THURSDAY, MARCH 10, 1887

THE AURORA BOREALIS

L'Aurore Boréale. Étude générale des Phénomènes produits par les Courants électriques de l'Atmosphère. Par M. S. Lemström. (Paris: Gauthier-Villars, 1886.)

Resultate der Polarlicht-Beobachtungen angestellt im Winter 1882 *und* 1883 *auf den Stationen Kingua Fjord und Nain.* Von Dr. K. R. Koch. (Berlin: A. Asher and Co., 1886.)

THE organised and obstinate scientific curiosity of our time has not neglected the beautiful phenomenon of the "Polar Dawn." Yet its investigation is attended by peculiar difficulties and discouragements. It can be profitably conducted only amid scenes of frozen desolation, in the grisly depths of Arctic winter nights, under conditions taxing man's energy and resource to live, to say nothing of observing. The appearances in question are, moreover, as elusive as they are surprising. They promptly kindle the imagination, but leave the understanding, unless prepared by special study to apprehend something of their causes, baffled and helpless. Nevertheless, auroral research, though Nature seem to frown upon it, has been pursued with indefatigable energy during the last half century. It has formed the principal object of some, it has occupied a prominent place in the programmes of all recent Polar expeditions; besides being furthered, with less heroic zeal, by writers and thinkers unequal or averse to the company of thermometers normally below the zero of Fahrenheit. Nor have these labours been thrown away. Much of the mystery long attaching to the evanescent splendours of Arctic skies has been dissipated. There is no longer any doubt as to the *kind* of explanation appropriate to them. Their laws and relationships have been, to a great extent, elucidated; a satisfactory theory of their origin is at hand; some circumstances of their occurrence, long in debate, have been attested on unquestionable authority.

An excellent specimen of the patient laboriousness by which these results have been brought about is afforded in the work of Dr. Koch, cited as one of our authorities. He was in sole charge of the German station of Nain, on the coast of Labrador, during the International Polar term 1882-83, and now presents us with the record of his observations there, together with those made simultaneously at the still more northerly post of Kingua Fjord. Although situated in about the latitude of Dundee—56° 33′—Nain appears to be, in point of climate, one of the grimmest localities accounted habitable on the face of the globe. Frost-bites were a quite common incident of Dr. Koch's daily experience; and furious winds, rendering the use of his meteoroscope impossible, often left him dependent upon the natural features of the solemn but forbidding landscape, for determining the azimuths of auroral bands and arches. As regards these phenomena, indeed, the station is admirably located. It lies close to the southern edge of, if not actually within, the zone of maximum frequency; auroræ are consequently numerous and intense, and appear almost indifferently above the northern or southern horizon. Their varying forms are beautifully delineated in the drawings which lend a greatly increased value to Dr. Koch's publication. Multiple arches, up to the number of eight, were frequently seen; and the incessant movements affecting them, both as a whole and in their parts, the transverse flashing of the rays set side by side to compose some of them, the torrential rushing of light along the paths others seemed to prepare for it, as well as the restless wanderings of the entire luminous structure up and down the sky, gave continual variety and animation to these strange exhibitions, while accentuating their baffling recalcitrance to exact measurement. No estimates of height were attempted at either Nain or Kingua Fjord; but there was a total absence of auroral appearances below the clouds, or otherwise unmistakably very near the earth, such as have been noted by M. Lemström and other observers in high latitudes. Luminous mists were, however, common. At times they suffused the whole sky; and shapeless masses of them constantly succeeded, and (at Kingua Fjord) were often the substitutes for the organised and definite forms of a perfect aurora. A sudden and wide-spread development of cirrus clouds was another curious secondary feature of the Nain polar lights. These were, at both stations, completely mute; not a suspicion of audibility attended their movements.

A no less intrepid observer than Dr. Koch is the author of the work with which we have coupled his in the heading of this article. M. Lemström's auroral researches began in 1868, when he was attached to the Swedish Polar Expedition commanded by Baron Nordenskjöld. They were continued during a sojourn of six weeks in Finnish Lapland in 1871, and were brought to a highly successful issue at Sodankylä in 1882-84. Finland held an honourable place among the eleven nations lately combined for a simultaneous attack upon the secrets of the Arctic circle; and the Professor of Physics in the University of Helsingfors was, by an almost inevitable choice, appointed chief of the Finnish meteorological station established in compliance with the terms of international agreement. Our readers are not unacquainted with the original line of work struck out by him in that capacity. Its upshot was to secure demonstrative evidence as to the *proximate* cause of the aurora borealis.

The book under review derives, then, a particular interest from its authorship. It is the production of a man who has devoted thought and labour without stint to the subject of which it treats, and has pushed the associated problems visibly nearer to solution. He now sums up the present state of knowledge as regards them in a well-arranged, concisely written, and copiously illustrated volume, recapitulating the most significant and surely established facts, fitting them, with the critical judgment bought by long experience, into their proper places, and expounding the theory best adapted to interpret and harmonise them.

Remarkably, as time went on, Halley's conjecture of a magnetic origin for auroræ gathered round it confirmatory circumstances entirely unknown to its author. Celsius and Hiorter noticed, in 1741, spasmodic disturbances of the magnetic needle coincident with the darting movements of northern lights. Wilcke, Ussher, and Dalton, ascertained, towards the end of the century, the close geometrical relations between the terrestrial magnetic

system and all the various parts composing a fully developed auroral display: the corona forming in the magnetic zenith, the streamers flitting parallel to the line of the dip, the arch erecting its summit in the magnetic meridian. When Faraday succeeded in obtaining luminous effects through magnetic action, and Rudolf Wolf demonstrated the subjection of auroræ to an identical periodicity with magnetic variations, the case might have appeared complete.

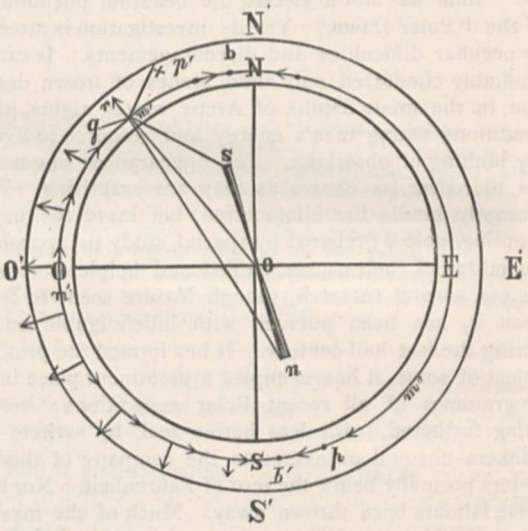
Yet the pure and simple magnetic theory of the aurora borealis, when attempted to be realised, either eluded the grasp of thought, or was found to involve admissions not very easy to make. Dalton, whose propensity towards forming distinct conceptions was a primary quality of his mind, had the courage to give it definite shape in 1793 (in his "Meteorological Observations and Essays"). Compelled, as he supposed, by the exigencies of observation, he conceived an envelope of an elastic fluid partaking of the nature of steel to replace atmospheric air at a height of about a hundred miles, and to supply the material alike of arches and streamers, shown, by their disposition in space, to be of a ferruginous character. It can scarcely be wondered at that the idea, in spite of Biot's adoption and development of it, failed to strike root. More vitality was in Canton's interrogative suggestion forty years earlier: "Is not the aurora borealis the flashing of electrical fire from positive towards negative clouds at a great distance, through the upper part of the atmosphere, where the resistance is least?" (Phil. Trans., vol. xlviii. p. 357.)

It was not, however, until the electrical illumination of rarefied gases came to be studied with detailed attention that the full effect of the visual identity of the two kinds of phenomenon became sensible. The analogy was defined and completed by some experiments made by De la Rive in 1853. They showed that a luminous discharge in an exhausted vessel, when influenced by a powerful electro-magnet, condenses into a ring of light encircling its pole, endowed, moreover, with a rotatory movement such as has frequently been observed to affect a system of auroral streamers. Here, for the first time, their true part in such displays was assigned to the forces emanating from the earth's magnetic poles. It is a directive, not a formative one. The structure, not the occurrence, of auroræ is conditioned by them.

A marked change in scientific opinion resulted, accordingly, from these investigations. The "magnetic effluvium" theory of the aurora borealis finally disappeared, and what we may call the "illuminated vacuum" theory took its place. The change was accompanied by a shifting of the ground of inquiry. What was urgently needed in order to render intelligible the mode of action producing the gorgeous flame-vesture of northern skies, was perceived to be, not so much improved knowledge (however desirable) of the laws of terrestrial magnetism, as a sound doctrine of atmospheric electricity. Here De la Rive broke down. His hypothesis of a polar accumulation, through the agency of the winds, of the positive charge of the air, was obviously untenable.

Nothing better was, however, proposed until 1878, when Prof. Edlund, of Stockholm, applied the principle of "unipolar induction," discovered by Weber in 1841, to explain the phenomena of atmospheric electricity (*Phil. Mag.*, vol. vi. p. 360). The effects thus designated are really derived, as a particular case (in M. Edlund's probable view), from the well-established laws of magnetic action upon electric currents.

Each element of the system of currents formed by the electrified particles of the rotating terrestrial crust and atmosphere is thus urged, by the powerful magnet which the earth may legitimately be regarded as inclosing within it, along a path at right angles to the line drawn from each of its poles to the current-element. The direction and relative strength of the impelling forces are indicated in the accompanying figure, copied from the work before



us (p. 166), where the particle m' is solicited towards × by the south pole (pointing north) of the magnet Sn, and towards g by its south pole. The combined result is to drive the particle upward and poleward along a line everywhere perpendicular to the swing of the dipping-needle. The vertical component, accordingly (represented by the arrows standing erect on the circle $m'\ m''\ m'''$), attains a maximum at the magnetic equator, where the dip vanishes; the tangential component is there = 0, and attains its highest value in middle latitudes.

Several remarkable effects ensue: first, that atmospheric electricity gains potential with elevation—an observed fact; next, that it is constantly travelling away from the equator towards either pole. The circulatory process, however, thus set on foot, must be carried further; and in its continuance and completion M. Edlund finds the key to the auroral mystery.

At and near the equator, recomposition of the positive electricity of the air with the negative electricity of the earth is opposed by the whole strength of magnetic inductive repulsion, there acting vertically. When effected at all, it can only then be by sudden, violent, disruptive discharges, apparent to our senses as lightning. But the increasing inclination of the magnetic needle in higher latitudes renders the line of no resistance marked by it continually more practicable as an avenue of descent for the accumulating positive fluid. Hence, when it has attained a certain potential, gradual discharges take place over two polar zones, *along the line of the dipping-*

needle. These constitute what we are accustomed in the northern hemisphere to call the aurora borealis.

Auroræ are, in this view, the polar equivalents of lightning. The same office of relieving the electrical tension of the air is fulfilled by them with innocuous tranquillity. Not indeed in absolute silence, though the "eerie din" of their rustling streamers has been caught by very few ears. Major Dawson, however, was fortunate enough to hear once, and once only, during his sojourn at Fort Rae, 1882-83, a sound "like the swishing of a whip, or the noise produced by a sharp squall of wind in the upper rigging of a ship," which accompanied, with its *crescendo* and *diminuendo*, the brightening and fading of an aurora visible at the time. This was the first official confirmation of innumerable less authentic reports to the same effect.

The mutual relations of auroræ and thunderstorms are full of significant interest. In point of geographical distribution, they may be termed complementary. The one kind of phenomenon is not more characteristically of polar than the other is of tropical origin. We take from M. Lemström's pages the following concise table, strongly corroborative of Edlund's theory, showing the dependence upon latitude of storm-frequency:—

Latitude				Mean annual number of storms
Between	0°	and	30°	... 52
,,	30°	,,	50°	... 20
,,	50°	,,	60°	... 15
,,	60°	,,	70°	... 10
About			70°	... 0

Yet the two kinds of atmospheric luminosity are separated by profound distinctions. Thunderstorms give no sign of systematic magnetic associations. Sometimes, it is true, the needle may be seen to quiver at the instant of a lightning-flash, but by what seems a casual disturbance, quite different from the tumultuous agitation which accompanies or even betrays the darting of northern lights.

Storms are, moreover (so far as is known), completely exempt from the complicated periodicity by which auroral appearances are regulated. Now this, as M. Tromholt discovered in 1882, is exactly inverted in the far north. His discussion of M. Kleinsmidt's observations (1864-80) at Godthaab in North Greenland made it apparent that, on the polar side of the great auroral zone, a sunspot maximum brings with it an auroral minimum, and *vice versâ*; that the two equinoctial peaks of the auroral curve in middle latitudes there coalesce into a single elevation at the winter solstice; and that the evening maximum noted further south is there shifted to the morning. Nor are these curious inversions peculiar to Godthaab.

Their immediate cause is easily understood. The auroral zone swings to and fro in several superposed periods, over the surface of the earth. As the sun's activity augments, it travels slowly towards the equator, and retreats towards the pole as it diminishes, diversifying its progress with minor oscillations, daily, bi-annual, and (perhaps) monthly. The analogy of the closing-in of the solar spot-zones with approach to maximum is striking, but unexplained. Auroral periodicity is thus seen to depend, not upon cessation, but upon removal, and the observed reciprocal relation between auroral frequency in middle and very high latitudes is completely accounted for.

We can even go a step further. By Edlund's theory an increase of atmospheric electricity must be attended by a lowering of the latitude in which recomposition takes place. That is to say, the observed shifting in space of the auroral zone implies, and is explained by, a rise and fall of potential in the upper conducting strata of the air, synchronising with the rise and fall of solar disturbance. This is probably in part an indirect effect of the fluctuations in the sun's activity.

Electricity, in M. Edlund's view, is simply the ether of space, a certain share of which belongs naturally to every ponderable substance. When this normal store is by any means augmented, the body on which the accumulation takes place is positively electrified; when it is diminished, negative electrification ensues. Hence, the expulsion of this so-called "fluid" from the earth by magnetic inductive action leaves it, *ipso facto*, negatively charged, and produces a positive charge in the air.

All this M. Lemström, in the work before us, readily admits; but he supplements the magnetic forces at work in disturbing our planet's electrical equilibrium with evaporation, of which the enormous capabilities for producing high potentials have been indicated by Prof. Tait (NATURE, vol. xxix. p. 517). But evaporation doubtless proceeds most vigorously when the sun's radiative energy is strongest—that is (presumably), at epochs of spot-maximum, so that an obvious link is thus supplied between the solar and auroral periods. The sequence of cause and effect is as follows: the sun's increased power quickens the development of aqueous vapour; this, in its turn, gives rise to a more copious supply of atmospheric electricity; added tension insures more speedy neutralisation; the zone of gradual recomposition descends towards the equator, and auroræ are more frequently visible in middle latitudes.

Yet this is perhaps not the whole truth. Many circumstances speak in favour of a direct electrical inductive action of the sun upon the earth. M. Quet has lately shown (*Comptes rendus*, t. xcviii. p. 1038) that the existence of a magnetic fluctuation corresponding in period with the sun's rotation on its axis is otherwise inexplicable; and the instantaneous response of the terrestrial magnetic system to the solar outburst of September 1, 1859, almost compels the same inference, which is strengthened by the undoubted growth of magnetic intensity with solar activity. Hence, as sunspots become numerous, the circulatory process described by M. Edlund must be quickened and strengthened; atmospheric electrical tension will be heightened; and although the repellent magnetic power is proportionately reinforced, this is more than counterbalanced by the added mutual attraction between the opposite electricities of earth and air. Through this cause also, then, the auroral zone widens its distance from the pole once in eleven years.

The view that auroræ are due to currents of positive electricity illuminating the air on their passage to the earth, has been solidly established by M. Lemström's results at Sodankylä. His "discharging apparatus" served the precise purpose of Franklin's kite. The one

experiment was not more decisive than the other. Not only did luminous appearances accompany the setting-in of a current towards the earth from the network of insulated wires spread over the summit of Mount Oratunturi, but the light evoked was distinctively *auroral*. Examined with the spectroscope, it yielded the still enigmatical "citron-line" discovered by Ångström in 1867. This is the invariable and chief constituent of auroral radiations. Besides one fitfully present, detected by Zöllner in the red, it is the only vivid line its spectrum includes. Ten others, more or less dubiously enumerated, are faint, hazy, indeterminate. M. Lemström holds that there is a fair agreement between some of them and lines in the laboratory-spectrum of rarefied air. But this is perhaps a too sanguine opinion. These seeming coincidences are very loose, and have not been drawn closer by careful inquiry. Vogel's conclusion that the spectrum of the aurora is modified from that of atmospheric air is indeed highly probable, but its probability is derived far more from external than from internal evidence.

A. M. CLERKE

THE BUTTERFLIES OF INDIA

The Butterflies of India, Burmah, and Ceylon. A Descriptive Hand-book of all the Known Species of Rhopalocerous Lepidoptera inhabiting that Region, with Notices of Allied Species occurring in the Neighbouring Countries along the Border. With Numerous Illustrations. By Lionel de Nicéville, F.E.S. Vol. II. Royal 8vo. (Calcutta. London: Bernard Quaritch, 1886.)

MORE than four years have elapsed since the first part of this book was published, and one of the authors has been obliged to resign his share in the work. The second volume, which has been written by Mr. de Nicéville alone, is in no way inferior to the first. When we remember that in the trying climate of Calcutta, and only in the leisure hours which can be spared from official work, Mr. de Nicéville has with but very trifling assistance from the Government of India completed a volume of nearly 300 pages, containing over 300 species of butterflies, we must allow that he deserves great praise; and though a volume produced under such difficulties must of necessity contain faults, yet it is in every respect very superior to Mr. Moore's work on the Lepidoptera of Ceylon, which was largely subsidised by Government. There is no doubt that the impetus given to the study of the butterflies of India by the publication of this work will have the best results, and we have every reason to hope and believe that it may be completed in three or four years more at latest. The present volume is devoted almost entirely to the family of Nymphalinæ, and brings up the number of Indian butterflies already described to over 600, all of which are treated in a thoroughly scientific, careful, and painstaking manner.

Though the author has gathered to his assistance a growing band of field workers in various parts of India, among whom Messrs. Möller, Knyvett, Graham-Young, Colonel Swinhoe, and others are conspicuous, and is rapidly accumulating a large quantity of specimens from all parts of the country, he still labours under the difficulty of being unable to see the types of many of the so-called species described by Messrs. Butler and Moore in Europe. Evidence is constantly being brought forward to confirm the opinion of most entomologists, that a large proportion of the names given by these authors represent no fixed or constant varieties, and that the characters described by them cannot be recognised in the insects themselves; but it is impossible to ignore them until this can be proved by comparison of these types with large series of specimens. Under these circumstances, Mr. de Nicéville has acted wisely in printing the descriptions of all these doubtful species, so that the attention of collectors may be called to them, and their existence proved or disproved. His remarks on them have the advantage of being intelligible, which is not always the case with the original descriptions of the authors in question, who have had for some years almost a monopoly in the description of Indian butterflies.

The kind of difficulty which occurs in many instances may be illustrated by the author's final remarks on the numerous varieties of the genus Abisara, described as species by Mr. Moore.

"A *prunosa* is typically the darkest coloured, and in the male most brilliantly purple-shot, of this group of the genus, specimens from Travancore being particularly large and dark. Even among Ceylon specimens, however, I find considerable variation; in some males the inner discal band on the fore-wing is evenly convex, and in others distinctly angled in the middle, and the purple suffusion is also variable; the size and number of the black spots on both sides of the hind-wing is extremely inconstant. In one very abnormal specimen there are two sub-apical spots, only the anal ones being entirely wanting. From an island one would expect to find some distinguishing characters in a species supposed to be peculiar to it, but I have quite failed to discover any. I can only repeat that, in my opinion, the name *echerius* should apply to all the species of this group of the genus Abisara, except perhaps to the Andaman local race, which has been named *bifasciata;* that as, in this case, the geographical range of numerous slight local races is not segregated, and each local race must interbreed with the next on the boundary-line which is supposed to separate them, it can serve no good scientific purpose to pick out a few apparently different specimens from each local race and to describe them, at the same time ignoring the intergrade specimens which exist."

If this opinion had been more generally held, the study of the butterflies of India would have been much simplified, and it is to be hoped that a new edition of "The Butterflies of India," which will certainly be called for almost before the first is complete, will show a large reduction in the number of names. A fixed nomenclature is the first desideratum in this as in other branches of science, and tends more than anything to attract good workers, who are often disgusted by a long list of synonyms and by changes in well-known old names.

The keys to the genera and species have been worked out very carefully, and will be useful to beginners. The literature, geographical distribution, and variation of each species are also well and carefully done. The volume will be indispensable to lepidopterists generally, and ought to interest many in India, who have hitherto looked on the collection of butterflies as rather a pastime than a science.

H. J. ELWES

OUR BOOK SHELF

The Deviation of the Compass in Iron Ships considered Practically. By W. H. Rosser. Second Edition, with considerable additions. (London: James Imray and Son, 1887.)

REMEMBERING the number of books already published treating in a practical form of compasses, their deviations on board iron ships, and the consequent adjustments, some persons may be disposed to ask, "What purpose will be served by an addition to them?" In answer it may be said that this, the second edition of a useful work by an author who bases his knowledge on the teaching of the "Admiralty Manual," and knows from instructing others their many difficulties, can hardly fail to be welcome to those having neither time nor ability to assimilate the subject without a guide at every turn.

Whilst we hope that Mr. Rosser's later edition will be duly appreciated, there is a certain definition which, for the sake of simplicity and accuracy, we would fain see removed from it. At pp. 30 and 31, clear definitions are given of true, magnetic, and compass courses. Why not let well alone, and not complicate the matter by introducing the term "correct" magnetic course? A reference to the later editions of the Admiralty publications on the deviation of the compass shows that the word "correct" in connection with "magnetic course" has been entirely omitted, apparently as no longer serving any purpose.

The concluding paragraph of the preface on patent compasses is hardly fair to Sir William Thomson's. The principles involved in the construction of his compass are not in themselves novelties, but he has done world-wide good by showing in it how that enemy of compasses—friction—may be avoided, whilst at the same time he has produced a card which is almost free from oscillation when the ship rolls heavily.

Travels in the Wilds of Ecuador. By Alfred Simson. (London: Sampson Low, 1886.)

"NO one with the spirit of roaming within him," says the author of this book, "can live long in Ecuador without cherishing a growing desire to explore its unknown parts." Some time ago, accordingly (the exact date is not mentioned), he started with a companion from Guayaquil for Baños, and from Baños they went through the forest to the village of Aguano, on the River Napo, completing the road in eighteen days' actual walking, or forty-five days' foot journey, including necessary stoppages. At Aguano they were obliged to remain forty-two days, which they spent partly in collecting Lepidoptera, partly in making voyages of discovery by land and water in search of provisions. They then made their way in canoes down the Napo to the Amazon, which they reached after a voyage of twenty-five days. At Iquitos the two friends parted, Mr. Simson's companion setting out to explore the Ucayali, while Mr. Simson himself joined a Mr. Reyes in an expedition up the River Putumayo.

The story is very simply and pleasantly told, and those who like to read about distant lands of which little is generally known, will find much to interest them in the author's record of his adventures. The best parts of the book are those in which he describes the Indian tribes of Ecuador, whose habits and modes of thought and feeling he closely observed. He also notes some rather curious facts in natural history. Probably few persons have ever heard of "the roaring of an alligator." "I heard it myself," says Mr. Simson, "on one occasion in the case of a huge beast who appeared to be following a female of his species." The animal was swimming very rapidly, diving and rebounding up to the surface of the water. Mr. Simson was in a small Rob Roy canoe, and remained still to watch his manœuvres. Immediately the alligator saw the canoe, he "came towards it, roaring like a bull at each bound above water." As he was diving, Mr. Simson (who was unarmed) forced the canoe straight over him, and so escaped. "Curiously enough," we are told, "not half an hour after this episode, an alligator jumped from a steep bank over my canoe, and only just cleared it, as I was distractedly paddling along under the shore, and inadvertently startled the reptile above me."

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.*]

Tabasheer

AS I have occasionally found the curious stony plug of which Mr. Thiselton Dyer writes (NATURE, vol. xxxv. p. 396), in the joints of bamboos accidentally broken, and been much exercised as to the nature and origin of the phenomenon, I have been much interested by his paper. May I further suggest that it is to a certain extent pathological—due, that is, to *arrested growth*, either longitudinal or lateral, in the shoot next above the joint in which the stony secretion or sediment is found.

In the onrush of tropical growth in the young shoot, Nature, after flooring the knot, has poured in, as it were, sap and silica sufficient for a normal length and width of stem to the knot next above it. But by some check to the impulse, or irregularity of conditions, the portion of stem thus provided for is shorter or narrower than intended; and the unused silica is left behind as a sediment, compacted by the drying residuum of sap. It is a question only to be settled by close examination of a great number of examples.

Something like it occurs, however, in the case of our own wheat. Larger joints, that is, and stronger walls are commonly found where the length of stem between joint and joint is a short one. As in the bath for electroplating the same amount of silver is deposited in a given time on a single penny as on a tea service of many pieces, so in the case of quick-growing silicated stems it would seem as if the same average amount of material were provided by the mounting sap, and the constructive use actually made of it determined by many accidents. In the wheat stem the silica is differently placed; in the fiercely-growing bamboo shoot the mineral in excess is left behind in a crude form, and disregarded. That is what I should expect to find.

HENRY CECIL

Bregner, Bournemouth, March 1

Temperature and Pressure in Jamaica

THE following table of elevations and averages is not as perfect as might be wished, but as some years must pass before it can be greatly improved, it is here given as one of many results obtained by the Meteorological Service in Jamaica:—

Station	Elevation Feet	Pressure Inches	Max.	Mean	Min.	Range
Kingston	0	30·00	87°·0	78°·2	71°·0	16°·0
Kempshot	1773	28·20	80·5	72·7	68·0	12·5
Cinchona Plantation ...	4907	25·27	68·5	62·6	57·5	11·0
Portland Gap	5477	24·71	69·0	59·7	54·6	14·4
Blue Mountain Peak...	7423	23·14	71·1	55 7	46·3	24·8

In NATURE, vol. viii. p. 200, it was suggested that the fall of temperature, δT was connected with the fall of pressure δP by the equation

$$\delta T = \lambda . \delta P,$$

where λ was taken equal to 3°·23.

We can now correct this expression and take

$$\delta T = \lambda . \delta P + \mu (\delta P)^2,$$

where $\lambda = 2°{\cdot}92$, and $\mu = 0°{\cdot}08$. But these values relate to mean temperatures; for minimum temperatures $\lambda = 0°{\cdot}96$, and $\mu = 0°{\cdot}40$.

These expressions and their connection are important, and it

would be interesting to know whether similar results have been found in India and elsewhere within the tropics, or may yet be obtained.

Computing δT by means of these formulæ, and applying the results to the temperatures at Kingston, we have

	Mean	Min.
Kempshot	72°7	68°0
Cinchona Plantation ...	62·6	57·5
Portland Gap	60·5	54·7
Blue Mountain Peak ...	54·4	45·6

which are fairly satisfactory.

Putting $\delta P = 30$ inches, the minimum formula gives $-311°$ as the temperature of space, the thermometer being shaded from the sun by any spherical body such as the earth or moon.

Putting $\delta P = 30$ inches, the mean formula gives $-81°$ as the mean temperature of a body devoid of atmosphere, such as a meteorite pursuing its course in space, or the moon, at the mean distance of the earth from the sun.

An expression for maximum temperatures cannot be as easily deduced; but if the surface of the meteorite or the moon which is turned from the sun be $-311°$, and if the mean temperature be $-81°$, it follows that the maximum temperature of the surface turned towards the sun must be about $+149°$.

Jamaica, February 12 MAXWELL HALL

Electricity and Clocks

IN addition to the plan pointed out by Prof. Sylvanus Thompson (the correct way to repeat from a striking clock to electric bells), I believe I have seen an arrangement in Dublin whereby a single port or going train only is made to strike the hours on an indefinite number of electric bells. I believe this mechanism is a patent. HORLOGE

Sandymount, March 2

Top-shaped Hailstones

ON August 6, 1885, a hailstorm occurred in this neighbourhood, during which two waterspouts were seen. After one of these had burst, a fall of hailstones, almost exactly similar to those described by Mr. Middlemiss in your issue of March 3 (p. 413), commenced and lasted for some minutes. I do not remember to have noticed that there was a mass of clear ice at the base of the cone, but the banding was very distinct.

Beside the horizontal stratification there was another perpendicular one, giving the hailstone the appearance of being composed of alternate cylinders of clear and white ice. If the hailstones which Mr. Middlemiss saw at Ramnagar showed this peculiarity, he will perhaps be kind enough to communicate the fact through your columns. Sketches of the hailstones which fell in this district were published in the *Meteorological Record* soon after the occurrence, but I cannot give the precise date of the copy. T. SPENCER SMITHSON

Facit, Rochdale, March 7

The Present Southern Comet

EITHER the present brilliant southern comet is periodic, or one of a large family of comets, moving in similar orbits and possessing marked similarities of structure. Its orbit, as far as an orbit can be determined from the approximate positions of a very indefinite nucleus, is similar to those of the 1843 and 1880 comets. In Grant's "History of Astronomy" the following description of the 1668 comet occurs:—"It appeared a little above the western horizon. The tail measured 23° in length, and resembled a huge beam of light. The head was so small as to be scarcely visible. The observations will be represented with sufficient accuracy by the elements of the orbit of the comet of 1843." A fairly accurate description of the present comet. There are other comets—1618, 1689, 1702—which possess this strong family likeness. If these comets be not one and the same, they must all have had a common origin. I do not know if it has been noticed that the aphelia of their orbits lie within a few degrees of Sirius. It may be possible that they have all been ejected from that gigantic sun; at any rate, it is impossible that they could have been attracted from nebulous masses lying beyond Sirius. A. W. R.

Lovedale, South Africa, February 1

The Earthquake

I EXAMINED my magnetograms very carefully on the day of the earthquake in North Italy, and I find no trace of any special disturbance on the H.F. trace similar to that on the Kew curve. It may be well to place this on record, as it may aid in fixing the limits of the disturbance. S. J. PERRY

Stonyhurst College, Blackburn, March 7

CEREBRAL LOCALISATION[1]

I.

IT is rather more than ten years since the first edition of this book came under review in the pages of this journal. And it was intrusted to very able hands, for the reviewer was George Henry Lewes, himself an experimentalist in this branch of physiology, and of the highest distinction as a philosopher and psychologist. The review is courteously but unflinchingly hostile: exception is taken to some of the facts and to most of the deductions of the author; although the value of the work, from its richness in suggestions as well as in facts, is ungrudgingly admitted. Mr. Lewes especially complains that the book "is so deficient in the indispensable correctives of counter facts and arguments, that the reader must be cautioned against accepting any position unless elsewhere verified. . . . From one cause or another there is a disregard of counter evidence, which, in a second edition, I should seriously urge him to rectify. . . . This disregard arises from no unfairness, but simply from the one-sidedness which comes from preoccupation with certain views."

The increased size of the work (498 pages instead of 323) is, no doubt, in part due to an endeavour to carry out this suggestion, although the growth of the subject may of itself, in great measure, account for such increase. Indeed, it must be confessed that the characteristic complained of by Mr. Lewes has not by any means entirely disappeared, and the student who may consult its pages must bear in mind that the book still remains the gospel of the functions of the brain "according to Ferrier."

The pervading idea of the work is expressed by the term "localisation of function." It was against this idea (and especially against certain applications of it) that Mr. Lewes brought to bear the full powers of his criticism.

One serious objection which was urged by him against many of Dr. Ferrier's results (those of localised extirpation) was that he was unable to keep the animals alive long enough to allow the effects of Disturbance of function to subside, so as to leave only the effects of Removal to be estimated. But the use of antiseptics has now permitted this objection to be removed, since there is no longer, in most instances, the same difficulty in preserving the animals, as was the case in Dr. Ferrier's first experiments.

It is further urged by the previous reviewer that "neither the effects of Disturbance nor the effects of Removal are to be taken as conclusive evidence that the function disturbed or removed is the function of the organ operated on." [But although not of themselves conclusive, yet if looked at in conjunction with other evidence they may furnish important indications regarding the function of the organ.] Mr. Lewes further affirms that "whenever a function persists or reappears after the destruction of an organ, this is absolutely conclusive against its being the function of *that* organ," meaning, of course, of that organ alone. That, in the case of recovery or reappearance, partial or complete, of a lost function, another organ previously possessed of a different function has vicariously taken its place, is a scarcely tenable hypothesis. And yet there are well-recorded instances of such reappearance: as in the case of Goltz's dogs, which recovered some of the lost power of voluntary movement; and in that of the visual disturbances which are caused by lesions of the occipital lobe, in which

[1] "The Functions of the Brain." By David Ferrier, M.D., LL.D., F.R.S. Second Edition, re-written and enlarged. (London: Smith, Elder, and Co., 1886.)

I have myself frequently observed recovery, to all appearance complete. It appears to me that the idea expressed by the term "concentration of function" harmonises much more fully with our existing knowledge of the facts relating to this question than the more inflexible phrase "localisation."

It is time, however, to turn to the edition which lies before us. Dr. Ferrier, in his preface, tells us that the book has been almost entirely re-written, and, in point of fact, so much has been added and modified as to constitute this edition, in many respects, a new book. But the principal teachings of the original—those to which the book from the first owed its chief interest—the doctrines, namely, therein advocated regarding the localisation of cerebral functions, are, it is claimed by the author, maintained in all essentials unchanged. Since it is to the exposition of these doctrines, and especially of the experimental facts upon which they rest, that the student of physiology or psychology would naturally first turn, in order to discover what that is new may have been adduced in support of the Ferrierian teachings, and in what manner the hostile attacks which have been directed against them are met by their author, no apology is needed if we devote our attention first and chiefly to those parts of the book which deal with this important question.

After it had been found impossible to deny the correctness of the facts regarding electrisation of the cortex of certain regions of the brain, a vigorous onslaught was made from various quarters upon the method of experimentation. It was especially contended (by Dupuy and others) that the movements produced by this method are really due, not to excitation of the cortex cerebri itself, but to conduction of the current to the basal ganglia (corpora striata). But a single new fact entirely overthrows the last remnant of this objection, since it has been shown (by Franck and Pitres) that similar movements may be caused by mere mechanical stimulation of the cortex (p. 228). Indeed, the same observers entirely deny that the basal ganglia respond at all to direct electrical excitation, a statement which we shall afterwards see is not, however, accepted by Dr. Ferrier.

In the review above alluded to, Mr. Lewes alleges two principal facts against the doctrine that the gray matter of the cerebral cortex is directly excitable, viz.: (1) the fact that only the electrical current causes an excitation,—mechanical and chemical stimuli have no such effects, because they cannot pass through the cortex to reach the white substance; (2) what he terms the "decisive experiment" of Dr. Burdon Sanderson. "If that part of the surface of the hemisphere which comprises the active spots is severed from the deeper parts by a nearly horizontal incision made with a thin-bladed knife, . . the result is the same as when the surface of the uninjured organ is acted upon" (Proceedings of the Royal Society, No. 153). But we have just seen that, under suitable conditions, the cerebral surface may be excited mechanically; and, with respect to the second fact, I imagine that Dr. Sanderson would now be the first to admit that his results were due either to imperfect severance or to the spreading of a current of too great intensity.

Moreover, the study of the characters of the contractions which result from excitation of the cortex has tended to show that its excitation is indeed a stimulation of centrifugally discharging nerve-centres, and in conformity with this view it is found that destruction of the cortex in the excitable regions is followed not only by immediate paralysis of the parts in which movement is evoked on excitation, but also by speedy degeneration of the efferent nerve-fibres. The arguments upon this point are set forth briefly, but clearly, by the author (pp. 231–33).

With regard to the results of localised excitation of the cortex (in the monkey), some modifications which are not wholly unimportant have been introduced; but to obtain these the author appears rather to have again consulted his original memoir (Proc. Roy. Soc., No. 161, 1875) than the results of any new experimental investigations. The facts that the excitable region extends over the margin of the hemisphere to include the marginal gyrus upon the mesial surface, and that this part of the excitable region is associated with movements of the leg and trunk, had not been definitely determined at the time of publication of the first edition, but are duly recorded here (p. 245).

The general correctness of Dr. Ferrier's statements regarding the results of localised excitation of the brain in the monkey (and, from its resemblance to the human brain, these will be those of chief interest to most readers) seems at the present time to be universally admitted. I have myself so frequently had the opportunity of verifying them as to have no doubt of their general applicability. But the *inferences* which he has drawn from the results of excitation have not, as we shall presently see, been allowed to remain unquestioned.

The method of localised ablation is of yet more importance for the determination of the functions of the cortex than that which we have just considered. In carrying out this method, the necessity of strict adherence to Listerian precautions is demonstrated when we compare the results which were obtained in the first instance by Dr. Ferrier himself, and recorded in the first edition of this book, with those which have been yielded by the antiseptic method in the hands of Prof. Yeo and himself, in a series of experiments undertaken with the express object of testing the applicability of that method to brain-surgery, several of which experiments are recorded in this edition. The path which their experiments indicated has since been trodden by my colleague Mr. Horsley and myself, and it is to-day a beaten track leading to previously undreamed-of possibilities in surgical science. The fact that the brain can be as effectually searched with a view to the discovery and removal of a tumour as any other part of the human body is an advance of vast extent—a boon to suffering humanity of incalculable value. And that this boon has been acquired, could have been acquired, solely as the result of experiments upon animals, is a fact which may well make the most frenzied of anti-vivisectors pause ere he would deny to his fellow-men the opportunity of acquiring benefits of such inestimable worth!

At the present time it is admitted, even by those physiologists who, like Goltz, have been hitherto accounted the most strenuous opponents of the doctrine of cerebral localisation, that the results of localised extirpation of the cortex vary with the part removed. These results consist of a loss or diminution in the power of voluntary action of different groups of muscles, or of a loss or defect in the appreciation of sensory impressions (but, according to some observers, both volition and sensibility may be at the same time affected by the destruction of certain parts): lastly, from experiments upon some parts of the hemisphere, it may happen that no effect appreciable to the observer is obtained. With respect both to these results and those obtained by excitation, Dr. Ferrier, in the first edition of this work, took up certain positions which have in the meanwhile been vigorously assailed from various quarters. These positions are, in the present edition, for the most part defended by the author with no less vigour, although one or two have been somewhat shifted, and one, at least, altogether abandoned.

In order to make clear these positions to those readers of NATURE who may not have followed closely the controversies which have been carried on during the past fifteen years regarding this subject of cerebral localisation, it will be necessary briefly to describe, with the aid of a diagram, the main features of the external configuration of the monkey's brain (every fissure and convolution in which is represented in the human brain). It will then be easy to indicate the regions to which special functions were originally ascribed by Dr. Ferrier, the modifications

which he has since seen reason to introduce in the original scheme, and the results which have been arrived at by certain other workers in this field of research.

Fig. 1 is a diagram of the outer surface of the left hemisphere of the monkey's brain: in it the fissures are represented by black lines. It is seen to be crossed obliquely by six prominent fissures (besides less important

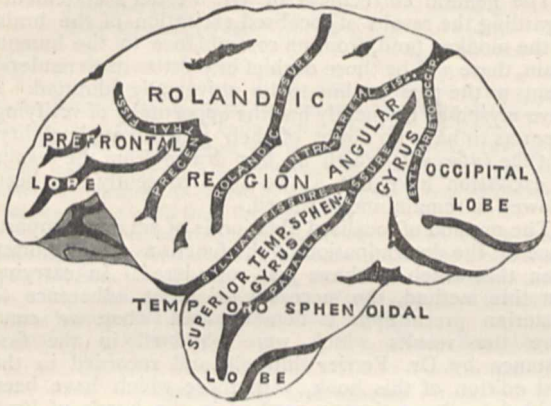


Fig. 1.

depressions). These, enumerated from before back, are the pre-central, Rolandic, intra-parietal, Sylvian, parallel, and parieto-occipital fissures. The anterior portion of the hemisphere in front of the pre-central fissure is termed the pre-frontal lobe. The part of the brain behind this, and bounded behind by the intra-parietal and Sylvian fissures, may be designated the Rolandic region, since it includes the Rolandic fissure. The next part, posteriorly, lies in the angle between the intra-parietal and parieto-occipital fissures, and has the end of the parallel fissure running up into it: it is known as the angular gyrus. Behind the parieto-occipital fissure is the occipital lobe. The rest of this surface of the hemisphere below and behind the Sylvian fissure is the temporo-sphenoidal lobe: the convolution in this which lies between the Sylvian and the parallel fissures, and which is thus very well marked off from the rest of the lobe, is the superior temporo-sphenoidal gyrus.

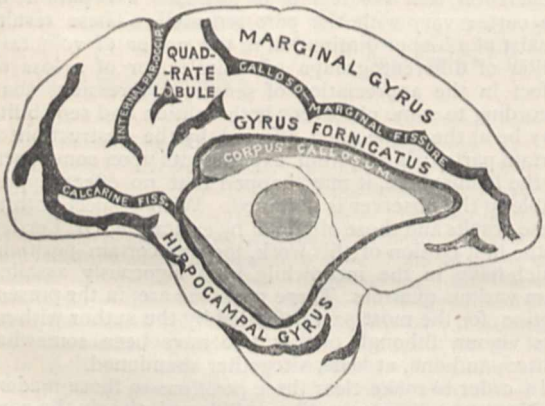


Fig. 2.

Fig. 2 represents the mesial and under surface of the left hemisphere. We here see, above the cut corpus callosum and the other parts which unite the two hemispheres, two convolutions running longitudinally, and separated by a well-marked fissure, the calloso-marginal. The upper one is termed the marginal gyrus, the lower the gyrus fornicatus. The latter expands posteriorly into the quadrate lobule, and is then continued around the posterior end of the corpus callosum on to the under surface of the temporo-sphenoidal lobe, where it becomes continuous with the hippocampal gyrus. The internal parieto-occipital fissure, continuous above with the external one of the same denomination, cuts off, like that, the occipital lobe from the rest of the brain.

Briefly stated, the positions taken up by Dr. Ferrier in the first edition of this work were as follows:—

(1) The Rolandic region is motor. This is the part of the hemisphere from which all volitional impulses (at least for the limbs, head, and face,—about the trunk-muscles nothing was ascertained) issue. It is not connected with sensory perceptions of any kind, not even with those of the muscular sense.

Evidence.—Electric excitation in this region in animals produces definite and co-ordinated movements of muscles of the limbs, neck, and face, similar to those which occur in voluntary efforts. Extirpation is followed by immediate and permanent paralysis of those muscles without the occurrence of any loss or impairment of sensation in the corresponding parts.

(2) The angular gyrus is the centre for vision with the opposite eye.

Evidence.—Electric excitation of this convolution produces movements of the eyes towards the opposite side, contraction of the pupils, and closure of the eyelids as if under the stimulus of a strong light. Movement of the head to the opposite side is also frequently produced. Extirpation of the angular gyrus on one side causes complete blindness in the opposite eye, but this is not permanent if the angular gyrus of the other hemisphere be intact. If this also be removed the loss of vision is complete and permanent.

(3) The superior temporo-sphenoidal convolution is the centre for hearing with the opposite ear.

Evidence.—Electrical excitation of this convolution produces sudden retraction or pricking up of the opposite ear, opening of the eyes, dilatation of the pupils, and turning of the head and eyes to the opposite side. "These phenomena resemble the sudden start and look of surprise which are caused when a loud sound is made in the opposite ear." Lesions of the temporo-sphenoidal lobe of one side which involve the superior convolution produce deafness of the opposite ear, as evidenced by the fact that the animal becomes deaf to ordinary sounds when the ear upon the same side as the lesion is stopped with cotton-wool. When the lesion is established bilaterally, so as to cause destruction of the superior temporo-sphenoidal convolution on both sides, the animal fails to respond to auditory stimuli.

(4) The hippocampal region is concerned with the appreciation of tactile sensation, if not of other forms of sensibility.

Evidence.—Unilateral destruction of this region is followed by complete absence of response to cutaneous stimulation on the opposite side of the body (without any true motor paralysis, although there may be disturbance of voluntary movements, "due to the loss of tactile sensation, by which movements are guided") "the effects being of a persistent character."

(5) The subiculum, or tip of the temporo-sphenoidal lobe, (under surface) is specially related to the sense of smell (in the nostril of the same side).

Evidence.—Electrical irritation of this part of the brain causes phenomena (torsion of the lip and partial closure of the nostril of the same side) such as are "produced by the direct application to the nostril of a powerful or disagreeable odour." Destruction of this region upon one side is accompanied, when the nostril of the opposite side is plugged, by impairment or loss of the olfactory sense: bilateral destruction by complete absence of reaction to olfactory sensations. "The comparative development of this region in animals in which the sense of smell is

largely developed, as in the dog, cat, and rabbit, strongly bears out this view."

(6) The lower part of the temporo-sphenoidal lobe, close to the subiculum, is probably to be regarded as the centre of taste.

Evidence.—Electrical excitation of this region produces movements of the lips, tongue, and cheek-pouches, which "may be taken as reflex movements consequent on the excitation of gustatory sensation." And the abolition of taste coincides with (bilateral) destruction of this region.

(7) The pre-frontal region is probably related to the reflective and intellectual faculties.

(8) The occipital lobe is related to the visceral sensations, such as hunger and thirst. The evidence in favour of this opinion was regarded even by its author at the time as very inconclusive, and since the subject is entirely ignored in the later edition we need not further consider it.

E. A. SCHÄFER

(*To be continued.*)

THE UNIVERSITY COLLEGES

THE other day (March 3) the *Times* printed a letter from Prof. Jowett containing a powerful appeal to the State on behalf of the University Colleges which have recently been established in large towns by the exertions of private individuals. On Monday evening last, Mr. Mundella, having asked the Chancellor of the Exchequer whether his attention had been called to this letter, proceeded to inquire whether the Government "would introduce or facilitate the passing of a measure authorising local authorities to contribute towards the establishment and maintenance of schools and colleges adapted to the wants of their several localities, and would recommend to Parliament annual grants in aid of the same." That Mr. Goschen, so far as his personal sympathies are concerned, would have liked to give an affirmative answer to this question there can be no doubt; but, speaking as a member of the Government, he adopted a very discouraging tone. He was not in a position, he said, to recommend to Parliament annual grants in aid of local colleges. He admitted that it was an open question whether local authorities should not be empowered to aid such institutions, but the Government could not undertake to introduce or facilitate the passing of a measure dealing with the matter.

This decision is greatly to be regretted, and we must hope that the Government will soon be compelled by the pressure of public opinion to reconsider the subject. No one disputes that the University Colleges have done, and are doing, most valuable service to the communities in the midst of which they are placed. Until they were established, what is called a University education was accessible only to very well-off persons. The University Colleges have brought a high intellectual training within reach not only of the middle classes, but of working men, and large numbers of eager and intelligent students have taken advantage of the opportunities provided for them. Even, therefore, if no material benefit were derived by the nation directly from the University Colleges, it would be the clear duty of the State to afford them the help they need. But from the point of view of industry and commerce, as well as from the purely intellectual point of view, it is hardly possible to overrate the importance of these colleges. That our traders are being driven by German and other competitors from important markets is, unfortunately, only too certain; and it is not less certain that they will never recover the ground they have lost until English industry in all its branches is carried on in accordance with strictly scientific methods. This is beginning to be pretty generally understood, and it will be strange if the country does not insist that justice shall be done to institutions in which a serious attempt is being made to impart the kind of knowledge without which it is impossible for manufacturers to adapt their work to the rigid conditions of the present age.

No doubt it would be very satisfactory if the University Colleges could be made self-supporting, but this they cannot be. If those of them which do not possess any considerable endowment receive no aid from the Government, they will soon be placed in a position of grave difficulty; and the question will have to be faced, whether it is worth while to maintain them at all unless they can be maintained in a state of high efficiency. After all, it is no very great sacrifice that the State is asked to make for their benefit. What is claimed is simply that not less shall be done for the English colleges than is done for like institutions in Scotland, Ireland, and Wales.

An aspect of the question which does not always receive adequate attention was well brought out in Prof. Jowett's admirable letter. "Among other benefits," he wrote, "the influence which is exercised by these institutions on the society of a place is not to be forgotten. The residence in a large manufacturing town of a number of highly educated persons, having a variety of literary and scientific interests, is a social element of great value. They raise the tone of conversation; they create ideas and aspirations which would not ordinarily have arisen in a mercantile community. They break in on the dull monotony of wealth. The posts which they occupy, though poorly paid, afford leisure for study and opportunities for research. Among the holders of them are to be found some of the most promising young men of the country. Many of them are known by their writings, and a large proportion of the papers published in English scientific periodicals is a record of the work done in University Colleges."

The *Times*, we are glad to say, cordially supports the cause advocated by the Master of Balliol. "The good," it says (March 3), "which the local colleges do is not exaggerated by Prof. Jowett. They form centres of instruction for all the young men and young women of a town who desire to improve themselves. They foster the love of study, and teach the art of making use of time. 'They may have even kindled in the minds of one or two the spark of genius.' To put the matter on a lower but not less practical level, they have done much, by means of their technical schools, to provide that very instruction of which, as everyone admits, our artisans are so much in need to enable them to carry on the struggle for existence against foreign rivals. Nor does the Master overstate the advantages which the town indirectly derives from the presence of these colleges, whose teaching staff do much to raise the tone of social life throughout the district. It is a sound argument of the defenders of the Church Establishment that it is a great gain to English society to have at least one educated gentleman settled in every parish. The argument may be extended in favour of the University Colleges, and we may say that in a large town, where the pursuit of wealth through commerce is the characteristic of the whole society, it is a great advantage to have four or five men of high intellectual training, whose aims are different, whose standard is different, and who represent science and literature sometimes with great distinction. It would on many grounds be matter for extreme regret if the excellent institutions which foster such men should disappear. Yet there is too much reason to fear that such will be the fate of most of them, unless help more permanent and certain than any that can be derived from voluntary sources is at once forthcoming. Neither Leeds, Newcastle, Sheffield, Nottingham, nor Bristol is in a satisfactory financial condition. The fees cannot pay even the very modest stipends of the professors, and the annual subscriptions are showing a lamentable tendency to diminish. It seems as though there was nothing for it but an appeal to the Exchequer, sorely tried as it now

is, and growing as is the need for economy. . . . The University Colleges during fifteen years have proved their value; and also, like every other educational institution, they have proved that they cannot live without external help. The only help that is likely to be permanent and that will enable them to feel secure is help from the State; and, in a moderate degree, it will be worth the State's while to give it."

The opinions of men of science on the subject were expressed in a letter from Sir Henry Roscoe, which appeared in the *Times* on Saturday last. "It is unnecessary now," he wrote, "to enlarge on the important national work in which these colleges are engaged. That the higher scientific and technical training which these colleges are now giving to the best of their power is a necessity, indorsed as this opinion has been by two Royal Commissions, is now, I am glad to think, generally admitted. It is, however, perfectly clear that if these colleges are to do the work which the country demands they must receive pecuniary assistance. They cannot from their very nature be made self-supporting. Their object is to afford a thorough but also a cheap education, and the localities have in almost all cases now practically exhausted the power of raising funds from private sources. How, then, are the necessary means to be found? They must come either from Imperial or from municipal sources. As the Master has pointed out, the remedy must be a speedy one. We cannot afford to wait until public opinion has reached the point at which ratepayers generally are convinced that it is to their advantage to support such colleges. The only alternative, therefore, is that the nation as a whole shall, through the Government, acknowledge its obligation to supply the necessary funds, the amount required being comparatively small and not one likely largely to increase. It is satisfactory to know that the whole subject of the furtherance of scientific and technical education in the country is at the present moment under the serious consideration of Members of Parliament of all political parties, and I have good reason to hope that our efforts to bring this question, vital as it is to the industrial and commercial supremacy of the country, to a satisfactory issue may, even this Session, be crowned by some measure of success. Among the several important matters engaging our attention, I need scarcely say that this particular one, affecting as it does the higher technical education of those who are hereafter to take positions as leaders in our commerce and industries, is by no means the least important."

We trust that the new impetus now given to this question may lead to beneficial results. It is to be hoped, however, that we shall hear less of the word "*technical*" in connection with these colleges, for if they are technical only, we may be better without them.

THE EARTHQUAKE IN SWITZERLAND

PROF. FOREL, the meteorologist, of Morges, on the Lake of Geneva, has just issued a report on the earthquake of February 23. He classifies the shocks under three heads—namely, preparatory shocks, strong shocks, and consecutive shocks. It is difficult, in the absence of trustworthy data, to indicate the precise locality of the first-named, but Switzerland was undoubtedly the region of the second; but it was to the third—that is, the consecutive shocks—that all the mischief was due. The professor traces the course of the phenomenon in Switzerland over a radius of at least four hundred square miles. Its force was greater in the southern parts of the country than in the north, though the shocks were felt throughout Geneva, Berne, Neuchâtel, Fribourg, Vaud, Valais, and Tessin; and observations go to prove that these shocks travelled almost due north and south, although the direction of the oscillations does not coincide with this course. The oscillations in Switzerland were characterised by their number and repetitions. In some localities they were longitudinal; that is, running parallel to the meridian; in others they were transverse, running or flowing from east to west. The vertical movements were marked by their feebleness where indicated, but in the greater part of the territory affected vertical oscillations were entirely absent. One of the peculiarities of the oscillations generally was the length of duration, which is set down as varying from 10 to 30 seconds. But the collected reports prove that the mean of these figures more nearly represents the prevailing duration. The intensity of the shocks was greater in the central and southern areas of the disturbance, and it would seem as if the shocks only just failed to attain the necessary strength which would have produced disastrous effects. As it was, church bells were rung, in some places violently; windows were rattled, doors thrown open, ceilings slightly cracked, and morsels of plaster were brought down, and here and there stacks of wood were thrown over. One of the most striking features of the phenomenon was the extraordinarily large number of clocks that were instantly stopped, and this fact has afforded the best possible means of determining with something like perfect accuracy the time of the shocks, which varies from three to four minutes past six in the morning, Berne time. The large astronomical clock of the Observatory at Basle stopped exactly at 6h. 4m. 7s. This, taken as representing Berne time, corresponds with 5h. 43m. 35s. of Paris, 5h. 55m. 43s. of Marseilles, 6h. 3m. 2s. of Nice, and 6h. 24m. 3s. of Rome.

The consecutive shocks, which were responsible for all the loss of life and damage to property, were centralised in the region of the Riviera. The greatest damage was done by the two first shocks, which occurred with an interval of fifteen minutes between them. The reports from the Swiss observatories also show that a series of feebler shocks were experienced in Switzerland later on in the same day, and also on several succeeding days.

NOTES

SEVERAL schools of science and art in the colonies and dependencies of the United Kingdom have expressed a wish to be allied with the Department of Science and Art and to have the advantage of its examinations. It has therefore been decided that upon the application of the Colonial Government or Educational Department, or other public authority of the colony, the Department of Science and Art will arrange for the examination of their schools, on the results of which examination certificates and returns of awards will be issued. The entire cost of the examination of the papers and works, and of their carriage, clearing in London, and conveyance to and from South Kensington, will, of course, have to be defrayed by the local authority concerned. The personal examinations, the subjects of which are stated in the Science and Art Directory, must be held in the colonies and dependencies upon the earliest date possible after the receipt of the examination papers, and these examinations must be conducted by qualified and responsible persons not immediately interested in the results of the examinations, who should on the conclusion of each examination furnish a certificate that the examination has been fairly conducted. The examination of works is held at South Kensington, and works to be examined must be forwarded to reach South Kensington not later than the end of April in each year. The Department will send upon application copies of lists of examples and prizes, and will, as far as possible, advise the local authorities in reference to the conduct of science and art schools or classes. The Department will also present specimen examination papers or works—when there are such in stock disposable—with the view of indicating the style of drawings

and paintings done by students and candidates in the United Kingdom, and the standards of attainment for the various examinations.

CAPT. A. W. GREELY has been appointed to succeed the late General Hazen, as Chief Officer of the Signal Service in the United States, with rank of Brigadier-General. This announcement has been well received in America even by those who have hitherto wished to see the Signal Service separated from the army. Capt. Greely was next in rank to General Hazen in the bureau, and his eminent fitness for the duties of his new position is universally acknowledged.

THE Paris Geographical Society will shortly celebrate the centenary of the La Pérouse expedition round the world. The last news received from the unfortunate explorer and his companions was brought to France by an uncle of M. de Lesseps.

SEVERAL interesting speeches were delivered in the House of Commons, on Monday evening last, in connection with the supplementary vote of 10,560*l.* for the Science and Art Department. Mr. Mundella said the vote asked for was the result of an automatic increase in which every member who had spoken ought to rejoice. The increase had been large and rapid. In 1875 the total number of pupils in every branch of art instruction was 444,000, while in 1885 the number had increased to 883,000, or nearly double. There had been a large increase of art schools, where, he thought it would be admitted, the work was much better done than in art classes. He did not, however, profess to be satisfied with the position we have attained. It was true, he said, our Estimates were large as compared with twenty-five or thirty years ago; but, as compared with other countries similarly situated to ourselves, they were a disgrace to us. The expenditure on education in England was 5 per cent. of the whole expenditure of the country, but in some other countries the expenditure on education formed one-third of the whole expenditure of those countries—in Switzerland, for instance, it was rather more than one-third. While it was the duty of the Treasury to keep down expenditure, there would be no real good done in this country until the expenditure on education was largely increased. Prof. Stuart also insisted that England does not yet do nearly enough for scientific education. To illustrate this, he quoted the school statistics of New Zealand and Australia, showing the large proportion of children attending science teaching in those colonies. Prof. Stuart argued strongly in favour of technical instruction being carried on in evening classes, so that the minds of workmen might be concentrated on those branches of work which they might not so easily acquire in the workshop. An immense impulse had been given in the right direction when the examination in chemistry had been made one of a practical kind, instead of merely book-work and paper-work, and a similar step would have a good effect in the case of physics and mechanics. In conclusion, Prof. Stuart urged upon the Government the desirability of extending as far as possible the scholarships, local exhibitions, and prizes in connection with the science classes. Sir H. Roscoe gave it as his opinion that the money which the country voted for the purpose of science and art instruction was money well spent. The importance of the question could not be overrated, and the Science and Art Department was in a position to carry out in the main the requirements of the country in regard to such instruction. There was, however, one matter to which the Department had not yet given attention, and that was the question of manual instruction in the use of tools. In view of what was being done on the Continent in extending science and technical instruction, he trusted the Committee would pass the vote as only the beginning of what they might hope to get in time.

WE regret to announce the death of Dr. August Wilhelm Eichler, Professor of Botany at the Berlin University, and Director of the Royal Botanical Garden and Botanical Museum at Berlin. He died on Wednesday, the 2nd inst.

DURING the past month there have been several fine displays of the aurora borealis in Northern Sweden. The displays generally began about 8 o'clock p.m., and continued till towards midnight, the point of culmination being reached about 11 o'clock. The auroræ appeared in the form both of streamers and clouds, the colours being mostly white and yellow.

ON February 19, about midnight, a brilliant meteor was seen in Central Norway. It went in a direction north-east to south-west, and was observable for several seconds. The colour was at first brilliantly white, but changed during the passage into yellow and green. The greatest apparent size of the meteor was equal to that of the full moon. It left a trail a couple of yards in length, portions of which remained for some seconds after the meteor had been lost to view behind a mountain ridge. During its passage it lit up the country within a great area.

THIS year Prof. Du Bois-Reymond will celebrate the twentieth anniversary of his appointment as secretary of the Academy of Sciences of Berlin. He is the oldest member of the physico-mathematical class of the Academy.

IN a lecture delivered at the Society of Arts on Wednesday, the 2nd inst., Mr. E. J. Beale stated that last season's experiments in the cultivation of tobacco in England and Ireland resulted in a success satisfactory beyond the hopes of the most sanguine promoters of the experiments. While reasonable caution in the matter of area and extent of future operations was necessary, those results, he thought, more than justified further trials.

THE fifty-fifth annual meeting of the British Medical Association will be held at Dublin on Tuesday, August 2, and the three following days. Dr. Withers Moore, Senior Physician to the Sussex County Hospital, is President, the President-Elect being Dr. John T. Banks, Regius Professor of Physic in the University of Dublin. An address in Medicine will be delivered by Dr. W. T. Gairdner, Professor of Medicine in the University of Glasgow; one in Surgery by Dr. E. Hamilton, Fellow and Professor of Surgery in the Royal College of Surgeons in Ireland; and one in Public Medicine by the Rev. S. Haughton, M.D., Senior Fellow of Trinity College, Dublin. The scientific business will be conducted in eight sections and two subsections. Dr. G. F. Duffey, of 30 Fitzwilliam Place, Dublin, is local Honorary Secretary.

THE Exhibition of Marine Meteorological Instruments organised by the Royal Meteorological Society, which will be held at the Institution of Civil Engineers, 25 Great George Street, Westminster, from Tuesday to Friday next, the 15th to 18th inst., promises to be very interesting and instructive. Many of the instruments used in the *Challenger* and other expeditions will be exhibited. At the meeting of the Society on Wednesday evening, Dr. H. R. Mill will read a paper on "Marine Temperature Observations." Any persons, not Fellows, wishing to visit the Exhibition or to attend the meeting, can obtain tickets on application to the Assistant Secretary, Mr. W. Marriott, 30 Great George Street, S.W.

IN the State of New York there are at least fourteen distinct laws relating to the medical profession. The State Legislature is now considering a measure for the entire repeal of some of these laws, and for the abrogation of parts of others. *Science* is of opinion that the measure "should meet with the hearty support of the medical profession, and receive the vote of every member of the Legislature."

MESSRS. CASSELL AND CO. will have ready, shortly, "A Manual of Practical Solid Geometry, adapted to the Requirements of Military Students and Draughtsmen," compiled by Major William Gordon Ross, R.E., Professor of Geometrical Drawing and Fortification, Royal Military Academy, Woolwich.

MESSRS. GRIFFIN will publish, shortly, a work on pathology, by Prof. Julius Dreschfeld, of Owens College.

DR. THOMAS JONES, Lecturer on Surgery at Owens College, has a work on surgery in preparation. Messrs. Smith, Elder, and Co., will be the publishers.

MR. H. K. LEWIS will issue immediately "Photography of Bacteria," illustrated with eighty-six photographs reproduced in autotype, by Dr. Edgar M. Crookshank; also a second edition, revised and considerably enlarged, of "Manual of Bacteriology," by the same author.

WE have received the first number of the *Wesley Naturalist*, a monthly journal of the new Wesley Scientific Society, of which the Rev. Dr. Dallinger, F.R.S., is President. In an introductory paper, Dr. Dallinger says the Society does not hope to do important original work. Its aim will be "to direct, stimulate, and help, mostly the young and those engaged in daily work, in acquiring correct knowledge of the principles of a chosen branch of science."

MESSRS. GURNEY AND JACKSON, the successors to Mr. Van Voorst, are about to publish a List of British Birds, which has been revised by Mr. Howard Saunders. It will be printed so as to be available for the labelling of specimens. The use of varied type will enable the student to distinguish readily the rarer visitors and the species having a doubtful claim to be considered British.

AN extensive fish-culture establishment is being formed by Mr. William Burgess on his estate at Malvern Wells, Worcester, for the propagation of Salmonidæ and coarse fish. A series of breeding- and rearing-ponds has been made, and a hatchery capable of incubating four millions of ova is being constructed. The site selected for the purpose is said to be admirably adapted for fish-culture, as there is an abundance of pure water. Mr. Burgess has already turned into his waters a quantity of fish, including trout, salmon, and carp.

IN the spring the U.S. Fish Commission steamer *Albatross* will sail for her work on the Pacific. The fish-bearing properties of the Kiu Sawa, or Black Stream of Japan, will be investigated. The Kiu Sawa, crossing the Pacific in a high latitude, is said to modify the temperature and climate of Alaska and the Aleutian Archipelago in very much the same way as the Gulf Stream modifies the climate of the British Isles.

THE managers of the Royal Victoria Hall and Coffee Tavern show much discretion in the choice of subjects for their well-known "Penny Science Lectures." On Tuesday last a lecture on "Vesuvius and Ischia, a Volcano and an Earthquake," was delivered by the Rev. W. W. Edwards. On Tuesday next, Prof. George Forbes will describe "A Journey across Asia, through Siberia," and, on the 22nd inst., the Dean of Westminster will lecture on "Westminster Abbey."

A REPORT of the proceedings of the thirty-fifth meeting of the American Association for the Advancement of Science, held at Buffalo in August last, has lately been published. It contains, besides many short papers and abstracts, the address of Mr. H. A. Newton, the retiring President, and the addresses of the Vice-Presidents in the Sections of Mathematics and Astronomy, Physics, Chemistry, Mechanical Science and Engineering, Geology and Geography, Biology, Anthropology, and Economic Science and Statistics.

IN the second Bulletin of Miscellaneous Information, issued from the Royal Gardens, Kew, there is an interesting account of Cape boxwood. Some time ago a sample of the wood of this tree was sent to Kew, and it was found that the two woods were almost identical. It was clear, therefore, that Cape boxwood was none other than a species of *Buxus*, and perhaps *B. sempervirens* itself. Small samples were exhibited in the Cape Court at the recent Colonial and Indian Exhibition, and in the Catalogue it was stated that the wood had been "very favourably reported on for engraving purposes." The general appearance of the specimens at the Exhibition did not recommend Cape boxwood to the notice of engravers.

WE regret to announce the death of Dr. Birnbaum, Professor of Chemistry at the Technical High School at Carlsruhe, on February 20; and of Dr. Reinhold von Reichenbach, the well-known chemist, who died at Gratz on February 23.

THE South American Exhibition at Berlin has resulted in a great pecuniary loss.

M. E. BERILLON has just published a little book on Paul Bert's scientific career. Being a medical man himself, he has been able to give a very clear and accurate idea of M. Bert's work in physiology.

AT a recent meeting of the Paris Biological Society an apparatus was shown, made of iron and glass, in which a pressure of 1000 atmospheres can be developed for the purpose of studying the influence of pressure on animal life.

THE third meeting of the French Congrès de Chirurgie will take place in Paris in the month of April 1888. The second one was held in November 1886. Prof. Verneuil is President-Elect for 1888.

THE earthquake which took place on February 6 in Southern Indiana, Illinois, a small portion of Kentucky, and East Central Missouri is said by American newspapers to have had an area of about 75,000 square miles. The greatest intensity was in South-Western Indiana and South-Eastern Illinois. The U.S. Geological Survey is trying to obtain accurate information as to the boundary of the area covered.

CORRESPONDENTS in Athens report that on Friday last successive slight shocks of earthquake were felt from noon to midnight at Philiatra. The direction was south-west by south.

M. FLORAN DE VILLEPIGNE has devised, in Paris, an instrument, the autographometer, which records automatically the topography and difference of level of all places over which it passes. It is carried about on a light vehicle, and those who wish to use it have nothing to do but to drag it, or have it dragged, over the ground of which they desire to obtain a plan.

THE University of Berlin is being attended, during the present term, by no fewer than 5357 students. This is the largest number of students that have ever been enrolled by a German University. In the Faculty of Philosophy there are 1984 students; in that of Medicine, 1297; in that of Law, 1282; in that of Theology, 794. The number of instructors is 288, of whom 147 are in Philosophy, 103 in Medicine, 22 in Law, and 16 in Theology.

THE Chicago Manual Training School has lately issued its fourth annual Catalogue. The requisites for admission to this institution are that the candidates be at least fourteen years of age, and be able to pass a satisfactory examination in reading, spelling, writing, English composition, geography, and arithmetic. The course extends over three years, and includes instruction in mathematics, science, language, drawing, and shop-work, during the entire period. The school has a well-equipped wood-room, foundry, forge-room, and machine-shop,

and ample apparatus for teaching the various subjects in which instruction is given. Although the regular school exercises were begun only in February 1884, the total number of pupils enrolled is now 190.

In his Report for 1886, Mr. Andrew S. Draper, Superintendent of Public Instruction in the State of New York, points out that that State is now spending 14,000,000 dollars annually in support of its public school system; and he suggests that it might be well to spend a few thousands occasionally in efforts to determine the best way of using this vast sum. Mr. Draper puts some questions which show that he is far from being perfectly satisfied with the educational system he has to administer. "Is there not," he asks, "too much French, and German, and Latin, and Greek, and too little spelling, and writing, and mental arithmetic, and English grammar, being taught? Have we been as ambitious of progress in the lower grades as in the advanced? Are not our courses of study too complex? Are we not undertaking to do more than we are doing well? Is not the examination business being overdone? Are we not cramming with facts, which will soon be forgotten, rather than instilling principles which will endure?"

In an article in the March number of the *Zoologist*, Mr. Robert Service tries to show that, until near the end of the first quarter of the present century, ptarmigan were natives of the south-west of Scotland. He thinks that when these birds were on the mountains of Dumfriesshire and Galloway they were probably also to be found on the Cumbrian Mountains. Mr. Service says that, in nearly all the outlying stations of the present race of ptarmigan in Scotland, such as Arran, Argyll, and the Outer Hebrides, they are decreasing.

Mr. William Burgess, who owns an extensive pheasantry at Malvern Wells, has recently made some observations upon the red worm, which is one of the worst assailants of birds. He thinks it comes from the droppings of cattle, which when young are especially liable to the attacks of this insect. Mr. Burgess finds that agricultural salt acts as a remedy against it.

A discovery of great geological interest was lately made on Juckatoo Island, Sydney, in the shape of a Mastodonsaurus. There is a similar specimen from Stuttgart in the collection of the University, but this one is remarkable from the fact that it is the first Labyrinthodont found in Australia. It belongs to the Triassic age of the Hawkesbury Sandstone formation.

Dr. Weill, of Paris, having carefully studied the new therapeutical agent, antifebrine, or acetanilide, discovered by Cohn and Hepp, of Strasburg, says that it is an anæsthetic agent, and that it combats fever very effectually.

A French translation of the "Phantasms of the Living" is being prepared in Paris by M. Ch. Richet and some other persons.

M. Hayez, of Brussels, has issued a second edition of "A General List of Observatories and Astronomers, and of Astronomical Societies and Reviews," prepared by M. A. Lancaster, Librarian of the Royal Observatory of Brussels. The List has been drawn up with great care, and, from the fact that a second edition has been called for, we may assume that astronomers have found it of considerable service. The names and addresses of all well-known astronomers are given, and the compiler has noted every Observatory, whether public or private, in which work is actually being done.

In the Proceedings of the U.S. National Museum, lately issued, there is a paper by Mr. G. H. Boehmer, on Norse naval architecture. Mr. Boehmer gives a clear and remarkably interesting account of the forms of boats represented in the ancient rock-sculptures of Sweden and Norway; of the boat-shaped stone burial-groups supposed to have been erected during the transition time from the Bronze period to the Iron Age; and of boat-remains dating from the third to about the ninth or tenth century of our era, and found at various times and places. The ship found at Tune, and the Gokstad ship, are carefully described. Mr. Boehmer thinks that the "Northland boats" now used in the fisheries along the coast of Norway are almost exactly like those which have always been used by Norsemen from the time of the rock-sculptures. These Northland boats are described as long, narrow, and low, light and elegant, and fit both for sailing and rowing.

The additions to the Zoological Society's Gardens during the past week include a Black-winged Kite (*Elanus cæruleus*) from the Cape of Good Hope, presented by Mr. R. Southey; a Hawfinch (*Coccothraustes vulgaris*), British, presented by Mr. W. H. Quintin; two Pike (*Esox lucius*) from British fresh waters, presented respectively by Mr. H. E. Young and Mr. G. G. Sykes; two Gloved Wallabys (*Halmaturus manicatus* ♂ ♀), two Cereopsis Geese (*Cereopsis novæ-hollandiæ*) from Australia, a Blossom-headed Parrakeet (*Palæornis cyanocephalus*) from India, received in exchange; two Pike (*Esox lucius*) from British fresh waters, purchased.

OUR ASTRONOMICAL COLUMN

Solar Activity in 1886.—The latter part of 1886 showed a most remarkable falling off in the number and size of the sun-spots, a falling off so great as to lead so experienced an observer as Prof. Tacchini to speak of it as possibly the minimum of the eleven-year period. The following numbers, taken from Prof. Tacchini's tables (*Comptes rendus*, vol. ciii. No. 2, and civ. No. 4), may be compared with those we gave (Nature, vol. xxxiii. p. 398) for the year 1885:—

	Relative frequence	Relative size of spots	Daily number of spot groups	Relative size of faculæ
January ...	8·84	60·42	2·00	47·63
February ...	6·30	29·00	1·70	32·10
March ...	14·39	84·78	3·87	43·91
April	8·13	51·91	3·00	41·32
May	6·50	52·77	1·92	37·81
June	7·14	25·22	2·32	37·14
July	8·30	39·93	2·17	35·42
August... ...	3·24	18·70	1·40	8·33
September ...	5·59	23·41	1·45	18·52
October ...	1·46	8·08	0·69	18·08
November ...	0·04	0·15	0·04	7·41
December ..	6·17	27·04	1·22	15·65

After the fine group of spots which were seen on May 7 and 8 had passed out of sight, the spots decreased in number and size pretty steadily until the end of October. From October 31 to December 12 there then ensued a long period of almost total quiescence. On six days only out of the forty-two could there be discovered on the sun any trace even of a spot, and on those days only one tiny spot could be seen. For an entire rotation and a half the sun was practically free from spots. M. Riccò has also drawn attention to this remarkable interval, and on searching the Palermo records for the earliest comparable period after the maximum of 1870, he finds a somewhat similar interval of quiescence in 1875, five years after the maximum of 1870, and nearly eight years after the minimum of 1867. The depression of last November follows the maximum of 1884 by less than three years, but the previous minimum by about eight years; reckoning from the minimum, the November depression follows the precedent of 1875, but reckoning from the maximum, it would appear to have occurred most exceptionally early. It would seem, therefore, that the irregularity has not been so much in the principal or secondary minima as in the maximum of 1884, which fell later than the mean by nearly two years. M. Riccò anticipates that the true minimum of the eleven-year period will fall in 1890.

A striking feature of the past year has been the great diminution, and for some months, the almost total cessation of spot activity in the northern hemisphere of the sun, nearly all the principal groups having been located in the southern hemisphere.

Faculæ and prominences have shown a falling off in 1886, but

one far less marked than that shown by the spots. The following numbers derived from notes by the Rev. S. J. Perry in the *Observatory* for February 1886, and March 1887, shows that the mean extent of the prominence arc has greatly diminished, though the mean height of the prominences has suffered little change. This diminution in extent was especially marked during the last three months of the year.

	Mean height of chromosphere, excluding prominences	Mean height of prominences	Mean extent of prominence arc
	″	″	° ′
1885	8·00 ...	28·67 ...	28 25
1886	8·05 ...	24·78 ...	13 36
Mean 1880 to 1885 ...	8·07 ...	25·71 ...	32 45

The "mean extent" for October is 9° 54′, for November 7° 25′, and for December 9° 31′.

COMET 1887 *d* (BARNARD, FEBRUARY 15).—Prof. Boss has furnished other elements of this comet than those he gave in his first circular, the first set of elements being thus superseded. They are as follows :—

T = 1887 March 28·47

ω = 36° 37′
Ω = 135 28 } Mean Eq. 1887·0
ι = 139 45
log q = 1·0059

Prof. Krueger (*Astr. Nach.*, No. 2774) has computed the following ephemeris for Greenwich midnight from these elements :—

1887	R.A.	Decl.	log r	log Δ
	h. m. s.	° ′		
March 13 ...	54 13	57 49 N.	0·0162	9·9430
15 ...	52 53	57 11	0·0129	9·9730
17 ...	51 44	56 39	0·0100	0·0008
19 ...	50 41	56 11	0·0076	0·0265
21 ...	49 46	55 46	0·0056	0·0400

THE WARNER OBSERVATORY.—Mr. Lewis Swift, director of the private observatory of Mr. Warner, of Rochester, N.Y., has recently published a pamphlet giving a description of the dome and 16-inch refractor and other accessories of the observatory. The great telescope has been used by Mr. Swift, since July 1883, in a systematic search for new nebulæ, of which 540 have been discovered up to January 1, 1887. The places and descriptions of over 400 of them are given. Mr. Swift is also engaged in searching for comets. The pamphlet, in addition, contains a list of the recipients of the Warner Prizes for cometary and other astronomical discoveries, as well as a reprint of the essays on comets and on the "sky-glows" of 1883 and 1884, to which prizes have been adjudged.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 MARCH 13–19

(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 March 13

Sun rises, 6h. 21m. ; souths, 12h. 9m. 39·3s. ; sets, 17h. 58m. ; decl. on meridian, 2° 56′ S. : Sidereal Time at Sunset, 5h. 22m.

Moon (at Last Quarter March 16) rises, 21h. 43m.*; souths, 3h. 8m. ; sets, 8h. 23m. ; decl. on meridian, 9° 34′ S.

Planet	Rises	Souths	Sets	Decl. on meridian
	h. m.	h. m.	h. m.	° ′
Mercury ...	6 22 ...	12 54 ...	19 26 ...	5 33 N.
Venus	7 6 ...	13 39 ...	20 12 ...	5 52 N.
Mars	6 41 ...	12 46 ...	18 51 ...	0 15 N.
Jupiter... ...	21 49* ...	2 52 ...	7 55 ...	11 53 S.
Saturn... ...	11 34 ...	19 43 ...	3 52* ...	22 29 N.

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

Occultation of Star by the Moon (visible at Greenwich)

March	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image
			h. m.	h. m.	° °
14 ...	γ Libræ	4½ ...	3 56 ...	5 10 ...	82 252

March 17 ... 14 h. ... Saturn stationary.

Variable Stars

Star	R.A.	Decl.		h. m.	
	h. m.	° ′			
η Geminorum ...	6 8·1 ...	22 32 N. ...	Mar. 15,	0 0	*M*
R Lyncis	6 51·9 ...	55 29 N. ...	,, 18,		*M*
R Crateris ...	10 55·0 ...	17 43 S. ...	,, 19,		*M*
δ Libræ	14 54·9 ...	8 4 S. ...	,, 16,	23 13	*m*
U Coronæ	15 13·6 ...	32 4 N. ...	,, 17,	3 18	*m*
U Ophiuchi... ...	17 10·8 ...	1 20 N. ...	,, 13,	2 40	*m*
		and at intervals of		20 8	
W Sagittarii ...	17 57·8 ...	29 35 S. ...	Mar. 13,	22 0	*M*
U Sagittarii... ...	18 25·2 ...	19 12 S. ...	,, 15,	21 0	*m*
R Sagittæ	20 8·9 ...	16 23 N. ...	,, 19,		*m*
U Capricorni ...	20 41·9 ...	15 12 S. ...	,, 16,		*M*
R Vulpeculæ ...	20 59·4 ...	23 22 N. ...	,, 19,		*M*
δ Cephei	22 25·0 ...	57 50 N. ...	,, 18,	11 0	*M*

M signifies maximum ; *m* minimum.

Meteor-Showers

	R.A.	Decl.	
	°	°	
Near α Persei	50 ...	48 N.	
β Virginis... ...	175 ...	10 N.	Slow bright meteors.
δ Ursæ Majoris..	185 ...	58 N.	March 17.
β Draconis ...	263 ...	50 N.	
η Serpentis ...	276 ...	6 N.	Very swift meteors.
κ Cephei	300 ...	80 N.	Slow bright meteors.

GEOGRAPHICAL NOTES

ON Tuesday last, the 8th inst., the Expedition under Mr. H. M. Stanley for the relief of Emin Pasha, arrived at Simonstown from Zanzibar. They were to resume their voyage on Wednesday, after taking supplies on board. Mr. Stanley is accompanied by Tippoo Tip, through whose agency, it is expected, Stanley Falls will be restored to the Congo State. Messengers have been sent across the continent to the Congo, and Mr. Stanley expects that a large addition to his caravan will be awaiting him when he arrives on the Upper Congo.

LIEUT. BAERT, of the Congo Free State, has recently made a journey up the Mongalla, a northern tributary of the Congo, considerably to the east of the Mobangi. The river had previously been navigated to some extent by Mr. Grenfell, but Lieut. Baert has succeeded in getting much beyond Grenfell's furthest. In fact, he attained the limit of navigation, at over 200 miles from the mouth of the river, where its course is broken by falls. The river flows in a general southward direction, through a well-wooded country, and its rapids are situated in about 3° 30′ N. lat., and 22° E. long. The Mongalla is very sinuous ; its rapids are situated in a mountainous district inhabited by a people named Sebi, who do good work in iron.

A FRENCH traveller, M. Chaffanjon, is exploring the Orinoco. He has already surveyed the Bolivar and the San Fernando, and discovered numerous errors in existing maps. He has made large collections in ethnology, archæology, and philology. He hoped to solve the puzzling problem of the Casiquiare, and reach the sources of the Orinoco last December.

IN the first number for 1887 of the *Mitteilungen* of the Vienna Geographical Society, is a German translation of the interesting paper by D. Isabelo de los Reyes, on the Tinguians of the Philippine Island, Luzon. The author is himself an Ilocan, a tribe which marches with the Tinguians, and has had exceptional opportunities of investigating the origin, and customs, and beliefs of his fellow-countrymen, and, being educated, can tell what he knows. A good map accompanies the paper, and to this Dr. Blumentritt contributes explanatory text. To the same number Herr Edward Glaser contributes a sketch of his journeys in South Arabia, which, while mainly for archæological purposes, have yet been the means of adding much to our knowledge of the little-known South Arabian mountain-land.

THE *Bollettino* of the Italian Geographical Society for January publishes a detailed account of the recently acquired Italian possessions on the Red Sea coast, extracted from an official memoir presented to the Chamber of Deputies by S. E. di Robilant. These possessions are grouped under three separate divisions : (1) territory garrisoned and administered by Italy, including Massowa, Emberemi, the Abd-el-Kader peninsula, Gherar, Taulud Island, and the neighbouring Dahlak Archipelago ; (2) protected territory, comprising the

coast-lands from Adulis (Annesley) Bay southwards to Assab, with stations at Hawakil, Mader, and Ed; (3) territory placed under the absolute sovereignty of Italy—Assab and surrounding district stretching for thirty-six miles between Ras Dermah and Ras Sinthiar, and including the neighbouring islets, annexed in July 1882. Massowa, the centre of government, occupies a strong position on an island connected by an embankment with Taulud, and defended by forts at Gherar and on the Abd-el-Kader peninsula. Since the Italian occupation it has been largely rebuilt in European style, and according to a rough census taken in September 1885 has a population of about 5000. There are several mosques, a Catholic church attached to the French mission, and a meteorological observatory where observations have been regularly recorded since May 1885. During this period the temperature has varied from 19°·1 C. in January, to 42°·8 in August, with a mean of about 26°·4.

DR. OTTO KRÜMMEL publishes in the *Zeitschrift für wissenschaftliche Geographie*, under the title of "The Relief of the Australian Mediterranean," *i.e.* the sea lying between Australia and the islands on the north, some valuable data as to recent soundings therein. They are as follows :—

S. Lat.	E. Long.	Depth in fathoms
4° 45′	123° 40′	90
4° 29′	123° 48′	110
4° 14′	123° 58′	80
3° 58′	124° 10′	55
3° 45′	124° 18′	60
3° 32′	124° 34′	60
3° 22′	124° 51′	75
3° 12′	125° 10′	90
3° 3′	125° 22′	120
2° 53′	125° 36′	105
2° 45′	125° 48′	90

On the other hand, Dr. Krümmel recalls the fact that we have the neighbouring Banda Sea in a depth of 2000 to 3000 fathoms. These data seem to indicate that between Celebes and Buru there exists a sub-oceanic ridge. We cannot say whether it extends over Ceram to New Guinea, and so indicates an ancient land-bridge between Asia and Australia, for between Ceram and New Guinea we have no soundings, and those on the borders of the strait between Buru and Ceram are from 1500 to 3000 fathoms.

MR. W. GRIGGS has published a facsimile of the famous map of the world lent by the Pope to the Colonial and Indian Exhibition, and placed in the West Indian section. This map, which is a copy of the chart in which Pope Alexander drew the line dividing the possessions of Spain and Portugal in the New World, was bequeathed to the Pope by the last of the Borgias in 1830, and has since then been preserved with much jealousy. It is drawn on a sheet of vellum seven feet long by three broad. The colours of the original are reproduced.

ON RADIANT-MATTER SPECTROSCOPY:—EXAMINATION OF THE RESIDUAL GLOW[1]

II.

IN the search for bodies giving discontinuous phosphorescent spectra I have submitted a great number of earths and combinations to the electric discharge *in vacuo*, and have noted the results. As the superficial phosphorescence apart from the composition of the emitted light has formed the subject of several recent papers by my friend M. Lecoq de Boisbaudran, before the Académie des Sciences, it may be useful if I place on record some of the more striking facts which have thus come under my notice. The bodies are arranged alphabetically, and, unless otherwise explained, were tested in the radiant-matter tube in the form of ignited sulphates.

Alumina, in any of the forms which give the crimson line (λ6942—6937), has a very persistent residual glow. In the phosphoroscope rubies shine with great brilliancy. This phosphorescence of alumina has recently been the subject of a paper read before the Royal Society (Roy. Soc. Proc. vol. xlii., 1887, p. 25).

Antimony oxide with 95 per cent. of lime (in the form of ignited sulphate).—White phosphorescence, the spectrum showing a broad space in the yellow, cutting the red and orange off. In the phosphoroscopes the residual glow is very strong, and of a greenish colour. The spectrum of the residual light shows that the red and orange are entirely obliterated, leaving the green and blue very luminous. Antimony oxide with 99 per cent. of lime gives a pale yellowish phosphorescence, which on heating turns red. In other respects it is like the 5 per cent. mixture.

Arsenious acid with 99 per cent. of lime gives a greenish white phosphorescence like pure calcium sulphate.

Barium 5 per cent., calcium 95 per cent.—The sulphates phosphoresce green, with specks of yellow and violet. The spectrum is continuous, with slight concentration in the red, great concentration in the green, and in the orange a broad black band hazy at the edges.

Bismuth 15 per cent., calcium 85 per cent., phosphoresces of a bright reddish orange. The spectrum shows a tolerably sharp and broad dark band in the red and orange, and a strong concentration of light in the green and blue; the spectrum being continuous and divided into two parts by a black band in the yellow, as in the case of the antimony-calcium spectrum. In the phosphoroscope the red and orange disappear and the green and blue remain. Bismuth 7 per cent., calcium 93 per cent.—The action is similar to the 15 per cent. mixture, except the colour of the phosphorescence, which is whiter. In the phosphoroscope the red and orange below the dark band is cut off. With 2 per cent. of bismuth the same phenomena occur. With 0·5 bismuth the phosphorescence is greenish blue and the spectrum is continuous, with strong concentrations in the orange and green. The phosphoro cope cuts off the red and orange.

Cadmium 1 per cent., calcium 99 per cent.—Similar to calcium sulphate, *q.v.*

Calcium sulphate was prepared from a colourless and transparent rhomb of Iceland spar which had been used for optical purposes. It was dissolved in nitric acid, the nitrate was decomposed with distilled sulphuric acid, and the ignited sulphate tested in the tube. The phosphorescence is bright greenish blue without bands or lines. In the phosphoroscope the colour is a rich green; the spectrum shows the red and orange entirely cut off, leaving the green and blue; the blue is especially strong.

Calcium sulphates prepared from Prof. Breithaupt's calcites (Phil. Trans., 1885, Part II., p. 697) were re-examined. All phosphoresce with the normal greenish-blue glow of calcium, except No. 11, which gives a reddish glow. A minute trace of samarium was found in this calcite, but not enough to affect the colour of the glow. In the phosphoroscope all the specimens give a continuous spectrum beyond the yellow, the red and orange being cut off as usual.

Chromium 5 per cent., calcium 95 per cent., as sulphates, gives a pale reddish phosphorescence. In the phosphoroscope the colour is green, and the red and orange are cut off. 1 per cent. of chromium with calcium phosphoresces green in the cold, and becomes a red when slightly heated. The behaviour of chromium with aluminium has already been described (Roy. Soc. Proc. vol. xlii. p. 28, *et seq.*)

Copper sulphate with 95 per cent. calcium sulphate behaves like calcium sulphate.

Diamonds phosphoresce of various colours. Those glowing pale blue have the longest residual glow, next come those phosphorescing yellow; I am unable to detect any residual glow in diamonds phosphorescing of a reddish colour. A large diamond of a greenish hue, very phosphorescent, shines almost as brightly in the phosphoroscope as out of it.

Glucina phosphoresces of a rich blue colour. There appears to be no residual glow with this earth in the phosphoroscope.

Lanthanum.—All the specimens of lanthanum sulphate I have examined in the radiant-matter tube phosphoresce of a reddish colour, and give a broad hazy band in the orange, with a sharp line—1/λ°280—superposed on it. This is identical with the line of Gε, one of the constituents of the samarium phosphorescent spectrum. Calcium added to lanthanum changes the colour of the phosphorescence from red to yellowish, and brings out yttrium and samarium lines, these metals being present as impurities; the Gδ and Gα lines are also seen, but the space which should be occupied by the Gβ green is now a dark space. I have shown that when Gδ, Gα, and Gβ are present in very small quantities with lime, the lines of Gδ and Gα are intensified, while that of Gβ is weakened. This new result seems to show that if only a small trace of Gβ is present with lime and lanthanum, the green line is not only suppressed, but the quenching

[1] Paper read before the Royal Society by Mr. William Crookes, F.R.S., on February 17. Continued from p. 428.

action has actually extended so far as to neutralise that part of the continuous lime spectrum having the same refrangibility as the Gβ line, the result being a black space in the spectrum. In the phosphoroscope the line of Gε is visible at the lowest speed; Gδ comes in at an interval of 0·0035 second, and the Gα line immediately afterwards.

Lead sulphate, by itself, in the radiant-matter tube glows with a nearly white colour, giving a continuous spectrum. In the phosphoroscope the red and orange are cut off, leaving a strong concentration of light in the green and blue. 5 per cent. of lead added to calcium sulphate phosphoresces like lime.

Magnesia phosphoresces pink. 5 per cent. with lime, as sulphates, give a greenish phosphorescence, with a tendency to turn red as the powder heats. The Oriental ruby containing about between 1 and 2 per cent. of magnesia, a mixture was prepared of acetate of alumina with 2 per cent. of magnesia, and tested after ignition. It gave no spectrum or lines. This was done to see if the crimson line of aluminium might be due to the presence of magnesia.

Nickel added to calcium sulphate in the proportion of 5 per cent. makes no alteration in the usual phosphorescent phenomena of calcium.

Potassium, 5 per cent., added to calcium sulphate gives a bright phosphorescence, and made the residual glow very persistent.

Samarium.—The phosphorescent behaviour of this body, alone and mixed with other substances, has been fully described in my paper on samarium (Phil. Trans., 1885, Part II., pp. 709–21.)

Scandium, either in the form of earth or sulphate, phosphoresces of a very faint blue colour, but the light is too feeble to enable a spectrum to be seen. Addition of lime does not bring out any lines.

Sodium sulphate mixed with an excess of calcium sulphate gives a greenish tinge to the usual colour of the phosphorescence. The sodium line is visible in the spectrum.

Strontia in the radiant-matter tube glows with a rich blue colour, showing in the spectroscope a continuous spectrum with a great concentration of light in the blue and violet. In the phosphoroscope the colour of the glow is bright green, showing in the spectroscope a continuous spectrum, with the red and blue ends cut off. A mixture of calcium sulphate with 5 per cent. of strontium sulphate behaves like calcium sulphate alone.

Thorium, as oxide or sulphate, refuses to phosphoresce, and the tube rapidly becomes non-conducting. A tube with thoria at one end and a phosphorescent earth such as lime or ytrria at the other end, and furnished with a pair of poles near each end, at a particular exhaustion is non-conducting at the thoria end, while it conducts at the yttria end. If the wires of the induction coil are attached to the poles at the thoria end, no current will pass; rather than pass through the tube, the spark prefers to strike across the spark gauge—a striking distance of 37 mm.—showing an electromotive force of 34,040 volts. Without doing anything to affect the degree of exhaustion, on transferring the wires of the induction coil from the thoria to the yttria end, the spark passes at once. To balance the spark in air the wires of the gauge must be made to approach till they are only 7 mm. apart, equivalent to an electromotive force of 6440 volts; the fact of whether thoria or yttria is under the poles making a difference of 27,600 volts in the conductivity of the tube. The explanation of this action of thoria is not yet quite clear. From the great difference in the phosphorescence of the two earths, it is evident that the passage of the electricity through these tubes is not so much dependent on the degree of exhaustion as upon the phosphorogenic property of the body opposite the poles. This view is supported by the fact that the thoria may be replaced by a metal wire, when the same obstructive action will result.

Lime does not give phosphorescent properties to thoria, if this earth be pure, but it brings out the lines of yttrium and samarium which are almost always present in small quantities in thoria unless it has been specially purified.

Tin with 95 per cent. of lime gives the lime phosphorescence only.

Thulium and *erbium* together phosphoresce with a green light, giving the erbium spectrum already described before this Society (Roy. Soc. Proc. vol. xl. p. 77, Fig. 1, January 7, 1886). There is, in addition, a faint blue line apparently double (see "Ytterbium"). The addition of lime causes the mixture to phosphoresce of a pale blue colour. The spectrum now shows a bright blue band, in the same position as the faint double blue band seen in the absence of lime. The blue line of Gα is also seen, and a faint line of Gδ. The red line of Gη, one of the constituents of the ordinary yttria spectrum, is prominent in this spectrum.

Tungsten and *uranium*, each mixed with 95 per cent. of lime, only give the lime spectrum.

Ytterbium.—I have not yet succeeded in preparing this body of trustworthy purity; but through the kindness of Prof. Clève, M. de Marignac, and Prof. Nilson, I have been enabled to experiment with specimens of ytterbia prepared by these chemists. Prof. Clève's ytterbia, in the form of sulphate, gives in the radiant-matter tube a blue phosphorescence, the spectrum of which shows a strong double blue band,[1] together with traces of the Gδ and the erbia green lines. The addition of lime broadens the blue band and makes it single. Prof. Clève writes that this ytterbia may contain some traces of thulia, perhaps also of erbia, but scarcely any other impurities. Measurements in the spectroscope give the following approximate results:—

Scale of spectroscope	λ	$\frac{1}{\lambda^2}$	Remarks
8·63	4626	4673	Commencement of first blue line. This edge is very hazy.
8·54	4574	4780	Centre of the first blue line.
8·45	4524	4885	End of first blue line.
8·44	4518	4898	Centre of dark interval between the two blue lines.
8·40	4475	4994	Centre of second blue line. This line is narrower than the first line.

The following are measurements taken with the mixture of this ytterbia and lime:—

Scale of spectroscope	λ	$\frac{1}{\lambda^2}$	Remarks
8·71	4674	4577	Up to this point there is the continuous spectrum of li-calcium. Here a black space commences.
8·515	4555	4819	Commencement of a hazy blue band.
8·475	4538	4855	End of hazy blue band. This band is of considerable brilliancy.

These blue bands are seen much fainter without lime, and are about as strong in the mixture of thulia and erbia with lime described above. I had ascribed them to ytterbia, when Prof. Nilson kindly forwarded me a small specimen of ytterbia, considered by him perfectly pure, and used for his atomic weight determinations. This ytterbia gives absolutely no blue bands. The origin of these bands therefore remains uncertain.

Ytterbia from Prof. Nilson, in the form of sulphate, refuses to phosphoresce without the addition of lime. When lime is added it only brings out traces of the phosphorescent bands of Gε, Gβ, and Gα. Evidently these are impurities.

Ytterbia from M. de Marignac is identical with that from M. Clève, as far as my examination can go. In sending me this ytterbia M. de Marignac warned me that he was very far from thinking it pure.

Yttrium.—During the fractionation of the higher fractions of yttria (+6, 118 and 119), a very sharp green line sometimes makes its appearance, situated between Gβ and Gγ (approximate position on the $1/\lambda^2$ scale, 325). It is very faint, and is not connected with the orange line of Sδ, although it is as sharp. The yttria showing these lines phosphoresces of a transparent golden-yellow colour, the fractions at the other end phosphorescing yellowish green.

I have previously described the action of a large number of

[1] This is the band spoken of in my Royal Society paper of June 9 last (Roy. Soc. Proc. vol. xl. 1886, p. 507), provisionally called Sγ, and ascribed to ytterbia. If it is not due to ytterbia it is a new body.

bodies on the phosphorescence of samarium ("On Radiant-Matter Spectroscopy; Part 2, Samarium," Phil. Trans., 1885, Part II. pp. 710-22.) The experiments resulting in the following observations were tried at about the same time. I will describe them in alphabetical order. Unless otherwise mentioned all the mixtures were in the form of anhydrous sulphates.

Yttrium 5 per cent., *aluminium* 95 per cent., gives a good yttria spectrum; the blue line of Gα is very distinct, and the double green of Gβ is well divided. In the phosphoroscope the Gβ and Gα lines first appear simultaneously, then the Gδ line.

Yttrium 99·5 per cent., *bismuth* 0·5 per cent.—The spectrum is bright, and on close examination a trace of samarium green, Gγ, is to be detected forming a wing to the Gδ line. In the phosphoroscope the citron line of Gδ entirely disappears and the samarium double green line, which out of the phosphoroscope is almost obscured by the great brightness of Gδ, now appears distinctly, together with the green Gβ line. Yttrium 95 per cent., bismuth 5 per cent., gives the usual yttria spectrum. No Gδ line appears in the phosphoroscope at any speed. At first only the Gβ line is seen, and next the Gα line appears, as in yttria. On gradually increasing the percentage of bismuth the spectrum of yttria grows fainter, until with 95 per cent. of bismuth the phosphorescence is bad and the spectrum faint.

Yttrium 5 per cent., *cadmium* 95 per cent., gives a brilliant phosphorescence, but the spectrum is almost continuous. In the phosphoroscope a faint concentration of light is seen in the green, which becomes sharper as the speed increases.

The action of calcium on the phosphorescence of yttrium has already been described.

Yttrium and *cerium*.—Cerium has the effect of deadening the brilliancy of the yttrium spectrum in proportion to the quantity added. All the bands remain of their normal sharpness.

Yttrium 5 per cent., *copper* 95 per cent., phosphoresces very feebly.

Yttrium 90 per cent., *didymium* 10 per cent.—This mixture gives a good yttria spectrum. Yttrium 70 per cent., didymium 30 per cent., phosphoresces very fairly, and gives all the usual lines.

Yttrium 50 per cent., *didymium* 50 per cent., refuses to phosphoresce. The tube is either too full of gas to allow the phosphorescence to be seen or it becomes non-conducting. When the mixture is illuminated by the glowing gas the absorption-lines of didymium in the green are seen. With higher proportions of didymium the same results are produced. On adding 25 per cent. of lime to the mixture containing 50 per cent. of didymium the yttria spectrum is brought out very well. Lime added to a mixture of 10 per cent. yttria and 90 per cent. didymium brings out the yttrium spectrum fairly, but the tube soon becomes non-conducting.

Yttrium 5 per cent. and *glucinum* 95 per cent. gives a bright phosphorescence, but the definition of the spectrum lines of yttria is bad.

Yttrium 5 per cent., *thallium* 95 per cent.—No spectrum is given by this mixture; it turns black and refuses to phosphoresce.

Yttrium 5 per cent., *tin* 95 per cent., phosphoresces faintly, the lines being very indistinct.

Yttrium 5 per cent., *titanium* 95 per cent., acts like thoria, and the tube becomes non-conducting.

Yttrium 5 per cent., *tungsten* 95 per cent.—This phosphoresces of a bright yellow colour, the spectrum is brilliant, but the lines are not sharply defined. In the phosphoroscope the colour becomes greenish, and the spectrum shows only the green lines of Gβ.

Yttrium 5 per cent., *zinc* 95 per cent.—The phosphorescence is of a pale yellowish-white, and the spectrum is very brilliant, being equal to that shown by 30 per cent. of yttrium with barium, calcium, magnesium, or strontium. In the phosphoroscope the colour becomes reddish, and the Gβ green line is the first to come. No citron line is seen. If the yttrium contains a trace of samarium, the samarium spectrum, which is scarcely seen under ordinary circumstances, now comes out distinctly.

Zinc sulphate mixed with 95 per cent. of calcium sulphate phosphoresces a bright bluish-green colour; the spectrum contains no bands or lines.

Zinc sulphide (Sidot's hexagonal blende, *Comptes rendus*, vol. lxii., 1886, pp. 999-1001; vol. lxiii., 1886, pp. 188-89).—This is the most brilliant phosphorescent body I have yet met with. In the vacuum tube it begins to phosphoresce at an exhaustion of several inches below a vacuum. At first only a green glow can be seen; as the exhaustion gets better a little blue phosphorescence comes round the edges. At a high exhaustion, on passing the current the green and blue glows are about equal in brightness, but the blue glow vanishes immediately the current stops, while the green glow lasts for an hour or more. In the phosphoroscope the blue glow is only seen at a very high speed, but the green glow is seen at the slowest speed, and the body is almost as bright in the instrument as out of it. Some parts of a crystalline mass of blende which, under the action of radiant matter, leave a glow with a bright blue colour, leave a green residual light when the current ceases; other parts which glow blue become instantly dark on stopping the current.

The different action of calcium, barium, and strontium on the constituents of yttrium is an additional proof, if confirmation be needed, that the bodies I have provisionally called Gα, Gβ, Gδ, &c. (Roy. Soc. Proc. vol. xl. 1886, p. 502), are separate entities. It may be as well here to collect together the evidence on which I rely to support this view. I will take the bodies *seriatim*:—

Gα.—An earth phosphorescing with a blue light, and showing in the spectroscope a deep blue line, of a mean wave-length 482. This earth occurs in different proportions in purified yttria from different minerals. Samarskite, gadolinite, hielmite, monazite, xenotime, euxenite, and arrhenite contain most Gα, whilst fluocerite and cerite contained notably less of this constituent. The addition of lime brings out the phosphorescence in Gα in advance of that of the other constituents. The behaviour in the phosphoroscope of Gα when mixed with the alkaline earths also points to a difference between it and its associates. With lime the blue phosphorescent band of Gα comes into view at a very low speed, the order of appearance with a small quantity of lime being Gβ, Gα, Gδ, and with a large quantity of lime, Gδ, Gα, Gβ. Employing strontia instead of lime, the order of appearance in the phosphoroscope when the quantity of strontia is small is Gβ, Gα, Gη, and when the quantity of strontia is in excess, Gα, Gη, Gβ. Baryta in small quantity brings out the lines in the phosphoroscope in the following order, Gβ, Gα, $G\eta_1$; but when the baryta is in excess the order is Gβ, Gη, Gα. The chemical position taken up by Gα in the fractionation scheme precludes it from being due to the bodies I have called Gβ, Gγ, Gε, Gζ, Sγ, or Sδ. It closely accompanies Gδ (the earth giving the citron line), concentrating at the least basic end, and I have not yet succeeded in effecting a separation of the two. If, therefore, Gα is not a separate entity, its blue line must be due to the citron-band-forming body called Gδ. The difference between Gα and Gδ is brought out in a marked manner by the phosphoroscope when baryta or strontia is present; the citron line of Gδ being entirely suppressed, while the blue line of Gα is brought out with enhanced brilliancy. For these reasons I am inclined to regard Gα as a separate body, although the evidence in favour of this view is not so strong as in the case of some of its other associates.

Gβ.—An earth phosphorescing with green light, and showing in the spectroscope a close pair of greenish-blue lines of a mean wave-length of 545. This earth can be separated by chemical fractionation from the other constituents of yttrium. It concentrates at the most basic end, and is present in the samarium which invariably makes its appearance at this end of the fractionation of yttrium. It is one of the prominent lines in Yα, where also it accompanies some of the samarium lines. Gβ, however, is not a constituent of samarium, for it is easy to purify samarium by chemical means so that it does not show a trace of the Gβ green lines, although it is very difficult to get Gβ free from some of the samarium lines. The residual phosphorescence of Gβ is very considerable, and its green lines show first in the phosphoroscope when only yttrium is present. The addition of lime keeps back the glow of Gβ, and brings forward that of Gδ. Strontium and barium act on Gβ very differently to lime. A small quantity of strontium brings forward the residual glow of Gβ, whilst in large quantities strontium keeps the phosphorescence of Gβ back to the last.

Gγ.—An earth phosphorescing with a green colour, and showing in the spectroscope a green line having a wave-length of 564. This is one of the least definite of all the supposed new bodies. It appears to be a constituent of samarium, occurring in the fractionation of yttrium among the most basic constituents connecting yttrium and samarium. Its point of maximum intensity is, chemically, very well marked, and is at a different part of the fractionation scheme to those of the other lines of

samarium, especially Gε. On dilution with lime, the phosphorescent line of Gγ vanishes before that of Gε.

Gδ.—An earth phosphorescing with a citron coloured light, and showing in the spectroscope a citron line having a wave-length of 574. Gδ is one of the least basic of all the bodies associated in yttrium, occurring almost at one extremity of the fractionation. It is not very difficult to separate chemically Gδ from all the other accompanying bodies except the one which I have called Gα (giving the deep blue line). Not only can Gδ be obtained free from the other four constituents of yttrium, but the body called by M. de Marignac Yα is a proof that the other four components of yttrium can be obtained quite free from Gδ. Lime intensifies the phosphorescence of Gδ, and deadens that of Gβ, while strontium has the opposite action. The behaviour of Gδ in the phosphoroscope, when mixed with lime, strontia, or baryta, also affords a striking evidence of individuality, lime enhancing the residual glow, while strontia or baryta altogether suppress it.

Gε.—An earth phosphorescing with a yellow colour, and, in the spectroscope, showing a sharp yellow line having a wave-length of 597. It is seen in the samarium spectrum as a sharp yellow line superposed on a hazy double band. As I have already pointed out, Gε fractionates out high up among the most basic earths, and generally accompanies lanthanum. In the phosphorescent spectrum of lanthanum the line Gε is seen quite free from the lines of other bodies.

Gζ.—An earth phosphorescing with a red light, showing in the spectroscope a red line of wave-length 619. This body is always more plentiful in yttrium obtained from samarskite and cerite than from gadolinite, hielmite, and euxenite, and is almost absent in yttrium from xenotime. Gζ is of about intermediate basicity. Working with samarskite yttria, Gζ becomes most brilliant after the line of Gη has completely disappeared. Further fractionation causes the line of Gζ to fade out, and the citron and blue lines are then left.

The phosphorescence of Gζ is developed to a different extent according to the metal with which the yttria is mixed. The order (beginning with the substance having the greatest action) is zirconium, tin, aluminium, bismuth, glucinum.

Gη.—An earth phosphorescing with a deep red light, and showing in the spectroscope a red line having a wave-length of 647. Like its fellow red constituent, Gη occurs most plentifully in samarskite yttrium, and scarcely at all in yttrium from hielmite, euxenite, and cerite. It is the first of the strictly yttrium constituents to separate out, on fractionation, at the most basic extremity, leaving Gα, Gβ, Gδ, and Gζ. In almost all samples of yttria, except when very highly purified, Gη is seen very brilliantly, and by its side can be detected the faint red band of samarium. In the phosphoroscope the line of Gη is the last to appear when yttria alone is being observed; strontia and baryta enhance the residual glow of Gη, strontia in moderate quantities bringing it out before that of Gβ, while baryta brings it out after Gβ.

Sδ.—An earth giving in the spectroscope when phosphorescing a very sharp orange line of wave-length 609. I have already (Roy. Soc. Proc. vol. xl. 1886, p. 504) discussed the claims of this earth to be considered a separate entity. It is not present in the rare earths from gadolinite, xenotime, monazite, hielmite, euxenite, and arrhenite; it is present in small quantity in cerite, and somewhat more plentifully in samarskite. In samarskite yttrium it concentrates at a definite part of the fractionation. Its sharp orange line is not strong enough to be seen in the phosphoroscope. A little calcium entirely suppresses the orange line, while samarium or yttrium seems to intensify it.

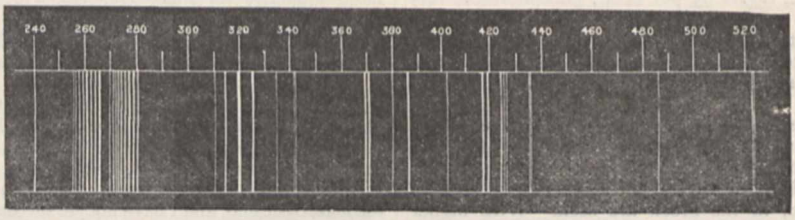


FIG. 5.

In addition to the above earths, it is not improbable that the sharp green line $\left(\frac{1}{\lambda^2}\ 325\right)$ mentioned under the heading "Yttrium" may be caused by still another earth.

The brilliant and characteristic spark spectra yielded when certain elements are volatilised and rendered incandescent by the spark from a powerful induction coil are relied on by chemists as an indisputable proof of the identity of such elements. Bearing this in mind I have endeavoured to ascertain how these yttrium constituents would behave in respect to the spark spectrum. Do the definite system of lines in the old yttrium spark spectrum belong to one constituent only, or are the yttrium lines broken up and distributed among the different bodies I have designated as Gα, Gβ, &c.? Also do the other constituents possess special spark spectra of their own? Very careful and long-continued experiments have shown me that neither of these hypothetical cases occur.

The spark spectrum given by old yttrium is shown in the drawing (Fig. 5). It is chiefly characterised by two very strong groups of lines in the red and orange. I now take the earth Gδ. This occurs near one end of the fractioning, and not only differs from the parent yttrium in its phosphorescent spectrum, but by virtue of the process adopted for its isolation it must likewise differ in its chemical properties. On examining its spark spectrum I see absolutely no difference between this spectrum and the one given by old yttrium.

I now pass to the other end of the fractionation of yttrium, where occurs a concentration of a body giving a totally different phosphorescent spectrum from the one at the first end. And it also differs chemically from old yttrium, and in a more marked manner from its brother, Gδ, at the other extremity of the fractionation. Here again its spark spectrum is perfectly identical both with old yttrium and with Gδ, and however closely I examine these three spectra in my laboratory, the whole system of lines is still identical.

Respecting the theoretical considerations involved in these results, I see two possible explanations of the facts brought forward. According to one hypothesis, research has somewhat enlarged the field lying between the indications given by ordinary coarse chemistry and the searching scrutiny of the prism. Our notions of a chemical element have expanded. Hitherto, the molecule has been regarded as an aggregate of two or more atoms, and no account has been taken of the architectural design on which these atoms have been joined. We may consider that the structure of a chemical element is more complicated than has hitherto been supposed. Between the molecules we are accustomed to deal with in chemical reactions and the ultimate atoms, come smaller molecules or aggregates of physical atoms; these sub-molecules differ one from the other, according to the position they occupied in the yttrium edifice.

An alternative theory commends itself to chemists, to the effect that the various bodies discussed above are new chemical elements differing from yttrium and samarium in basic powers and several other chemical and physical properties, but not sufficiently to enable us to effect any but a slight separation. One of these bodies, Gδ, gives the phosphorescent citron line, and also the brilliant electric spectrum. The other seven do not give electric spectra which can be recognised in the presence of a small quantity of Gδ, whilst the electric spectrum of Gδ is so sensitive that it shines out in undiminished brilliancy even when the quantity present is extremely minute. In the process of fractionation, Gα, Gβ, Gδ, &c., are spread out and more or less separated from one another, yet the separation is imperfect at the best, and at any part there is enough Gδ to reveal its presence by the sensitive electric spark test. The arguments in favour of each theory are strong and pretty evenly balanced.

The compound molecule explanation is a good working hypothesis, which I think may account for the facts, while it does not postulate the rather heroic alternative of calling into existence eight or nine new elements to explain the phenomena. However, I submit it only as an hypothesis. If further research shows the new element theory is more reasonable, I shall be the first person to accept it.

Neither of these theories agrees with that of M. Lecoq de Boisbaudran, who also has worked on these earths for some time. He considers that what I have called old yttrium is a true element, giving a characteristic spark spectrum, but not giving a phosphorescent spectrum *in vacuo*. The bodies giving the phosphorescent spectra he considers to be impurities in yttrium. These he says are two in number, and he has provisionally named them Zα and Zβ. By a method of his own, differing from mine, M. de Boisbaudran obtains fluorescent spectra of these bodies; but their fluorescent bands are extremely hazy and faint, rendering identification difficult. Some of them fall near lines in the spectra of my Gβ and Gδ. At first sight it might appear that his and my spectra were due to the same bodies, but according to M. de Boisbaudran the chemical properties of the earths producing them are widely distinct. Those giving phosphorescent lines by my method occur at the yttrium extremity of the fractionation, where his fluorescent bands are scarcely shown at all; whilst his fluorescent phenomena are at their maximum quite at the terbium end of the fractionation, where no yttrium can be detected even by the direct spark, and where my phosphorescent lines are almost absent.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Girton College has withdrawn from the arrangement by which it was hoped that a united scholarship for men and women might be established in geology and palæontology out of the Harkness fund. The council of Girton do not consider that the scheme proposed fulfils the essential condition of placing students of Girton and Newnham on the same terms as members of the University. A scheme has consequently been propounded for men alone, open to B.A.'s of not more than four years' standing. The electors are to be the Vice-Chancellor, the Woodwardian Professor, the Examiners in Geology in the Natural Sciences Tripos for the current and the preceding year, and an additional elected examiner. The electors are to take any steps they think desirable to ascertain the qualifications of candidates, and in making the award they are to have regard to proficiency in geology and palæontology, and to promise of future work. One scholar is to be elected annually; but in case no person shall be deemed worthy of election, the income for the year is to go to a reserve fund, to be given, when advisable, to scholars to aid them in prosecuting geological or palæontological researches.

The acceptance of the John Lucas Walker Studentship for the furtherance of original research in pathology, which has been offered to the University by the Attorney-General, is to be voted on in the Senate to-day. The amended regulations provide that the studentship shall be usually tenable for three years, with power of further prolongation for two years more when exceptionally valuable work has been done by the student. The fund, consisting of about 8300*l.* 4 per cent. debentures, is to be managed by the Professor of Pathology for the time being, the Professors of Physic and Physiology, and the President of the London College of Physicians. The studentship is not to be awarded by competitive examination, but any other mode of ascertaining qualifications may be taken. After full announcement of a vacancy, the Professor of Pathology is to nominate the best qualified candidate, but the other electors may overrule the nomination if they are unanimous in favour of some other candidate. The student shall not necessarily be a member of Cambridge University, and may be of either sex. No occupation interfering with pathological research may be followed by the student, who is also to vacate his studentship if elected to a professorship or fellowship. At least three terms of study are to be pursued at Cambridge. Exhibitions or prizes not exceeding 50*l.* may from time to time be awarded by the managers to any person, except the student for the time being, in respect of any essay, discovery, or meritorious service connected with or conducing to the science of pathology, and grants may be made for the furtherance of original research in the science.

The amended regulations for the Mechanical Sciences Tripos also come to a vote to-day.

The Senate has accepted the subscription of 500*l.* offered through Prof. Newton to enable the University to become a Governor of the Marine Biological Association.

The following new appointments of electors to various Professorships have been made: Botany, Mr. Thiselton Dyer; Political Economy, Right Hon. A. J. Balfour, M.P.; Experimental Physics, Dr. D. MacAlister; Downing Professorship of Medicine, Dr. A. Macalister; Mental Philosophy and Logic, Prof. A. Marshall; Surgery, Dr. A. Macalister. The remaining appointments are re-elections.

SCIENTIFIC SERIALS

American Journal of Science, February.—Kilauea after the eruption of March 1886. Under this general heading are grouped three separate papers, disposed in chronological order, describing the appearance of the volcano at different times since the great outburst of last March. The first is a communication to Prof. W. D. Alexander, Surveyor-General of the Hawaiian Islands, by J. S. Emerson, assistant in the Survey, dated August 27, and embodying a series of observations ranging from March 24 to April 14. This paper is illustrated by a plate showing the crater and new lake drawn to a scale of 1 : 20,000. The second, by L. L. Van Slyke, Professor of Chemistry, Honolulu, describes the general appearance of the volcanic district during the month of July, when considerable changes had already occurred, including a general upheaval in the centre of Halema'uma'u, and the reappearance of liquid lava in three different places. The third comprises a report to Prof. Alexander by Mr. Frank S. Dodge, on the survey of Kilauea in the last week of September and the first of October, with a plate of the crater on a scale of 1 : 6000. This observer expects that perhaps in a few months the great central pit will again fill up and overflow, as it did prior to the last eruption.—Volcanic action, by James D. Dana. The general question of igneous disturbances is discussed in connection with the recent eruptions of Kilauea, Vesuvius, and Tarawera. The author's conclusions on the causes of these phenomena, as summed up in his "Manual of Geology" (1863), are mainly confirmed, being attributed to the hydrostatic pressure of the column of lava; the pressure of vapours escaping in underground regions from the lavas, or produced by contact with them, acting either quietly or catastrophically; and the pressure of the subsiding crush of the crust forcing up the lavas in the conduit.—On the Coahuila meteorites, by Oliver Whipple Huntington. It is shown that the assumed new meteorite discovered near Fort Duncan, Maverick County, Texas, and recently described by Mr. W. E. Hidden, is really one of the "Coahuila irons," described by J. Lawrence Smith, and supposed to belong to one fall, although found on the opposite side of the Rio Grande from Maverick County.—A new rhizostomatous Medusa from New England, by J. Walter Fewkes. This is a large acraspedote jelly fish, not only new to New England, but also unlike any yet captured on the Atlantic coast of North America. It was captured in September 1886 in New Haven harbour, and is allied to a common species found on the west European seaboard, *Pilema* (*Rhizostoma*, auth.) *octopus*, Haeck., and to *P. pulmo* of the Mediterranean.—A short study of the atmosphere of β Lyræ, by Orray T. Sherman. The author's observations lead to the conclusion that in stars known to possess a spectrum comprising bright lines, these lines, while persistent in place, are not persistent in intensity. Comparing Lockyer's result in the study of the atmosphere with his own, he draws a general conclusion regarding the condition of the stellar atmosphere, describing it as consisting of an outer layer of hydrogen positively electrified, an inner layer of oxygen negatively electrified, and between them a layer of carbon mingling on its edge with the hydrogen. The electric spark passing through the mixture forms the hydrocarbon compound, whose molecular weight carries it into the oxygen region where combustion ensues with the formation of carbonic acid and aqueous vapour, both of which descending under the influences of their molecular weight are again dissociated by internal heat, and return again to their original positions.—Phenacite from Colorado, by Samuel L. Penfield, with notes on the locality of Topaz Butte, by Walter B. Smith. Some interesting facts are communicated with regard to the crystallisation of this remarkable mineral, the occurrence of which in the United States (Pike's Peak, El Paso County, Colorado), was determined by Messrs. Cross and Hillebrand.

Topaz Butte, five miles north of Florissant, marks the southern limit of the "crystal beds" whence have come most of the specimens labelled *Pike's Peak*. The largest phenacite ever found in this locality is a rough lenticular crystal about 15 mm. in diameter.—The norites of the Cortlandt series on the Hudson River, near Peekskill, New York, by George H. Williams. In continuation of his memoir on the peridotites of the Cortlandt series (*American Journal of Science*, 1886, p. 26) the author here begins a petrographic description of the massive rocks of this system. The present paper deals with the non-chrysolitic rocks, norite proper and hornblende norite. He designates all rocks in which one-half or more of the non-feldspathic constituents are hypersthene as norite, and names varieties of this after the prevailing accessory component.—A method for subjecting living protoplasm to the action of different liquids, by George L. Goodale. An apparatus is described by means of which the necessity is obviated of transferring specimens from the litre-flask to the stage of the microscope, all handling being thus avoided, while the object can be placed under the action of as large a quantity of liquid as may be desirable.—On the topaz from the Thomas Range, Utah, by A. N. Alling. The topaz crystals here under examination are from the cabinet of Prof. Brush, vary in length from 3 mm. to 10 mm., and are perfectly clear and colourless.—On a simple and convenient form of water battery, by Henry A. Rowland. A simple, convenient, and cheap form of water battery is described, which the author has had in use for many years.

Bulletin des Sciences Mathématiques, tome x. December 1886, tome xi. January 1887, Paris.—We single out these two recently issued parts, as they contain papers on subjects intimately connected with notices of Greek geometry, which we have from time to time communicated to NATURE when giving an account of Dr. Allman's contributions to *Hermathena*. In the *Mélanges* of the earlier number M. Paul Tannery has two notes: one of nine pages, entitled "Démocrite et Archytas" (see Gow's "History," p. 129, and NATURE, vol. xxxiv. p. 548); the other, of eleven pages, on "Les Géomètres de l'Académie." The later part has an article of twelve pages, by the same writer, on "La Technologie des Éléments d'Euclide." All three are quite up to M. Tannery's well-known excellent form for thoroughness of research and soundness of inference. The rest of the matter consists as usual of reviews (*inter alia*, of the French translation of Clerk Maxwell's "Electricity and Magnetism" and Mr. Greenhill's "Differential and Integral Calculus"), and of useful abstracts of papers in the various Continental and British mathematical journals.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, February 24.—"Problems in Mechanism regarding Trains of Pulleys and Drums of Least Weight for a given Velocity Ratio." By Prof. H. Hennessy, F.R.S.

As trains of wheels, pulleys, and drums are frequently employed in machinery for the transformation of large and small velocities of rotation, it appeared to the author desirable to inquire into the conditions which would favour the greatest economy of weight of the parts forming such trains. Eighty years since Dr. Thomas Young had arrived at a theorem for the minimum number of teeth in a train of wheels and pinions with a given velocity ratio, and when the pairs of wheels and pinions are similar. By investigating the question of minimum volume for minimum weight of trains the author has been led to the following results, which are fully demonstrated in his paper: namely, that for a train of cylindrical pulleys composed of similar pairs the ratio of the diameter of a large to that of a small pulley should be as 19 to 10. For drums composed of hoops supported by disks of the same thickness, and with the breadth of each hoop equal to the radius of the small drum, the ratio of the diameters should be 11 to 5. If the hoop was supported by spokes whose volume taken together would be half the volume of a complete disk, the ratio would be 51 to 20. With regard to a train of pulleys, it was shown that a single pair possessing the same velocity ratio as a series with the ratio of diameters found for minimum volume, the latter would be considerably less than the former. Thus, with five pairs whose velocity ratio would be nearly $24\frac{3}{4}$, the volume would be less than the 1/26 of a single pair possessing the same velocity ratio. A model constructed in brass of such a train, with all the large pulleys 1·9 inches in diameter, and all the small 1 inch, weighed 18·34 ounces. A train of four pairs of drums illustrative of the last problem solved weighed 16·788 ounces, the large drums being 2·55 inches, and the small 1 inch diameter, while all the hoops were half an inch broad. The velocity ratio of this train is 42·2825, or a little more than $42\frac{1}{4}$.

March 3.—"The Etiology of Scarlet Fever." By E. Klein, M.D., F.R.S., Lecturer on General Anatomy and Physiology at the Medical School of St. Bartholomew's Hospital, London.

The investigation, the results of which I now record, was commenced at the end of December, 1885. It arose out of an inquiry into the prevalence of scarlatina in different quarters of London, undertaken by the Medical Department of the Local Government Board as a part of its business of investigating local epidemics. That inquiry had demonstrated milk from a farm at Hendon as the cause of the scarlatina, and had adduced strong circumstantial evidence that the scarlatina had been distributed, not in the whole, but in certain sections of the Hendon milk, and further that the ability of the sections of milk service to convey the disease had been related to a malady affecting particular cows. This evidence against particular cows at the Hendon farm could not and did not aim at furnishing direct and definite proof of the connection of this cow disease with scarlet fever of man, for the inductive methods usually employed by the Medical Department of the Local Government Board when applied to inquiries about epidemic spread of scarlatina can for obvious reasons yield but circumstantial evidence. As on various former occasions, so also on this, the Medical Department sought to put the above conclusions to the test of scientific experiment. This task was delegated to me by the Board. The first part of this work has been published in the recently issued volume of the Reports of the Medical Officer of the Local Government Board for 1885–86. I have therein shown that the suspected cows from the Hendon farm that had been made the object of special study, showed besides a skin disease—consisting in ulcers on the udder and teats, and in sores and scurfy patches and loss of hair on different parts of the skin—also a general disease of the viscera, notably the lungs, liver, spleen, and kidney, which resembled the disease of these organs in acute cases of human scarlatina. I have further shown that the diseased tissues of the ulcers on the teats and udder produced on inoculation into the skin of calves a similar local disease, which in its incubation and general anatomical characters proved identical with the ulceration of the cow; and further, that from the ulcers of the cow a species of micrococcus was isolated by cultivation in artificial nutritive media, which micro-organism in its mode of growth on nutritive gelatine, on Agar-Agar mixture, on blood serum, in broth, and in milk, proved very peculiar and different from other species of micrococci hitherto examined. With such cultivation of the micrococcus I have produced by subcutaneous inoculation in calves a disease which in its cutaneous and visceral lesions (lung, liver, spleen, and kidney) bears a very close resemblance both to the disease that was observed in the Hendon cows as well as to human scarlatina.

The second part of the work, carried out during 1886–87 for the Medical Department, had for its object to investigate whether or no the disease, human scarlatina, is associated with the identical micrococcus, and whether this, if obtainable from the human subject, is capable of producing in the bovine species the same disease as was observed in the Hendon cows and in the calves experimented upon from the latter source. The definite and clear proof that this is really the case has now been obtained, and the evidence I now bring to the notice of the Royal Society.

On examining acute cases of human scarlatina—for which opportunity I owe great thanks to Dr. Sweeting, the Medical Superintendent of the Fulham Fever Hospital—I soon ascertained the fact that there is present in the blood of the general circulation a species of micrococcus, which on cultivation in nutritive gelatine, Agar-Agar mixture, blood serum, and other media, proved to be in every respect identical with that obtained from the Hendon cows. Out of eleven acute cases of scarlet fever examined in this direction, four yielded positive results: three were acute cases between the third and sixth day of illness with high fever temperature, and the fourth was a case of death from scarlatina on the sixth day. In all these four cases several drops of blood were used, after the customary methods and under the required precautions for establishing cultivations in a series of tubes containing sterilised nutritive gelatine, and generally only a very small number of these tubes revealed after an incubation of several days one or two colonies of the micrococcus. This

shows that the micrococci were present in the blood in but small numbers.

Having ascertained the identity in morphological and cultural respects of the micrococcus of the blood of human scarlatina with the organism obtained from the Hendon cows, the action of the cultivations of both these sets of micrococci was then tested on animals and the results compared. It was found that mice—wild mice better than tame ones—after inoculation or after feeding, became affected in exactly the same manner, no matter whether the one set of cultivations or the other was used. The great majority of these animals died after between seven and twenty days; the *post-mortem* examination revealed great congestion of the lungs, amounting in some cases to consolidation of portions of the organ, congestion of the liver, congestion and swelling of the spleen, great congestion and general disease of the cortical part of the kidney. From the blood of these animals, taken directly from the heart, cultivations were established in nutritive gelatine, and hereby the existence of the same species of micrococci was revealed; they possessed all those special characters distinguishing the cultivations of the micrococcus of the Hendon cows, and of the human scarlatina.

In the third and concluding section of the work, cultivations of the micrococcus of two cases of human scarlatina were used for infecting calves: two calves were inoculated, and two were fed from each set of cultivations. All eight animals developed disease, both cutaneous and visceral, identical with that produced in the calves that had been last year infected with the micrococcus from the Hendon cows.

From the heart's blood of calves thus infected from human scarlatina the same micrococcus was recovered by cultivation, possessing all the characters shown by the cultures of the micrococcus of the Hendon cows, and of the cases of human scarlatina.

It must be evident from these observations that the danger of scarlatinal infection from the disease in the cow is real, and that towards the study and careful supervision of this cow disease all efforts ought to be directed in order to check the spread of scarlet fever in man. It is also obvious that in the agricultural interest investigations of this cow disease are greatly called for.

Anthropological Institute, February 22.—Mr. Francis Galton, F.R.S., President, in the chair.—The election of Mr. Joseph Straker was announced.—Prof. Ferrier read a paper on the functional topography of the brain. He discussed the question how far recent investigations into the functional topography of the brain could be brought into relation with craniological and anthropological researches with a view to establish the foundations of a scientific phrenology. Then he sketched the functional topography of the brain so far as it had been settled, but pointed out that the psychological aspects of brain functions were still far from being made out, although that correlation must be established and proved before a practical psychology, in any degree serviceable to the physician or the anthropologist, could be regarded as possible. He offered some speculations on the subject, and illustrated them by reference to certain facts and phenomena of disease in man. On the question as to how far it was possible from an anatomical examination of the brain to form an estimate of the forces and capacities of the individual, he pointed out many great difficulties which had to be encountered. *Cæteris paribus*, greater anatomical development might be considered as an index of greater functional capacity. He thought the attempt to determine differences in functional capacity from the examination of the head involved all the difficulties connected with the examination of the brain, and a great many more. He indicated the cranial relations of the principal convolutions, but expressed his belief that in the present state of our knowledge the data of a scientific phrenology were still very deficient. There was reason to believe, however, that, if the subject were taken up from different points of view by anatomists, physiologists, psychologists, and anthropologists, great progress might be made.—Mr. H. D. Rolleston read a paper on the cerebral hemispheres of an adult Australian; and a paper by Mr. Sören Hansen on a fossil human skull from Lagoa Santa, Brazil, was taken as read.

Entomological Society, February 2.—Dr. D. Sharp, President, in the chair.—The President nominated Mr. R. McLachlan, F.R.S., Mr. O. Salvin, F.R.S., and Mr. H. T. Stainton, F.R.S., Vice-Presidents during the Session 1887-88.—The Rev. W. J. Holland, Dr. F. A. Dixey, Mr. C. J. Gahan, and Mr. S. Klein, were elected Fellows.—Mr. P. Crowley exhibited a new species of *Synchloë*—*S. johnstoni*—from Kilima-njaro; also, for comparison, specimens of *Synchloë mesentina* and *S. hellica*, which the new species closely resembled.—Mr. W. White exhibited a number of preserved larvæ of European Lepidoptera in various stages of growth, illustrating the gradual development of the markings and colours, as explained by Prof. Weismann, in his "Studies in the Theory of Descent."—Mr. Gervase F. Mathew exhibited a variety of a female of *Lycæna telicanus*, from the neighbourhood of Gallipoli; some specimens of a *Lycæna* from Vigo, believed to be varieties of *Lycæna baton*; and several examples of a *Leucophasia* from Vigo, which appeared to be identical with *L. æstiva*.—Mr. Porritt exhibited, on behalf of Mr. N. F. Dobrée, a series of a remarkable red form of *Teniocampa gracilis*, bred from larvæ collected in Hampshire.—Mr. Eland Shaw exhibited specimens of *Pachytylus cinerascens* (Fab.), *Mecostethus grossus* (Linné), and *Gryllus flavipes* (Gmel.), and read a note on the identity of *Gryllus* (*Locusta*) *flavipes* (Gmel.).—Mr. H. Goss read a communication from Prof. Riley, of Washington, on the subject of the Australian bug (*Icerya purchasi*). It was stated that the insect had of late years become very destructive to various trees and shrubs in California, into which country, as well as into New Zealand and Cape Colony, it had been introduced from Australia.—The Rev. T. A. Marshall communicated a monograph of the British *Braconidæ*, part 2.—Mr. F. P. Pascoe read a paper entitled "Descriptions of some new species of *Brachycerus*."—Mr. Francis Galton, F.R.S., read a paper "On pedigree moth-breeding as a means of verifying certain important constants in the general theory of heredity," in which he suggested the institution of a system of experimental breedings, to be continued for several years, with the object of procuring evidence as to the precise measure of the diminution of the rate at which a divergence from the average of the race proceeds in successive generations of continually selected animals.—Mr. F. Merrifield read a paper entitled "A proposed method of breeding *Selenia illustraria*, with the object of obtaining data for Mr. Galton." Mr. McLachlan said he considered the fact that *S. illustraria* was dimorphic an objection to its selection for the experiments proposed, and suggested that the common silkworm moth would be more suitable. Prof. Meldola remarked that, although for some reasons the species selected was well adapted for testing Mr. Galton's conclusions, he believed that the fact of the moth being seasonally dimorphic was likely to introduce disturbing elements into the experiments which might influence the results. The discussion was continued by Dr. Sharp, Messrs. Baly, Kirby, White, Klein, Porritt, Dunning, Waterhouse, Bates, Merrifield, Galton, and others.

Chemical Society, February 17.—Dr. Hugo Müller, F.R.S., President, in the chair.—It was announced that the following changes in the Council list were proposed by the Council:—As President: Mr. W. Crookes, F.R.S., *vice* Dr. Hugo Müller, F.R.S. As Vice-Presidents: Prof. McLeod, F.R.S., Prof. Schorlemmer, F.R.S., and Mr. Ludwig Mond, *vice* Mr. Crookes, F.R.S., Prof. Liveing, F.R.S., and Prof. T. E. Thorpe, F.R.S. As ordinary Members of the Council: Prof. A. H. Church, Dr. P. F. Frankland, Prof. Kinch, and Dr. H. F. Morley, *vice* Messrs. H. T. Brown, A. E. Fletcher, and Profs. Meldola and Pickering.—The following papers were read:—The influence of temperature on the heat of dissolution of salts, by Prof. S. U. Pickering. This is an extension of the author's previous work on the sulphates, entitled "The Influence of Temperature on the Heat of Chemical Combination" (Trans., 1886, 260), which tended to show that the heat of dissolution of a salt does not increase regularly with a rise of temperature, but that irregularities occur at various points, so that the heat of dissolution must be represented by a series of curves. The experiments with potassium sulphate, hydrated and anhydrous magnesium sulphate, and hydrated and anhydrous copper sulphate have been repeated, and the investigation extended to potassium, sodium, hydrated and anhydrous strontium chloride, potassium and the two strontium nitrates, the two sodium carbonates, sodium acetate and potassium sodium tartrate. The investigation comprises over 700 determinations, the mean results with each salt being deduced from two to five distinct series of experiments, each performed with different thermometers. The observations extended from 3° to 25°. In all cases it was found that the irregularities previously noticed were the result of error, and that the heat of dissolution of a salt is represented by a series of straight lines. In rising from low temperatures the heat of dissolution is expressed by a straight line up to a certain point, when the rate becomes suddenly lowered and remains constant till a further sudden reduction occurs at

some still higher temperature. The average divergence of all the mean results from lines of perfect straightness amounted to less than one-thousandth of a degree. . . . The heat of combination of a salt with its water of crystallisation is deduced from the author's results. He concludes that it is not a constant quantity at all temperatures; the general effect of rise of temperature being to diminish it, although at very low temperatures this effect seems to be more than counterbalanced by some other cause, probably the tendency of the water molecules to unite with each other, the heat of combination diminishing then with fall of temperature. The more water a salt contains the more marked are both these results.—Periodates, by Dr. C. W. Kimmins.—Sulphonic acids derived from the β-monohaloid-derivatives of naphthalene, by Prof. Henry E. Armstrong and Mr. W. P. Wynne.—The decomposition of potassium chlorate and perchlorate by heat, by Dr. Frank L. Teed.—The formation of ethylic cyanacetoacetate, by Dr. J. William James.—The relation of diazobenzene anilide to amidoazobenzene, by Mr. R. J. Friswell and Mr. A. G. Green.—Note on Wallach's explanation of the isomeric transformation of diazoamidobenzene into amidoazobenzene, by Prof. R. Meldola, F.R.S.

Victoria Institute, February 21.—Prof. T. McKenny Hughes read a paper on caves, their formation, uses as places of refuge, and the influences which in many cases cause uncertainty as to the ages of the deposits therein. In regard to English sea caves he held that our coasts had not recovered their present elevation, after the submergence that followed on the Glacial age, before man came on the scene, marine shells being found buried in the same earth as Palæolithic man and the extinct animals.

Middlesex Natural History Society, February 15.—Mr. Mattieu Williams in the chair.—Mr. Logan Lobley read a paper on the geology of the parish of Hampstead. Commencing with a sketch of the work of those distinguished geologists who have made Hampstead classic ground, Mr. Lobley referred especially to the work of the late Mr. Caleb Evans, and mentioned that Mr. Evans's well-known model of the area had passed into safe keeping. The London Clay was described in detail; its minerals, the nature of its clays, and the material manufactured from them, were treated of, as well as the sections, and the fossils they have yielded. Passing on to the Bagshot Sands, Mr. Lobley traced their age, their connection with similar beds of other districts, and the important part they play in the question of water-supply. Some remarks upon the formation of the present features of the area by denudation, and some interesting and suggestive notes upon the sources and direction of flow of the former smaller streams, such as the Fleet, the West Bourne, and the Bays Water, with a reference to the great folds of the Chalk, and the relation of the geology of London to that of the southern area, concluded the paper.

EDINBURGH

Royal Society, February 7.—Lord Maclaren, Vice-President, in the chair.—Dr. E. Saug read a paper on cases of instability in open structures.—Mr. W. Peddie communicated a paper on the time-rate of increase of electrolytic polarisation.—Sir W. Thomson discussed the equilibrium of a gas under its own gravitation alone, and pointed out the bearing of the problem on the question of the probable age of the sun.—Dr. Ralph Copeland, of Dun Echt Observatory, communicated some astronomical notes.

Royal Physical Society, January 19.—Dr. Alexander Bruce showed some microscopic specimens tending to confirm Gower's views with regard to the existence of the ascending lateral tract in the spinal cord. His sections were taken from a case of meningo-myelitis confined to the lower dorsal cord. They showed ascending degeneration of Goll's columns, of both cerebellar tracts, and of a comma-shaped tract in the situation of the ascending lateral tract of Gower's.—Dr. R. H. Traquair communicated the first part of a revision of the nomenclature of the fishes of the Old Red Sandstone of Scotland.—Mr. W. E. Hoyle read a report on a collection of shells brought from the West Coast of Africa, the Canaries, and Cape Verde Islands, by Mr. John Rattray.

Mathematical Society, February 11.—Mr. George Thom, President, in the chair.—Mr. W. J. Macdonald gave a proof of a geometrical theorem; Mr. A. Y. Fraser submitted a paper on vortices, by Mr. Charles Chree; Mr. R. E. Allardice communicated a note on a theorem in algebra, by Mr. John L. Mackenzie; Mr. George A. Gibson called attention to a point in the history of definite integrals; and Mr. John S. Mackay gave a few trigonometrical notes.

CAMBRIDGE

Philosophical Society, January 31.—Prof. Babington in the chair.—On the motion of a ring in an infinite liquid, by Mr. A. B. Basset.—Form and position of the Horopter, by Mr. J. Larmor.—On the finer structure of the walls of the endosperm cells of *Tamus communis*, by Mr. Walter Gardiner. It would appear, from the author's more recent researches, that the perforation of the walls of the endosperm cells in the plant referred to is established after the formation of the wall, and in a similar manner to that which occurs in sieve-tubes during the formation of the sieve-plate. The author further hopes to show that this is a special instance of a general phenomenon.

February 14.—Mr. Trotter, President, in the chair.—On the influence of capillary action in some chemical decompositions, by Prof. Liveing.—On homotaxis, by Mr. J. E. Marr.—Note on the function of the secreting hairs found upon the nodes of young stems of *Thunbergia laurifolia*; on the petiolar glands of the Ipomœas; and on the occurrence of secreting grandular organs on the leaves of some Aroids, by Mr. Walter Gardiner. In the last paper the author remarked that it has been frequently stated that the entire absence of all extra-floral secretory structures in monocotyledonous plants furnishes one of the most striking points of difference between the above-named group and the Dicotyledons. One would be led to expect, however, that some form of secretive organ should be present, and that probably they would be found—if anywhere—among the Aroids. Guided by these considerations, the author made a careful examination of the Aroids at Kew, and was so fortunate as to find two individuals, viz. *Aglaonema Mannii* and *Alocasia cuprea*, which appear to him to possess definite organs of secretion. The structure of these organs was then shortly described, and a comparison was instituted between them and certain forms of extra-floral nectaries. As to the existence of intramural glands, *e.g.* in *Anthurium punctatum*, the author's observations confirmed those of Dalitzsch recently published in the *Botanisches Centralblatt*.

LIVERPOOL

Biological Society, January 22.—Prof. W. Mitchell Banks, President, read his inaugural address, which dealt with the aims and objects of the Society.—Prof. W. A. Herdman read a paper on recent researches in connection with the vertebrate brain (the pineal eye in lizards, and the pituitary gland in the Vertebrata and Tunicata), and their bearing on the hypothetical protochordata.

February 12.—Prof. W. A. Herdman, Vice-President, in the chair.—Mr. A. O. Walker contributed some notes on the *Mysidæ* of Liverpool Bay, with a description of some abnormal specimens.—A paper was read by Mr. J. Lomas on some points in the structure of *Alcyonidium gelatinosum*.—The Secretary (Mr. R. J. Harvey Gibson) drew attention to the new English translation of Sachs's "Text-book of Botany," Book II., by Goebel, and made some remarks on the value of a uniform terminology for the reproductive organs, not merely in botany, but in biology generally.—Dr. Ellis contributed some notes on boring insect larvæ.—Dr. Larkin exhibited and described some physiological apparatus.

PARIS

Academy of Sciences, February 28.—M. Gosselin, President, in the chair.—Remarks accompanying the presentation of MM. Charcot and P. Richer's work, "Les Démoniaques dans l'Art," by M. Charcot. Representations of persons "possessed by the devil," that is subject to epilepsy and other nervous affections, have been brought together from ivories, enamels, tapestries, engravings, paintings, and other sources, for the purpose of studying these works from the stand-point of scientific truth. Such masters as Andrea del Sarto, Domenichino, and Rubens are generally found to have depicted these subjects with a strict regard to nature, so that their figures accurately reproduce the traits of a now well-understood pathological state.—Determination of the constant of aberration: first and second method of observation, by M. Lœwy. The author here deals with the somewhat feeble part played by refraction in these already described processes. From this study it appears that, the action of refraction being at all altitudes the same, the measure of the distance (except for very low regions) may be everywhere effected under almost

identical conditions of accuracy. Hence it is no longer necessary to observe the two stars only when found at considerable altitudes, a circumstance which greatly facilitates compliance with the other geometrical conditions of the problem.—On the great movements of the atmosphere, in connection with M. Mascart's last note of February 21, by M. Faye. The author reviews the whole subject of aërial movements as bearing more especially on his well-known theory regarding the direction of the wind in cyclones. The paper is followed by a brief reply from M. Mascart, who still maintains that this theory is unsupported by observation.—Note on the measurement of the photographic plates of the transit of Venus across the solar disk in 1882, by M. Bouquet de la Grye. These measurements, which have been executed in the Institute, deal altogether with 1019 plates, involving lengthy calculations which cover no less than 32,000 sheets of paper.—On the phosphorescence of the sulphuret of calcium, by M. Edmond Becquerel. In connection with M. Verneuil's recent paper on the determining causes of the phosphorescence of the sulphuret of calcium, the author makes some observations on the views already announced by him on the influence of foreign substances in modifying the molecular condition of the sulphuret of phosphorescent calcium.—On the red fluorescence of alumina, by M. Lecoq de Boisbaudran. It has recently been shown that highly calcined alumina yielding a bluish fluorescence *in vacuo* assumes a red tint in the phosphoroscope. Notwithstanding this observation the author still contends that the presence of chromium is necessary to obtain the red fluorescence of alumina. A mere trace of Cr_2O_3 superadded suffices to produce the fine fluorescence described by M. Becquerel in his work on "Light."—Note on the earthquake of February 23 at Marseilles Observatory, by M. E. Stephan. The movement which was attended by such disastrous effects along the Riviera, and even in the Maritime Alps, was very little felt at Marseilles, where two series of shocks were recorded at the Observatory, the first at 5.55 in the morning, and lasting about 90 seconds, the second ten minutes later, and lasting only some 15 seconds. The astronomic pendulums were somewhat disturbed, but the meridian-circle was not appreciably affected.—Observations of Barnard's new comet (1887 *d*), and of Palisa's new planet 265, made at the Paris Observatory (equatorial of the West Tower), by M. G. Bigourdan.—On a new method of determining the parallax of the sun by the photographic observation of the transit of Venus, by M. Obrecht. The method here described yields formulæ by means of which the parallax may be determined from the observations of *a single station*.—Additional note on the measurement of aberration, by M. J. C. Houzeau. It is shown that the objections recently raised by M. Lœwy to the author's method rest on a serious error.—On applicable surfaces, by M. E. Amigues. A definition is given of rectilineal applicable surfaces, from which several theorems are deduced.—On the product of two sums of eight squares, by M. X. Antomari. A fresh demonstration is given of the theorem that the product of two sums of eight squares is a sum of eight squares. It is further remarked that by means of this theorem a rule of multiplication of complex quantities in a space of eight dimensions may be conceived analogous to the rule of multiplication of quaternions.—Note on entropy, by M. Félix Lucas. It is shown on theoretical grounds that when a gas is heated under a constant volume or under a constant pressure, the increase of its entropy is in proportion to the increase of its true temperature.—On the coefficients of chemical affinity, by MM. P. Chroustchoff and A. Martinoff. Certain analytic and thermic experiments are described, from which it is inferred that neither the initial nor the final composition of precipitates can serve to give coefficients of chemical affinity. Characteristic constants of affinity cannot be evolved by the method of simultaneous precipitation.—The action of heat on heptene, by M. Adolphe Renard. From the experiments here described, it follows that under the influence of heat heptene is decomposed chiefly into toluene and hydrogen, at the same time yielding a certain quantity of its lower homologues, hexene and pentene.—On the special characters of the loss of activity experienced by diastase under the action of heat, by M. Em. Bourquelot. A series of experiments are described, from which it would appear that the quality of the fermentation is modified rather than its quantity diminished, unless it be admitted that in natural diastase there are two or more soluble ferments intermingled, which by the increase of temperature become successively destroyed.—On the earths of cerite, M. Eug. Demarçay.—On the ferrite of zinc, by M. Alex. Gorgeu. Several methods are described for easily preparing this substance, and comparing it with the natural ferrite known as franklinite.—On the nitrates and superphosphates, by M. A. Andouard. The author's experiments show that it is a mistake to mix these substances together as artificial manures.—On the destruction of the Nematodes of beetroot, by M. Aimé Girard. The sulphuret of carbon is proposed as a more practical remedy than the expensive system of "decoy plants" (*plantes pièges*) introduced by Kühn.—On the cause of the changes which take place in the blood on contact with air, oxygen, and carbonic acid, by M. Béchamp. These changes are referred to the activity and influence of the microzymes of the blood.—On the transfusion of blood into the head of decapitated animals, by MM. Hayem and Barrier. It is argued that the assertions contained in M. Laborde's recent communication on this subject are not justified by his own publications.—On the gastric glands secreting mucus and ferment in birds, by M. Maurice Cazin.—On the structure of the muscular fibres in the edriophthalmous crustaceans, by M. R. Kœhler.—On the anatomy of Bilhazia (*B. hæmatobia*, *Distomum hæmatobium*), by M. Joannes Chatin.—On the geology of the Lake Kelbia district and of the Central Tunisian seaboard, by M. G. Rolland. From his extensive studies of this region the author concludes that during the historic period the relief of the land has not perceptibly changed, and that in the Roman epoch as well as now Lake Kelbia communicated only intermittently with the sea.—On the deposits of tin, from the geological stand-point, by Mr. Reilly. Excluding those of Mexico and Bolivia, the author argues that all these deposits, from Cornwall to Australia, are connected by a vast curve, which he calls the "axis of Sumatra."—On some new methods of artificially producing crystallised silica and orthose, by M. K. de Kroustchoff.—On the earthquake of February 23, recorded at the Perpignan Observatory, by M. Fines. As at Marseilles, the vibrations were but slightly felt in this district.—On the effects of the same earthquake in East Switzerland, by M. F. A. Forel. The main shock appears to have been very generally felt throughout this region.—Papers followed describing its effects at Nice, Voreppe (Isère), and Saint-Tropez, and discussing the relations that may exist between seismic and magnetic disturbances.

Berlin

Physiological Society, January 28.—Prof. Du Bois-Reymond in the chair.—Dr. Benda mentioned that his researches, according to which the "spermatoblasts" resulted from the coalescing of the cells forming the spermatozoa with the supporting cells, had some years earlier been anticipated by the French anatomists, and that Prof. Grünhagen, who formerly opposed this view, was now likewise presenting it as his own.—Dr. Rawitz had examined the green gland of fresh-water crayfish. It was situated on the first member of the antennæ, was uniformly green on the ventral side, but on the dorsal side only at the periphery, elsewhere white, with a round yellow-brown speck in the centre. The gland consisted of two tubules closely interwoven. The cells of the green part had a round grass-green drop of protoplasm, the yellow-brown cells a uniformly yellow-brown coloured nucleus. The tubules anastomosed, the yellow-brown cells being the terminal portions of the tubules, and secretory. No conclusions respecting the function of the glands could be drawn from their anatomical structure.—Dr. Gad made a communication respecting the peculiar strange albumen-precipitate with salt recently described by Dr. Wurster. If to the white of eggs lactic acid, peroxide of hydrogen, and common salt were added, almost the whole of the albumen was precipitated as a white flaky mass, perfectly similar in appearance and taste to newly-precipitated caseine (curd), but distinguished from caseine by its chemical reactions. The easy digestibility of this form of albumen, which had hitherto been precipitated by no other reagent was especially remarkable. It was interesting that, in accordance with the reactions shown by Dr. Wurster's test paper for active oxygen, hydrochloric acid was formed on the mixture of lactic acid, peroxide of hydrogen, and common salt, and this acid *in statu nascendi* might be the specific precipitate for this new form of albumen, which could be obtained just as well from blood serum as from white of eggs.

Meteorological Society, February 1.—Prof. von Bezold in the chair.—Dr. Frölich gave a report on measurements of solar heat, which, following up those instituted in 1883 and already published, he had made in the years 1884 to 1886 after some alterations in his apparatus. The most important modifications made in the apparatus consisted in the removal of the rock-salt

plate in front of the thermo-electric pile which he had made use of in his first measurements. He had been induced to remove the rock-salt plate by the conviction that after a time rock-salt developed a quality of transmissibility which was not identical both for luminous and for non-luminous heat. The bare thermo-electric pile showed itself by oft-repeated proofs to be constant towards the rays of a Leslie cube. The relation of the rays from the blackened side of the cube to the rays from the white side continued invariably the same. The same constancy was manifested in the registrations of the thermal element towards the luminous heat of a white-glowing platinum chimney, which was uniformly heated by two gas-flames. The observations of solar heat were made on perfectly bright days and under a perfectly clear atmosphere, the thermo-electric pile being directed to the sun under very different heights, as far as 10°, and exposed to the sun till the diversion of the galvanometer had become constant. The values obtained on the various days and under different solar positions were graphically delineated, on the supposition that the absorption of the atmosphere was an exponential function of its density. The result came out that the "curve" was practically a straight line, or a line concave or convex to so small a degree as to deviate but very little from a straight line. When the curve was lengthened till it met the perpendicular co-ordinate, then the intersecting point representing the magnitude of the solar heat was the same for all days of observation. The deviating results of Mr. Langley and Messrs. Angot and Crova were explained, in part from the fact that in their calculation the reflection of the thermal rays in the different atmospheric strata had not been taken account of, and in part from the fact that the different atmospheric strata were assumed to be parallel, and so their incurvation was left out of account. Notwithstanding the circumstance that the absorption by the atmosphere was different for the different kinds of rays, and also different from day to day, yet was the "curve," the co-ordinates of which were represented by the observed heat and the abscissæ by the logarithms, without exception, a straight line. This empirically ascertained fact was the main result of the whole series of investigations extending over three years.

Physical Society, February 4.—Prof. Helmholtz in the chair.—Dr. Sprung described the barograph designed by him, which avoided the errors of the older balance-barometer (first constructed in 1760 by Samuel Moreland) by making the barometer work on a resting horizontal beam, which through horizontal automatic displacement of a sliding weight was kept always in exact equilibrium. The travelling vertical tread-wheel constantly marked its position on the writing-table of the instrument. Seeing, moreover, that this displacement of the tread-wheel was effected by a clockwork, any disturbance that might arise from its rubbing against the barometer was completely precluded. The automatic equilibration of the beam of the balance was produced by an electric current. The speaker had quite recently instituted a series of the most various experiments, by which he demonstrated how the registering balance designed by him was with great advantage available for a large number of physical investigations: how, for example, he was able by his balance to permanently register the state of the quicksilver in the barometer; the progress of the evaporation of alcohol; the discharge of a fluid from a capillary tube; the change of intensity in an electric current; the evaporation of water through a clay-ball; the changes of density in the atmospheric air recorded by the variations of rise on the part of a large glass ball; and phenomena connected with permanent change of weight. The registering balance, which was being executed by the mechanician Fues in Berlin, allowed, in short, a large series of physical processes to be automatically recorded, and would prove highly useful in many physical investigations.—Prof. Helmholtz, by an experiment, demonstrated the great cohesion of an air-free column of water. A siphon-shaped glass tube, the longer leg of which was closed and the shorter one open, was filled with quicksilver, and above the quicksilver there was superposed a small quantity of distilled water. If the filling was effected without admission of air, then, on the tube being placed in an upright position, the water adhered to the closed end, and its adhesion supported the quicksilver column, which was longer than the barometer height. The speaker now brought the open end of the siphon tube into communication with an air-pump, and caused to be pumped out as much as down to 2 mm. pressure, but even then the cohesion of the water supported the quicksilver column. Only by shaking was the water column shattered, and the quicksilver immediately sank. If there was no shaking, the apparatus continued for an unlimited length of time unchanged. This contrivance should serve the purpose of electrolysing air-free water and ascertaining the strength of the current under which gas bubbles developed themselves by electrolysis. The experiment showed that on the transmission of a current of 2 volts the water continued adherent. The depression of the quicksilver column in consequence of gas development occurred, however, in an experiment with a current of 2·15, and in another with a current of 2·18 volts.

February 18.—Prof. Schwalbe in the chair.—Dr. Frölich spoke of his measurements of the solar heat in the years 1883, 1884, and 1886, and refuted at length the objections which had been raised against these measurements by MM. Vogel, Langley, Angot, and Crova. In the discussion following thereon, Dr. König stated that experiments carried out in the Physical Institute with a Langley bolometer indicated that very considerable influence is exercised by the air-currents on this delicate measuring-instrument.

BOOKS AND PAMPHLETS RECEIVED

Catalogue of the Fossil Mammalia in the British Museum, Natural History, part iv.; R. Lydekker.—Practical Electricity: W. E. Ayrton (Cassells).—A Treatise on Algebra: Profs. Oliver, Wait, and Jones (Finch, Ithaca).—Contributions to Meteorology, chap. ii. revised edition: E. Loomis (New Haven).—The Game of Logic: L. Carroll (Macmillan).—Bees and Bee-keeping, vol. ii. parts 5 and 6: F. R. Cheshire (U. Gill).—British Dogs, parts 2-5: H. Dalziel (U. Gill).—Fancy Pigeons, 3rd edition: J. C. Lyell (U. Gill).—Vegetable Biology: Dr. T. W. Shore (Churchill).—Anecdota Oxoniensia; Alphita: edited by J. L. G. Mowat (Clarendon Press).—Journal of the Anthropological Institute, February (Trübner).—Outlines of Lectures on Physiology: T. W. Mills (Drysdale, Montreal).—Schools of Forestry in Germany: Dr. J. C. Brown (Oliver and Boyd).—Social History of the Races of Mankind, 2nd division: A. Featherman (Trübner).—Complete Hand-book on the Management of Accumulators, 2nd edition: Sir D. Salomons (Whittaker).—The Encyclopædic Dictionary, vol. vi. part 1 (Cassells).—Journal of the Chemical Society, March (Gurney and Jackson).—Bulletin of the American Geographical Society, Nos. 4 and 5, 1885 (New York).—Annual Report of the Proceedings of the Sussex Association for the Improvement of Agriculture, 1886.—Journal of the Asiatic Society of Bengal, vol. lv. part 2.—Aborigines of Hispaniola: H. Ling Roth (Harrison).—Bibliography and Cartography of Hispaniola: H. Ling Roth.

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