Jas. Inglis (Low).—Our Fancy Pigeons: George Ure (Mathew, Dundee).—The Solomon Islands and their Natives: H. B. Guppy (Sonnenschein).—The Solomon Islands, their Geology, &c.: H. B. Guppy (Sonnenschein).—A Sketch of Geological History: Prof. E. Hull (Deacon).—Factors in Life: Prof. H. G. Seeley (S.P.C.K.).—Pictorial Geography of the British Isles: M. E. Palgrave (S.P.C.K.).—Sixth Annual Report of the U.S. Geological Survey: J. W. Powell (Washington).—Journal of the Royal Statistical Society, September (Stanford).—Mind, October (Williams and Norgate).

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