THURSDAY, MAY 18, 1899.

TRAVELS IN NEW GUINEA.

Through New Guinea and the Cannibal Countries. By H. Cayley Webster. Pp. xvii + 387. (London: T. Fisher Unwin, 1898.)

AFTER perusal of this book we are not able to say that its title is strictly descriptive of its contents. It s as regards New Guinea too comprehensive, and too vague in respect of "the Cannibal Countries." It deals with adventurous cruises on the New Guinea coast, and among the islands from the Admiralty Group to the Solomons, with a land journey undertaken in German New Guinea. Of this our author says:

"In the interior of German New Guinea I traversed a greater distance on foot than any white man has done before or since, and on that expedition I discovered the non-existence of a range of mountains previously marked on the chart."

The printing of the book is as excellent as is the paper. The illustrations, some three hundred and fifty in number, are generally good, sometimes excellent. It contains qne map, the weakest part of the work. It takes no heed of latitude or longitude, makes Captain Webster more than half cross New Guinea, and sail recklessly over great islands. It is in every respect inferior to older maps. The style of the book is light and easy; the spelling of German names inaccurate. Captain Webster is in some ways typical of the travelling Englishman, ready to go anywhere, but by preference where there is danger to be incurred, and with a mission to put right whatever he finds wrong. We meet him engaged in this way at Batavia, where we take up his narrative. On the German steamer were many coolie labourers. The Government agent kicked, bullied, and ill-used them till Captain Webster, who was only a passenger, interfered. But our author is also an enthusiastic collector. He writes:

"One of my earliest captures [in German New Guinea] was a magnificent specimen of the *Ornithoptera paradisea*, of which only one specimen had before reached Europe, and I felt that it was worth the whole of my journey to New Guinea to see this superb insect lying glistening in my hand."

On November 9, 1893, he reached the headquarters of the New Guinea Company, and received every kindness and assistance from the Governor. A day or two afterwards he saw a coolie flogged for having induced some others to run away. He thought the terrible punishment inflicted exceeded the offence. He found the natives true Papuans, but wisely abstains from describing a Papuan. Captain Webster noticed a strong Hebrew type running through their features, "as indeed I have seen throughout the whole of the country, both in British, German, and Dutch possessions." Surely he did not find this common from Hale Sound to Kiriwina.

He observes that they all smoke tobacco—apparently speaking of the natives of German New Guinea—"which has been introduced into the country by Europeans." He states that he has "on more than one occasion observed a mere infant remove the pipe from his mouth to refresh himself from the natural food provided by his mother." This we presume is to be regarded as a figure of speech.

The introduction and distribution of the tobacco-plant is, however, of real scientific interest. Romilly ("The Western Pacific and New Guinea," p. 226) says of Astrolabe Bay, "Tobacco I should say there certainly was not." He would thus appear to agree with Captain Webster, who carried out his explorations in that district. But Giglioli (p. 120, "I Viaggo del Pattore," O. Beccari) quotes a letter from a Russian officer of the *Vitiaz*, from which Maclay landed in Astrolabe Bay in 1871, which says: "In quanto al tabacco essi [the natives] lo coltivano, e, lo fumano, rivoltandolo in una foglia di banana." On the other hand, we know from the British New Guinea Reports that seven or eight years ago it had not reached the low lands of the large rivers on the north-east coast of that colony.

Our author also relates that he has seen a Papuan woman "nourishing her child and a small pig at the same time, carrying one under each arm, appearing to be more anxious for the welfare of the latter, in consequence of its greater market value." We are aware that if a Papuan woman loses her child she sometimes employs a small pig to remove, and, it may be, to utilise the lacteal secretion. We have, however, never seen a Papuan woman carry her child under her arm, though they do carry dogs and pigs in that way. Captain Webster does not say where he saw this; but at p. 29 we are told what he gave for a small boy. It was more than the market value of a young pig.

Captain Webster's only journey towards the interior was on the watershed of Astrolabe Bay. Romilly wrote:

"Astrolabe Bay has always been looked upon, for some reason unknown to me, as a suitable place for a party of adventurers to swoop down upon and take possession of."

The reason why travellers prefer it is that it offers apparent easy access to the interior. When our author wrote his book, he was evidently unacquainted with the German literature that deals with the Astrolabe Bay district.

The officers of the Russian corvette *Vitiaz* mapped it in 1871, and Guido Cora published the map in 1875. Maclay was in 1871 or 1872 as far inland as the top of the coast range (*Nachrichten über Kaiser Wilhelms Land*, 1896), Zöller and Lauterbach will be mentioned later. The Governor furnished Captain Webster with military police and carriers, under the command of Pierson, who perished later with Herr Otto Ehlers in an unfortunate attempt to cross New Guinea from north to south. It has been claimed for Captain Webster by his publisher that he discovered the Minjim River; he asserts himself that he followed its stream to its source, and he has a photograph of it which purports to say "Hier ist des Stromes Mutterhaus," though it does not look like it. Zöller ("Ersteigung des Finisterre-Gebirges," 1891) found that the road from two German plantations crossed the Minjim. It was, therefore, when Captain Webster arrived in the bay, well known to every one there except himself. Zöller forded the Minjim near the sea, and found it knee-deep in the dry season. In German writings it is sometimes termed a *Bach*, sometimes a *Fluss*. It was in flood when Captain Webster's

party started, but they forded it eleven times in that condition the first day, having, however, many narrow escapes. They left Stephansort on March 22, and reached their furthest distance on April 10. In giving no map of this journey Captain Webster is just neither to himself nor to his reader. Where he really got to, it is quite impossible to say. But this much is clear: that as the Minjim valley runs from the coast towards the Ramu nearly at right angles, and as our author did not reach the Ramu, and never left the watershed of the Minjim, his claim to have beaten the German record falls to the ground, and need not be further considered.

The second and most important geographical discovery of Captain Webster is of a decidedly negative character. He unhesitatingly asserts the non-existence of the great Bismarck Range, of which the German travellers are not a little proud, as it is the highest part of their colony, and on their map a note, "Zeitweise Schnee," appears at a spot where Captain Webster's map makes him cross the range.

The Bismarck Range was discovered and named by Dr. Otto Finsch ("Samoafahrten," 117). He estimated its altitude with wonderful accuracy at 14,000 to 16,000 feet; its distance from the coast at seventy or eighty miles. It was seen by Romilly (*loc. cit.*, 227). Zöller says that in clear weather it is visible from Astrolabe Bay. In his "Routenskizze der Expedition in das Finisterre-Gebirge," Zöller gives the bearings from his highest point on that range to the different summits of the Bismarck Range. These, with bearings from Astrolabe Bay, must give the position with sufficient approximation to accuracy. In 1896, Drs. Lauterbach and Kersting examined the middle course of the Ramu, and actually ascended from thence some of the slopes of the Bismarck Range (*Nachrichten*, 1896, 42) to an altitude of 1000 metres. Lauterbach's positions were determined by astronomical observations, since published. Against this we have the statement of Captain Webster, that from his furthest point he "ascertained the true position of the Albert Victor Range of mountains in British New Guinea," which he thinks was mistaken by "some," who proudly named it after the late ex-Chancellor. In what manner our author ascertained in a few hours the true position of a mountain in British New Guinea from a single unknown and undetermined point on the Minjim will probably remain unknown for all time.

We entertain no doubt that Captain Webster, from his position on the watershed of Astrolabe Bay, was looking at the Bismarck Range itself in the distance. It should interest him greatly to peruse the reports on the splendidly conducted and completely successful expeditions of Zöller (1888) and Lauterbach (1896), and to study their maps, prepared and worked out on scientific principles. If our author will do that, he will wish to rewrite his preface.

In May 1894, Captain Webster visited New Britain just after a massacre of white men, and received the proverbial hospitality of Ralum. He gives an interesting account of how Mrs. Parkinson defeated a native attack, and relates how "the natives for many miles round worship the very ground she walks upon." This follows the very remarkable statement:—

"Within a mile or two of Ralum one may find, even to-day, chiefs who keep slaves for the purpose of food, and who are in the habit of killing them every few days to satisfy their diabolical tastes."

Now there lives at Ralum the enlightened and philosophic Parkinson, a name known to, and deservedly held in high esteem by many of the best men in Europe and elsewhere. That the atrocities mentioned by Captain Webster should be in constant practice under the eye, so to speak, of Mr. and Mrs. Parkinson, it is not easy to comprehend. The attitude of the German authorities is not alluded to by our author. He visited the Sacred Heart Mission, which he pronounced to be "excellent." His historical account of the mission is not quite accurate. The missionaries did not, according to this story, leave Woodlark Island on account of its small size, or of fever, but because they could do nothing with the natives. He states that the country has been divided into Protestant and Catholic countries. We know, from a recent issue of the *Illustrirte Zeitung*, that these divisions are not observed by the Roman Catholic missions in other German colonies. Captain Webster does not say whether the boundaries are respected in New Britain, but he states that the mission is obliged by law to teach the children to read and write German.

He then visited the Solomon Islands, where, as usual, several murders had been committed. He points out that ships of war cannot deal with these matters, a fact that has long been well known to those who study the subject. Captain Webster says the Solomon Islanders are all cannibals, and that the practice of offering up human sacrifices on even the most trivial occasions prevails throughout the group. No information whatever is vouchsafed as to the nature of this strange sacrificial practice.

On page 136, Captain Webster says:—

"I have been an eye-witness to more than one such expedition (head-hunting raids) when a large haul had been made, and more than sixty trophies in the shape of heads had been captured, which were immediately smoke-dried and preserved by being plastered over with chinam."

It is much to be hoped that in the interests of social and political evolution Captain Webster may in the proper place lift the veil on his unique and gruesome experiences. He does not state where or when he assisted at these scenes, which must be very rare. We are not able to believe that "heads" can be preserved in the manner described by our author. The few we have seen had been carefully preserved by a different process, on rational and scientific principles.

Captain Webster brought his visit to the Solomons to a characteristic close by backing out in the presence of a hostile tribe with his face to the foe and his revolver in his hand.

The second part of his book shifts the scene to the Batavian archipelago. On the south-coast of Dutch New Guinea the author met Arab traders, and Christian missionaries who are making very little progress. At the Kei Islands he met his yacht, and was henceforth master of his own movements. He sailed for the nearest part of the New Guinea coast, provided with hunters, and the yacht armed with a quick-firing Krupp gun.

The party next reached British New Guinea. Our author found Port Moresby dreary and dried up. It has often been described as picturesque. He tells us the dress of the men consists "only of a small piece of cord round the waist." The dress does consist of a piece of small cord; but a respectable member of the community would be as much scandalised to appear in public dressed as described by Captain Webster as would be that gentleman himself. The philosophy of clothes offers in New Guinea a great field for the student, but it is not so near the surface as Captain Webster thinks. On the way to Samarai they saw

"numerous villages along the coast, and cocoa-nut trees in great profusion were observed high up on the mountains, but I was informed (says Captain Webster) that the natives were very treacherous and have a bad reputation."

As a matter of fact they are, according to the British New Guinea Reports, under the control of the village police all along the coast from Port Moresby to Samarai, and are settled communities. At Samarai he found "a judge from Queensland presiding there to try the numerous small native cases." It did not occur to Captain Webster that the Queensland judge would have no jurisdiction in another colony. He visited native villages in that district. He describes the weapons of the natives as "bows, arrows and spears." The bow and arrow is, however, not used east of Port Moresby He visited Kwato, and pays a meed of praise to the mission there. He adds:

"At night could be heard far away in the forest weird sounds from their tom-toms and drums, wailings and shouting, which told us that their lewd dances and other disgusting orgies were taking place."

This is a *tour de force* of the imagination fit for the "Inferno" of the Divina Commedia. In sober fact there is no man within "tom-tom" range of Kwato that is not a church-goer. The great fault one really has to find with their dances is their dull, dreary monotony. The disgusting orgies are not scientific facts. John Knox said to his Queen:

"And of dancing, madam, I do not utterly damn it."

He was right. No wise Government will try to put down dancing, especially in a coloured population. Its suppression has been attempted more than once in the Pacific. In the code of M. Tardy Montravel it was enacted:

"13° Toute danse nocturne est interdite. Les delinquants seront punis d'un emprisonnement de un à trois jours."

Of this Paul Cordeil, chief of the Judicial Service of New Caledonia, writes:

"Les codes de M. de Montravel sont toujours restés lettre morte."

Let legislators and travellers take warning accordingly. Dancing is, next to eating, the greatest enjoyment the Papuan has. The drum is silent only after death or disaster. It is only unacquaintance with the drum and the dance that connects these with heinous sin. Assignations are doubtless made at dances. They would be made in any case. It was in church that Petrarch fell in love with Laura, and Boccaccio with Fiametta.

Nothing noteworthy occurred after the party left Kwato till they met with the "duk-duk" in the German Islands. Captain Webster thinks it was invented in the Duke of York group as a form of native police. His view of it is far too narrow. Many natives came off to them on the coast of New Ireland. "They are all ferocious cannibals and very treacherous. Many had been to Fiji, to Samoa, and Queensland, but they are none the more to be trusted." They landed at New Hanover, assisted at some festivities, saw some pretty dances, and obtained photographs. Of course these dances were seen by Captain Webster, and were decent. Here he "found that the natives have a belief that every man, woman, and child belong to one or other species of birds, according to the lines of the hands." He connects this with the old palmistry of our forefathers. We recognise it as belonging to the totemism that exists or existed from the St. Lawrence to the west end of New Guinea, and probably much further. But we shall before long hear more on this subject from Captain Webster's distinguished host at Ralum.

The party then proceeded to the Admiralty Group, but did not dare to land there.

The last chapter is a summary of anthropology and ethnology. It requires to be regarded cautiously before it can be used for scientific purposes.

The collections made were large. In birds it was disappointing, at least as regards those of the Paradise family. The insects turned out better. The specimens collected are already to be met with in museums from the south of Italy to the north of Germany. Captain Webster has therefore the satisfaction of knowing that, as a collector, he has made a contribution to the sum of human knowledge.

OUR BOOK SHELF.

The Philosophy of Memory, and other Essays. By D. T. Smith, M.D. Pp. 203. (Louisville, Ky.: J. P. Morton and Co., 1899.)

DR. D. T. SMITH is an amateur of philosophy in that wider sense of the word which includes physics, and his speculations, as they are modestly put forward in the present volume, range from psychology to sphere-formation, and from the distinction of organic and inorganic to an adverse criticism of the nebular hypothesis. The essay which gives its title to the book is an attempt, notwithstanding the sterility of the inorganic and the reproductive capacity of the organic, to trace continuity, and apply analogies, from the one to the other, in the form of a physical-vibration theory of ideation. Even conscience is an "orderly operation of ether vibrations with respect to conduct." The second essay, on emphasis or rhythm, is a further application of the wave-theory. The third paper, on "the functions of the fluid wedge," is interesting as suggested by the author's expert physiological studies, and carried out in the alien field of hydrostatics. The present writer confesses to non-comprehension. The fourth essay objects to the nebular hypothesis that the facts of rotation are against it. "The earth could revolve on its own separate axis in the same direction as the sun only by

being caused to move in a larger orbit than that described by it while still a part of the sun's mass," and the author suggests the action of comets carrying off portions of the nebulous border of a sun, as they struck it in the direction of its motion at a suitable moment.

The fifth and last article, in the results of which Dr. Smith expresses confidence other than he shows in respect of his earlier excursions into heterodox and quasi-heterodox physics, is devoted to "the laws of river-flow." Residence on the banks of the Mississippi enabled him to discover the formula of a double spiral action, by which to explain the elevation of the middle of a stream, the drift of floating material from the sides and of sunken material to the sides, the shape and depth of the eroded channels, the different speed of diverse portions of the current. This piece of at any rate unborrowed speculation appears not unworthy of consideration. H. W. B.

Das Heidelberger Schloss und Seine Gärten in alter und neuer Zeit und der Schlossgarten zu Schwetzingen. By H. R. Jung and W. Schröder. Pp. 74. (Berlin: G. Schmidt, 1898.)

IN this work we have an historical account of the gardens and castles of Heidelberg—the famous German university town, and its less well-known neighbour Schwetzingen. The authors are both gardeners, and, although the book is written chiefly from a garden point of view, a good deal of space is given to purely historical matter. Judging from the photographs, the gardens at Schwetzingen seem to be far more beautiful and natural than those of Heidelberg, where grottoes, shrines, and various other architectural devices appear to be the leading features, and not always ornamental ones either. To those interested in the history of very old and famous gardens, this treatise may be of use; and it will not take up much space on the library shelf, being only about a quarter of an inch in thickness. It is well printed and illustrated, and is practically free from misprints; the only one of any importance being at p. 47, where Azalea appears as Aralea. Were it not that there is a genus Aralia, this slip would not be worth mention.

JOHN WEATHERS.

Graduated Test-papers in Elementary Mathematics. By Walter J. Wood, B.A. Pp. 71. (London: Macmillan and Co., Ltd., 1899.)

THERE are forty test-papers in this collection, each containing questions in arithmetic, Euclid, and algebra. At the head of each test are notes stating the parts of the subjects required in order to solve the questions. The papers are primarily intended to test the progress of students preparing themselves for the examination in first stage mathematics of the Department of Science and Art, and Departmental teachers will find them of real value for that purpose. In the lower mathematical forms of secondary schools, also, the papers should be of service, as many of the questions have been selected from the papers of public examining bodies mostly favoured by such schools. Care appears to have been taken in selecting and arranging the questions, and answers are given to all the questions in arithmetic and algebra.

The Story of the British Race. By John Munro. Pp. 242. (London: George Newnes, Ltd., 1899.)

SOME time ago Mr. Munro wrote "The Story of Electricity" for this library of useful stories. In this volume he transfers his attentions to the science of anthropology, and expresses in his preface the hope that his book will "tend to destroy some errors regarding the origin and pedigree of the nation which have infected life and literature for ages." The volume should be the means of creating an interest in the study of mankind, in addition to imparting a knowledge of the nature of the races in the British Islands.

LETTERS TO THE EDITOR.

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

Fourier's Series.

I HAVE M. Poincaré's authority to publish the accompanying note regarding the applicability of Fourier's series to discontinuous functions, and send it accordingly for publication in NATURE. A. A. MICHELSON.

MON CHER COLLÈGUE,—Comme je l'avais prévenu vous avez, tout à fait raison. Prenons d'abord l'integrale $\int_0^y \frac{\sin xz}{x} dx$, dont la limite pour $y=\infty$ est $\pi/4$, 0, $-\pi/4$ selon que z est positif, nul ou négatif.

Faisons maintenant tendre simultanément z vers o et y vers l'infini de telle façon que zy tende vers a. La limite sera $\int_0^a \frac{\sin x}{x} dx$ qui peut prendre toutes les valeurs possibles depuis o jusqu'à $\int_0^\pi \frac{\sin x}{x} dx$.

Si nous prenons maintenant n termes dans la série $\Sigma \frac{\sin kz}{z}$ en faisant tendre simultanément z vers o et n vers l'infini de telle façon que le produit nz tende vers a, cela sera évidemment la même chose; et la différence entre la somme et l'integrale sera d'autant plus petîte que z sera plus petît. Cela se voit aisément.

Tout à vous,

(Signed) POINCARÉ.

A Note upon Phosphorescent Earthworms.

IT has been long known that earthworms may be phosphorescent. So long ago as 1836 Prof. Dugès described, under the name of *Lumbricus phosphoreus*, a worm which showed this peculiarity. In 1887 Prof. Giard showed that a worm probably identical with this, and, if so, not a *Lumbricus* at all, was marked luminous, especially when the soil was disturbed in the vicinity. Giard named the species *Photodrilus phosphoreus*. It has been met with and noticed to be luminous by two other observers. Quite recently (*Zoolog. Jahrbücher*, xii., 1899, p. 216) Dr. Michaelsen, of Hamburg, ascertained that this species of Giard is really identical with *Microscolex modestus* of Rosa. The multiplication of names is hardly the fault of Prof. Giard, since the genus *Microscolex* had only been instituted a few months before his genus *Photodrilus*. This species, unlike the majority of its congeners, which are chiefly congregated in Patagonia, and there very abundant, is not only European, but also occurs in England. It seems also to be, at least usually, phosphorescent. I received some time since, through the kindness of Mr. Carleton Rea, a few small earthworms from the neighbourhood of Worcester, which were undoubtedly a *Microscolex*, and at least not much different from *M. modestus*. Mr. Rea informed me that they were phosphorescent, with a "light emitted exactly similar to that of the glow-worm." They could be stimulated to show this light by "stamping the lawn." It has been suggested that this phosphorescence in earthworms is really due to photogenic bacteria entangled in the slime upon the skin. Possibly such an explanation may account for the occasional phosphorescence of *Allolobophora foetida* (the "Brandling"), observed by Vejdovsky. But the regularity, and the mode of excitation, of the luminosity seems to show that *Microscolex* is phosphorescent in its own right.

FRANK E. BEDDARD.

ON THE CHEMICAL CLASSIFICATION OF THE STARS.[1]

IN the attempts made to classify the stars by means of their spectra, from Rutherford's time to quite recently, the various criteria selected were necessarily for the most part of unknown origin; with the exception of hydrogen, calcium, iron, and carbon, in the main chemical origins could not be assigned with certainty to

[1] By Sir Norman Lockyer, K.C.B., F.R.S. A paper read at the Royal Society, May 4.

the spectral lines. Hence the various groups defined by the behaviour of unknown lines were referred to by numbers, and as the views of those employed in the work of classifying differed widely as to the sequence of the phenomena observed, the numerical sequences vary very considerably so that any coordination becomes difficult and confusing.

Recent work has thrown such a flood of light on the chemistry of the stars that most definite chemical groupings can now be established, and the object of the present communication is to suggest a general scheme of classification in which they are employed, in relation to the line of cosmical evolution which I have developed in former papers communicated to the Society.

The fact that most of the important lines in the photographic region of the stellar spectra have now been traced to their origins renders this step desirable, although many of the chemical elements still remain to be completely investigated from the stellar point of view.

The scheme is based upon a minute inquiry into the varying intensities, in the different stars, of the lines and flutings of the under-mentioned substances :—

Certain unknown elements (probably gaseous, unless their lines represent "principal series") in the hottest stars, and the new form of hydrogen discovered by Prof. Pickering (which I term proto-hydrogen for the sake of clearness). Hydrogen, helium, asterium, calcium, magnesium, oxygen, nitrogen, carbon, silicium.

Iron, titanium, copper, manganese, nickel, chromium, vanadium, strontium ; the spectra being observed at the highest available spark temperatures. The lines thus observed I term enhanced lines, and I distinguished the kind of vapour which produces them by the affix proto, *e.g.* proto-magnesium, for the sake of clearness.[1]

Iron, calcium, and manganese at arc temperatures.

Carbon (flutings) at arc temperatures.

Manganese and iron (flutings) at a still lower temperature.

In a communication to the Society[2] I stated the results arrived at recently with regard to the appearances of the lines of the above substances in stars of different temperatures, and the definition of the different groups or genera to be subsequently given are based upon the map which accompanied the paper, together with more minute inquiries on certain additional points, the examination into which was suggested as the work went on.

So far as the inquiry has at present gone, the various most salient differences to be taken advantage of for grouping purposes are represented in the following stars, the information being derived from the researches of Prof. Pickering[3] and Mr. McClean,[4] as well as from the Kensington series of photographs.

Hottest Stars.

Two stars in the constellation Argo (ε Puppis and γ Argûs).[5]

Alnitam (ε Orionis). This is a star in the belt of Orion shown on maps as Alnilam. Dr. Budge has been good enough to make inquiries for me which show the change of letter to have been brought about by a transcriber's error, and that the meaning of the Arabic word is "a belt of spheres or pearls."

Stars of intermediate Temperature (Ascending Series).

β Crucis, ε Tauri, Rigel, α Cygni, [ ] Polaris, Aldebaran.

[1] *Roy. Soc. Proc.*, vol. lxiv. p. 398.
[2] *Roy. Soc. Proc.*, vol. lxiv. p. 396.
[3] *Astro.-Phys. Journ.*, vol. v. p. 92, 1897.
[4] "Spectra of Southern Stars."
[5] The spectrum of this star contains bright lines, but I show in a paper nearly ready for communication to the Society, that when these occur with dark lines, the latter alone have to be considered for purposes of chemical classification.

Stars of intermediate Temperature (Descending Series).

Achernar, Algol, Markab, [ ] Sirius, Procyon, Arcturus.

Stars of lowest Temperature.

Ascending Series.	*Descending Series.*
Antares, one of the brightest stars in Duner's observations of Class III*a*.[1]	19 Piscium, one of the brightest stars in Duner's Class III*b*.
[Nebulæ.]	[Dark Stars.]

In order to make quite clear that both an ascending and a descending series must be taken into account, I give herewith two photographs showing the phenomena observed on both sides of the temperature curve in reversing layers of stars of nearly equal mean temperatures, as determined by the enhanced lines. The stars in question are :—

Sirius (descending). }
α Cygni (ascending). }
Procyon (descending). }
γ Cygni (ascending). }

The main differences to which I wish to draw attention are the very different intensities of the hydrogen lines in Sirius and α Cygni, and the difference in the width and intensities of the proto-metallic and metallic lines in Procyon and γ Cygni.

These differences, so significant from a classification point of view, were first indicated in a communication to the Society in 1887,[2] and the progress of the work on these lines has shown how important they are.

I have based the group—or generic—words upon the following considerations.

As we now know beyond all question that a series of geological strata from the most ancient to the most recent brings us in presence of different organic forms, of which the most recent are the most complex, it is natural to suppose that the many sharp changes of spectra observed in a series of stars from the highest temperature to the lowest brings us in presence of a series of chemical forms which become more complex as the temperature is reduced. Hence we can in the stars study the actual facts relating to the workings of inorganic evolution on parallel lines to those which have already been made available in the case of organic evolution.

If then we regard the typical stars as the equivalents of the typical strata, such as the Cambrian, Silurian, &c., it is convenient that the form of the words used to define them should be common to both ; hence I suggest an adjectival form ending in *ian*.

If the typical star is the brightest in a constellation, I use its Arabic name as root ; if the typical star is not the brightest, I use the name of the constellation.

The desideratum referred has to a certain extent determined the choice of stars where many were available. I have to express my great obligations to Dr. Murray for help generously afforded in the consideration of some of the questions thus raised. The table runs as follows :—

Highest Temperature, Simplest Chemistry.

Argonian.
Alnitamian.

	Ascending Series.	*Descending Series.*
	Crucian.	Achernian
	Taurian.	Algolian
	Rigelian.	Markabian
	Cygnian.	
	——	Sirian.
	Polarian.	Procyonian.
	Aldebarian.	Arcturian.
	Antarian.	Piscian.

The chemical definitions of the various groups or genera are as follows :—

[1] "Sur les étoiles à spectres de la troisième classe."
[2] *Roy. Soc. Proc.*, vol. lxi. p. 182.

Argonian.

Predominant.—Hydrogen and proto-hydrogen.
Fainter.—Helium, unknown gas (λ 4451, 4457), proto-magnesium, proto-calcium, asterium.

Alnitamian.

Predominant.—Hydrogen, helium, unknown gases (λ 4089·2, 4116·0, 4649·2).
Fainter.—Asterium, proto-hydrogen, proto-magnesium, proto-calcium, oxygen, nitrogen, carbon.

Crucian.

Predominant. — Hydrogen, helium, asterium, oxygen, nitrogen, carbon.
Fainter.—Proto-magnesium, proto-calcium, unknown gas (λ 4089·2), silicium.

Achernian.

Same as Crucian.

Proto-metallic lines relatively thick, hydrogen relatively thin.

Taurian.

Predominant.—Hydrogen, helium, proto-magnesium, asterium.
Fainter. — Proto-calcium, silicium, nitrogen, carbon, oxygen, proto-iron, proto-titanium.

Algolian.

Predominant —Hydrogen, proto-magnesium, proto-calcium, helium, silicium.
Fainter. — Proto-iron, asterium, carbon, proto-titanium, proto-copper, proto-manganese, proto-nickel.

Rigelian.

Predominant.—Hydrogen, proto-calcium, proto-magnesium, helium, silicium.
Fainter.—Asterium, proto-iron, nitrogen, carbon, proto-titanium.

Markabian.

Predominant.—Hydrogen, proto-calcium, proto-magnesium, silicium.
Fainter.—Proto-iron, helium, asterium, proto-titanium, proto-copper, proto-manganese, proto-nickel, proto-chromium.

Cygnian.

Predominant.—Hydrogen, proto-calcium, proto-magnesium, proto-iron, silicium, proto-titanium, proto-copper, proto-chromium.
Fainter. — Proto-nickel, proto-vanadium, proto-manganese, proto-strontium, iron (arc).

Sirian.

Predominant.—Hydrogen, proto-calcium, proto-magnesium, proto-iron, silicium.
Fainter.—The lines of the other proto-metals and the arc lines of iron, calcium, and manganese.

Proto-metallic lines relatively thin, hydrogen relatively thick.

Polarian.

Predominant—Proto-calcium, proto-titanium, hydrogen, proto-magnesium, proto-iron, and arc lines of calcium, iron, and manganese.
Fainter.—The other proto-metals and metals occurring in the Sirian genus.

Procyonian.

Same as Polarian.

Aldebarian.

Predominant. — Proto-calcium, arc lines of iron, calcium, and manganese, proto-strontium, hydrogen.
Fainter. — Proto-iron and proto-titanium.

Arcturian.

Same as Aldebarian.

Antarian.

Predominant. — Flutings of manganese.
Fainter.—Arc lines of metallic elements.

Piscian.

Predominant.—Flutings of carbon.
Fainter. — Arc lines of metallic elements.

We may take for granted that as time goes on new intermediate genera will require to be established; the proposed classification lends itself conveniently to this, as there are no numerical relations to be disturbed.

A still more general chemical classification is the following, it being understood that in it only the most predominant chemical features are considered, and that there is no sharp line of separation between these larger groups. The peculiar position of calcium and magnesium render this caveat the more necessary.

Highest temperature.

Gaseous stars	Proto-hydrogen stars ...	Argonian.	
		Alnitamian.	
	Cleveite gas stars	Crucian.	Achernian.
		Taurian.	Algolian.
Proto-metallic stars		Rigelian.	Markabian.
		Cygnian.	——
		——	Sirian.
Metallic stars...		Polarian.	Procyonian.
		Aldebarian.	Arcturian.
Stars with fluted spectra		Antarian.	Piscian.

Lowest temperature.

The detailed chemical facts to be gathered from the definitions of the several genera indicate many important differences between the order of appearance of chemical substances in the atmospheres of the stars and that suggested by the hypothetical "periodic law." Special investigations are in progress by which it is hoped some light may be thrown on this and other points of a like nature.

THE USE OF PHOSPHORUS IN THE MANUFACTURE OF LUCIFER MATCHES.

OUR readers will be aware that about a year ago the attention of the public was specially directed to the danger which attends the use of yellow phosphorus in the manufacture of matches. Numerous cases of necrosis of the jaw were reported, and some of these occurred in factories which were supposed to be conducted on hygienic principles. There were also some cases in these factories which had been intentionally concealed from the proper authorities. The Home Office accordingly requested Profs. Thorpe and Oliver to inquire and report upon the subject, and shortly afterwards these authorities were joined by Dr. Cunningham, senior dental surgeon to the London Hospital, in view of the importance of the practical dental question at issue.

These three gentlemen have now presented their report, and it has been issued (January 1899) as a Blue Book of 236 pages. It is to be hoped that the Government will see their way to act promptly on the recommendations here set forth, and that by a proper system of inspection they will provide for the carrying out of the new regulations; many excellent rules for the management of match factories already exist, but in some cases these have become practically a dead letter, as they have not been enforced sufficiently stringently.

We have nothing but praise for the way in which the three investigators have carried out their work. Prof. Thorpe deals with the question from the chemical standpoint, and enters into such matters as the differences between the allotropic forms of phosphorus, the composition of phosphorus fumes, their solvent action on teeth, and the composition of the various pastes, &c., used in the manufacture of matches. Full and illustrated accounts of the process of manufacture are given, both in this and in other countries, and the precautions taken to minimise the danger to the workpeople. Dr. Oliver, whose work in connection with other dangerous trades is so well known, approaches the question from

the medical standpoint, and the portion of the report for which he is responsible is clear, concise, and intensely practical. Dr. Cunningham's report contains a full account of phosphorus necrosis, and is illustrated by diagrams showing various stages of the disease in the teeth and jaws. This condition is the most frequent and most obvious of the poisonous effects of phosphorus; it is not by any means the only one. He also gives in full the precautions which should be adopted in all factories for combating the injurious effects of the poisonous fumes. There are various appendices which give in detail the facts upon which the main body of the report is founded.

The whole report is a clear evidence of the painstaking way in which the Commission has carried out of its work, and is specially valuable, seeing that the investigators have visited various foreign countries in order to compare what is being done there with what occurs in our own country. An admirable summary of conclusions is furnished by Dr. Arthur Whitelegge, the chief inspector of factories. The main conclusions are as follows:—

In the match industry two forms of phosphorus are used: *yellow phosphorus*, which is highly poisonous, and gives off poisonous fumes which consist mainly of low oxides of phosphorus; and *red phosphorus*, which does not fume, and is hardly poisonous even if swallowed.

Then, as is well known, there are two principal varieties of matches used: the "safety matches," which are tipped with a composition free from phosphorus; the surface on which they strike is covered with a composition of which red phosphorus forms a part. The "strike anywhere" matches are tipped with a paste containing yellow phosphorus in a proportion which varies from 3 to 30 per cent.; but in this country not more than 6 or 7 and often less than 5 per cent. is used. It is in the making of such matches only that danger arises. Attempts are being made to make "strike anywhere" matches which contain no yellow phosphorus, and rewards have been offered for an effective match of this kind, but up to the present these efforts have not been successful; either such matches do not strike anywhere, or else they are violently explosive.

The specially dangerous processes in the manufacture of matches containing yellow phosphorus are *mixing* the paste, *dipping* the wood or wax stems, *drying* the bundles after dipping, and *boxing* the dried matches; it is the last process which involves the most handling of the matches.

The rules that already exist require (1) natural and mechanical ventilation to be efficient in the rooms where these processes are being carried out; (2) effectual means to prevent the fumes entering other parts of the factory; (3) that no person shall be employed who has suffered from necrosis, or had a tooth extracted; (4) that persons suffering from toothache shall be at once medically examined; (5) notification of cases of necrosis is obligatory; and (6) proper conveniences for washing shall be provided.

Both here and abroad many firms have done a good deal more than this: the dental supervision has been efficient, and the introduction of elaborate machinery instead of hand labour in the four dangerous processes has done more than anything else to lessen the danger. In some foreign countries the precautions taken are in advance of our own, but in this country special praise is given to the Diamond Company's factory at Liverpool, where cases of phosphorus necrosis have never occurred. In Germany, Austria, and Switzerland, there is, however, the surreptitious manufacture of matches as a home industry to be contended with; this disastrous practice has, happily, not been attempted in Great Britain.

The main point which the Commission had to decide was undoubtedly whether they should recommend the use of yellow phosphorus to be prohibited. We may give their decision in their own words:—

"So far as the home consumption is concerned, it does not seem that the prohibition of the use of yellow phosphorus would involve any serious hardship, and this course has already been adopted by Denmark, and decided upon by Switzerland, care being taken at the same time to prohibit the use or importation of yellow phosphorus matches. But neither of these countries has or had any export trade to lose. The United Kingdom, Belgium, Sweden, and Japan, manufacture largely for export,[1] and it is feared that immediate prohibition of yellow phosphorus would at once divert that portion of our trade to other countries, unless international agreement upon the subject was arrived at. If grave injury to the health of the workpeople were inevitable, the loss of the trade might well be regarded as the smaller sacrifice of the two, but the result of the inquiry points to a different conclusion. With due selection of workpeople, strict medical and dental supervision, proper structural and administrative conditions, and substitution of machinery for hand labour, it seems that the dangers hitherto attending the use of yellow phosphorus can be overcome."

We need not go into the details of all the precautions set forth; they will involve revision of the present rules, and put briefly they consist of absolute cleanliness, perfect ventilation, medical selection of workpeople (children, debilitated persons, and those with unsound teeth being excluded), compulsory dentistry, substitution of machinery for direct handling, and limitation of the percentage of phosphorus in the paste.

We learn that in Russia a tax is imposed upon the manufacture of yellow phosphorus matches, with the result that safety matches are displacing the "strike anywhere" kind. The Commissioners make no recommendation that a similar tax should be imposed here; they are also silent in regard to recommendations concerning international agreement in view of the total prohibition of the use of yellow phosphorus. No doubt this would have been the most stringent and the most effective course to adopt. But legislation is a slowly moving machine, and international legislation a more cumbrous one still. Recognising this, the report suggests what is a more practical remedy, and certainly a more immediate one. What has been accomplished by the Diamond Factory at Liverpool should be made compulsory elsewhere, and for the sake of the workers it is to be hoped that there will be no delay in carrying the suggested rules into operation.

MIMICRY AND WARNING COLOURS.[2]

IT is just twenty years ago since the late Charles Darwin called the writer's attention to a little paper, by Fritz Müller, published in *Kosmos* for May 1879, and containing a new suggestion concerning the theory of mimicry. It was the writer's misfortune to have foreseen that the principle discovered by Müller was likely to exert a profound influence on certain biological problems of which the solution had up to that time been unattempted, and he accordingly introduced the new idea to the entomologists of this country by inserting a translation of the paper in the *Proceedings* of the Entomological

[1] For foreign and colonial use, especially in hot and humid climates, the yellow phosphorus matches keep better and resist damp.

[2] "Natural Selection the Cause of Mimetic Resemblance and Common Warning Colours." By Edward B. Poulton, M.A., F.R.S. (*Journ. Linn. Soc. Zoology*, vol. xxvi. pp. 558–612.)

Society of London. The misfortune lay in the circumstance that the entomologists of that time were unprepared for new ideas, and the writer had accordingly to incur the opprobrium of an innovator. He has happily survived this treatment, but how far any advancement has been made by entomologists since the year 1879 may be gathered from the discussion of the whole subject which was raised in the Entomological Society in 1897, and of which a summary is given by Prof. E. B. Poulton in the paper now under consideration. So far as the writer of this notice is concerned, the first gleam of encouragement came from Dr. Alfred Russel Wallace, who, with his well-known power of mental penetration, had no sooner had the case submitted to his judgment than he accepted the new doctrine, and incorporated it in his book on "Darwinism." From the discussion of 1897 it appears that the majority of our entomologists are still hostile to the Müllerian theory; but conspicuous among those who have helped to support and develop it is the author of the paper now before us. We may claim also Dr. F. A. Dixey, of Oxford; Mr. Roland Trimen, one of the early pioneers with Bates and Wallace in the subject of mimicry; Colonel Swinhoe; Dr. A. G. Mayer, of America; Mr. Gahan, of the British Museum, and some few others, as co-heretics in this later development of the theory of mimicry.

The original theory propounded by Bates in 1861 is so well known, and has been so frequently discussed in these columns, that it is unnecessary to restate it. The fundamental condition is that the imitated form should be objectionable to insectivorous enemies, while the mimic should not be protected by any distasteful qualities. The Müllerian theory, briefly stated, is that two or more species belonging to distasteful groups will derive benefit from mimetic resemblance because, although immune as compared with non-protected species, they are not altogether exempt from persecution, and the loss in individuals incurred by each mimetic species becomes proportionally more and more diminished the larger the number of indivduals over which the loss is distributed. Thus the resemblance being advantageous can be conceived to have been brought about by natural selection in the Müllerian mimicry in precisely the same way that it has been conceived to have been brought about in the Batesian mimicry. Whether it has actually been so brought about, is just the point about which there has been so much discussion; but if natural selection plays any part at all in species formation—and the writer still finds himself in the position of being without any other adequate theory—then a perusal of Prof. Poulton's paper, and the powerful arguments which he has marshalled therein, cannot fail to convince the unprejudiced naturalist that if natural selection was valid for Bates it is equally valid for Müller, and, further, that if natural selection is inadequate in either or both cases, then we have no theory of mimicry that will at all bear critical examination, and the whole body of facts remain as inexplicable as in pre-Darwinian times.

The method adopted by Prof. Poulton in the present paper is that of exclusion. He discusses all the alternative explanations which have been suggested, and finds them to be untenable when submitted to close analysis. There is thus left only the theory of natural selection The competing theories are all resolvable into three—viz. (1) external action of environment (2) independent development along similar lines by internal causes, and (3) psychical influence of predominating types of colour and pattern leading to the sexual selection of that type. The latter theory is not very likely to survive, although Mr. Darwin in 1872 wrote to the writer of this notice: "I do not feel at all sure that this view is as incredible as it may at first appear." It should be added that the said suggestion also came from Fritz Müller in a letter to Darwin. Rejecting for the present No. 3, the author deals at length with Nos. 1 and 2. Before marshalling the facts it is, however, considered necessary to insist that the resemblances herein dealt with are part and parcel of the general phenomenon of Protective Resemblance. This point is strangely put into the background, or altogether ignored, by the upholders of non-Darwinian theories of mimicry, and Prof. Poulton has done good service in bringing it well to the front again. It is surprising that the two sets of facts, viz. resemblance to environment and resemblance to other living species, should be dissociated, in spite of the circumstance that Bates and Wallace and most writers on the subject since have distinctly recognised the fundamental importance of grouping them together. It is, of course, inconvenient to the opponents of the Darwinian explanation to admit that resemblances to bark, leaves, twigs, &c., which are so well explained by natural selection, should be of the same order as a set of resemblances for which that explanation is regarded as indequate. And even if it is allowed that protective resemblance and the old (Batesian) mimicry are due to natural selection—as some of the speakers seemed to admit in the discussion of 1897—the extension to the newer (Müllerian) mimicry is opposed by either ignoring or denying the facts, or by substituting untenable theories.

The original theory of Müller was limited in its application to certain butterfles (*Ituna* and *Thyridia*) which were not very remote in their kinship, but in which the superficial resemblance was too exact to admit of explanation by blood-relationship alone. In 1882 the writer of this notice, in a paper published in the *Annals and Magazine of Natural History*, ventured upon an extension of the Müllerian principle to whole groups of related and "protected" species in which a general similarity in the type of pattern and colouring prevails. The idea was that the abstract type of marking became associated with a knowledge of inedibility in the mind of insectivorous enemies. Five years later (*Proc. Zool. Soc.*, 1887), the author of the paper now before us made a further advance by extending the Müllerian principle to large groups of insects quite unrelated by affinity, and belonging, in fact, to different orders. It is only necessary to bring together an assemblage of species belonging to different orders, and having a general superficial resemblance among themselves, to constitute a presumptive case of "Müllerian association." If it can be shown that this group of species is for one reason or another more or less exempt from persecution as compared with non-protected species, the case would at once become Müllerian as distinguished from Batesian. It is, of course, doubtful in many cases to which class a particular example of mimicry may belong. The result of the recent work of Poulton, Dixey and Mayer is to make it appear probable that the Müllerian principle is of more widespread importance in nature than the older principle of Bates.

Since the superficial resemblance of insects belonging to distinct orders, such as a moth to a wasp or beetle, a beetle to an ant, and so forth, cannot have been aided at the outset by blood-relationship, the result in all cases where the association is Müllerian, whether attributed to natural selection or to any other cause, can only have been brought about by a process of convergence. The essence of the Müllerian principle also is that the so-called protected species are subject to a certain percentage of extinction, and the resemblance which we now find among them is accordingly advantageous, in the same sense that a distasteful caterpillar is gorgeously coloured according to Wallace's well-known theory. For this reason Prof. Poulton prefers to limit the term mimicry to the Batesian principle; the Müllerian cases are described

in the present paper as "common warning colours, and the author proposes for them the term *synaposematic*.

Not the least satisfactory feature of the present summing up of the position by Prof. Poulton is the distinct convergence of the evidence in favour of the natural selection theory which has been accumulated since 1879. The sacrifice of a certain percentage of individuals to the inexperience of their enemies was an assumption on Müller's part, and the present writer well remembers pointing out in a letter to that eminent naturalist that his case would be enormously strengthened if he would make observations on the spot. The result was a long series of a distasteful *Acraea*, collected by Müller in order to show that bird-pecked wings were of frequent occurrence. Much evidence of the same kind has been since obtained, and a most valuable series of experiments conducted by Mr. Finn, in India, during the years 1895-96-97, and published in the *Journal* of the Asiatic Society of Bengal, have led that author to the conclusion that unpalatable forms are by no means altogether free from attack.

It must be further borne in mind that in 1879 the question of the non-transmission of acquired characters had not been brought into prominence. It was tacitly assumed in the theory of Bates that a knowledge of edible and inedible types could be transmitted by heredity. It is remarkable that Müller, by virtue of his hypothesis, should have unconsciously challenged this tacit assumption by suggesting that young birds had to learn by experience, and did not derive their knowledge of eatable and distasteful forms by heredity. The whole tendency of Prof. Lloyd Morgan's work of late years has been to confirm this suggestion by actual observation and experiment; and Mr. Finn, also, in summing up his results, states that "each bird has to separately acquire its experience, and well remembers what it has learned." Thus the Müllerian theory of 1879 has now been placed on a psychological basis of well-ascertained facts.

Those who still believe that common warning colours can be explained by internal or external causes, as defined in the present paper, will, we imagine, find the ground crumbling away from beneath their feet if they will seriously weigh the arguments set forth by Prof. Poulton. What series of external causes in nature are there, for example, which can so act upon an organism as to modify only those superficial characters which are required to bring about a resemblance to another form while leaving all other characters unmodified? To attribute such modification to independent evolution by virtue of innate tendencies or laws of growth or internal forces, appears to the writer to be substituting mysticism for scientific explanation. What external agencies can be conceived which shall, while acting without visible result upon the early stages of all kinds of insects, culminate only in a resemblance between the imagos? The external conditions of life are imposing themselves during the whole of the larval and pupal existence, and yet these forms remain quite distinct, while the imagos come forth at once with all their disguising characters perfected.

On considering again the undoubted fact that in many cases of mimicry and common warning colours the female only is affected, the inadequacy of any explanation depending on direct action of environment or internal evolutional "tendencies" becomes strikingly apparent. So also, as Prof. Poulton illustrates by a most remarkable set of examples, when insects of different orders resemble each other, the superficial similarity must necessarily be brought about by the most diverse kinds of modification of parts. To attribute such distinct and diverse modifications of form, directed towards a common end, to similarity of external forces or internal tendencies, seems to the writer to be a straining of hypothesis beyond any degree of rashness attributed to the supporters of natural selection. What natural agency can be imagined that will account for the production of a similar colour in two or more species—in one form by developing pigment, and in another by developing striation of surface, so as to produce the same chromatic effect, excepting selection which works only for advantageous results irrespective of means? Even within the same order, where the resemblances might be more reasonably supposed to be due to similarity of external conditions, the likeness is superficial only, and is brought about by the most diverse means. There is apparently no chemical relationship between pigments which produce the same visual effect in mimetic butterflies of different families. A visual resemblance is required only by natural selection; external and internal causes have been incompetent in such cases to modify the more deeply concerned physiological processes so as to produce similarity of appearance by identity of pigment. Such a character as transparency of wing, also, is shown to have been attained by several distinct methods; by reduction in the number of scales, by reduction in their size, by loss of pigment, by being set up on edge instead of lying flat, and so forth. Any common set of forces, external or internal, which can bring about the same result, viz. wing transparency, by such diverse methods is simply inconceivable.

We have given only a few illustrations of the arguments which the author makes use of in this paper to dispose of the theories which have been advanced by way of substitutes for natural selection. As Prof. Poulton says in conclusion: "The review of the whole subject during the past thirty-six years increases our confidence in the theories of Bates and Fritz Müller, while it disposes of all alternative hypotheses."

It should be added that many new examples of mimicry and common warning colours—some of them of the most striking character—are given in the paper. More particularly will English entomologists be interested in the resemblance of the young larvæ of *Stauropus fagi* to an ant, and of the similarity in appearance and habit of the young larvæ of *Endromis versicolor* to saw-fly larvæ.

R. MELDOLA.

PROFESSOR CHARLES FRIEDEL.

FRANCE has lost one of her most distinguished chemists in the person of Prof. Charles Friedel, member of the Institute, who died at Montauban on April 20. He was born in Strassburg on March 12, 1832. His father was a banker; his mother was the daughter of Dr. Duvernoy, well known in his day as a scientific man. He distinguished himself so greatly in his studies that he took his degree of Bachelor of Science with special honours. Desiring to follow science as his profession he went to Paris, and gained the special esteem of M. de Sénarmont, who caused him to be appointed conservator of the mineralogical collections at the École des Mines. He worked in the laboratory of the distinguished chemist M. Adolph Wurtz, also a native of Alsace, at the École de Médecine. In 1856 he married Miss Kœchlin, by whom he had five children, one of whom, George Friedel, is known as a professor at the mining school of St. Etienne. Mrs. Friedel died in 1871, at Vernex, where she had retired during the Franco-German war; and her husband, who was shut up in Paris, knew nothing of the sad event until after the city capitulated. He was married again, in 1873, to Mlle. Louise Combes, whose father was a member of the Institute of France, and who, with their son and a large circle of relations, now mourn his recent decease. To return to his professional distinctions: in 1869 he became Doctor of Science; two years after he received a high appointment at the École Normale Supérieure. In 1876 he became Professor of Mineralogy at the Faculté des Sciences, at the Sorbonne; and in 1878 he received the

distinguished honour of membership of the Institute (Academie des Sciences). In 1884 he took the position of his late master, Prof. Wurtz, in the chair of Organic Chemistry at the Sorbonne. His merits were fully recognised in this country. In 1876 he became a foreign member of the Chemical Society, and four years later he received the Davy Medal of the Royal Society. In 1894 he made one of his rare visits to England to receive the degree of D.C.L. of Oxford University, an honour which he acknowledged as a great encouragement.

His influence on the advance of science was of a two-fold character: as a teacher, and as an original investigator. He was not known as a popular lecturer or writer upon science; but he had the happy faculty of infusing the love of science into the minds of the large number of students who attended his professorial lectures or worked in his laboratory. This result was no doubt greatly enhanced by the respect and personal attachment with which he was regarded. The advancement of education was in fact one of the objects of his life. This was evidenced by the successful efforts he made in promoting the École Alsacienne in 1874, which, to use his own words, was "designed to react against the exclusively literary and formal instruction, and directed in a Protestant and Christian spirit, without having any denominational colour." Its aim was to develop in each scholar the faculties which belong to him, and to arouse a spirit of observation and scientific curiosity. Natural science has, of course, an honoured place in the curriculum. He watched over this school with great interest, and helped to make it one of the best in the capital of France. The technical side of science also engaged his attention; and he had a large share in founding at Paris, three years ago, a laboratory of practical chemistry applied to industry, at the Sorbonne, and to which he gave special attention. He was one of the founders of the French Chemical Society. It is said also that the French Association for the Advancement of Science owes its origin to his suggestion; at any rate he came to the meeting of the British Association at Brighton in 1872 to learn the details of its working, for the benefit of the French Association which was to be inaugurated at Bordeaux in September of that year. The two Associations, though very different in their constitution, are carried on in much the same manner. M. Friedel generally took an important part in the French Association's annual meetings. In the last of the numerous letters that I received from him, he made reference in hopeful terms to the approaching meetings of the two Associations at Dover and Boulogne in September next, and to the efforts which were in contemplation to bring together the savants of the two nations.

Throughout the whole of his career he carried on original research, the results of which are published in about one hundred papers communicated to the Academy of Sciences and other learned societies. Some of these refer to the artificial formation of felspar and albite, crystallised quartz and other minerals, and to the dimorphism of zinc blende; but by far his most important work has reference to the carbon compounds, and the long controversies which raged over the question of their constitution, and how it should be expressed. His first paper seems to have been a contribution, in 1857, bearing on the constitution of acetone. This was followed by others on lactic acid, glycerine, propylene and other members of the three-carbon family. The relation of these bodies one to another, and to their isomers, led to much fruitful controversy. To him, in fact, is due in great measure the introduction of the new views of atomic valency, of which the chief apostles were Cannizzaro and Kekulé. In France these ideas were not readily received; the chief advocacy of them came from the laboratory of Wurtz, and although Friedel had not the enthusiasm and brilliancy of the master, his expositions and arguments were wonderfully clear, and his experiments in support of them very convincing. Among these was the production, in conjunction with Ladenburg and Crafts, of a number of compounds of silicon and titanium showing the quadrivalence of these elements and their chemical analogy with carbon. In this way they broke down the barriers between organic and inorganic chemistry, and showed the generality of the laws of chemical combination. During these researches he was fortunate in discovering a new method, by means of chloride of aluminium, of bringing about the synthesis of organic compounds, often producing hydrocarbons of a highly complex character.

With the rapid advance of chemical knowledge, especially in the organic department, and the gradual growth of chemical theory, the nomenclature was found to be inexact and often misleading. Hence in 1892 a congress of chemists was held in Geneva to revise the nomenclature. Leading representatives of chemical science from many countries met together, and Friedel was appointed president. The recommendations arrived at were published in Wurtz's Dictionary of pure and applied chemistry, which was carried on under the direction of Friedel.

But he did not confine his work to scientific teaching and investigation. Born in a Protestant family, he seems from his youth to have adopted the religious principles in which he was brought up. He sympathised with all Christian, philanthropic or patriotic movements of his country, and took an active part in many of them, especially those that related to the welfare of young men. Those of us who knew him intimately will feel disposed, like the President of the Academy in announcing his death, to dwell not so much on his great scientific achievements as on the amiability and uprightness of his character and on the moral worth of his personality.

J. H. GLADSTONE.

CHARLES NAUDIN.

CHARLES NAUDIN, whose contributions to science extend over the last sixty years, died on March 19, at Antibes, at the age of eighty-four. A systematist by his studies of the orders *Melastomaceae* and *Cucurbitaceae*, a biologist by his work on hybrids, he is perhaps best known by many contributions to economic botany.

The bravery with which he met the hardships of his life wins admiration. His father, a schoolmaster, ruined himself; his mother died when he was but eight years old. At Montpellier, while working for a degree, he served as usher in small establishments: the degree gained, he became a teacher at Château-Chinon, then at Cette. In 1839 we find him at Paris earning his living by teaching, by copying commercial letters, and lastly as a gardener at the Jardin des Plantes, burning the midnight oil in order to obtain his licentiate in 1841 and the degree of Doctor of Science in 1842.

After helping Saint-Hilaire with his flora of South Brazil, Naudin became professor of zoology at the Collège Chaptal. But, when success seemed assured, severe facial neuralgia and an incurable deafness, worse than the neuralgia, cut him off from free communion with his fellow-men. Forced back from his course, he applied himself again to herbarium-work, and the study of the *Melastomaceae*—an order richly represented in Brazil—gave him employment till 1849.

Five years later Decaisne made him his aide-naturaliste, and under his stimulus Naudin commenced the experiments on hybrids which secured his reputation. Darwinism had disturbed science; and Decaisne, who, like others, was asking what are species, had commenced to experiment on variability with admirable patience by growing pears from seed. Naudin chose the Gourd

family for like experiments on the variability of hybrids, in doing which he came face to face with difficulties in classification needing the eye of a systematist. How these were met, Sir Joseph Hooker, whom he helped in dealing with this order for the *Genera Plantarum*, and others testify. It is clear that if he multiplied names unduly, he still grouped naturally and truly the allied forms. In the question of hybridity he emphasised abundantly the fact that hybrids frequently have a varying measure of fertility, stating at the same time that in varying they return to the parent forms, and for that reason fail to establish their race—a contention which led to a long controversy.

At this period his work as a gardener came into fruit: the *Manuel de l'amateur des jardins*, and a connection with the *Revue Horticole*, *Flore des Serres* and *Le bon Jardinier* testify to it. But the neuralgia increased, and drove him to seek an asylum away from work in the Pyrenees, whence in 1878 he was called to take charge of the experimental station known as the Villa Thuret at Antibes.

There, in the pleasant climate of the Mediterranean shore, he experimented in the acclimatisation of such plants as were suitable. Algeria, among French Colonies, needed improved cultivation; and the exigence of Algeria called his attention to the vegetation of dry countries. From Australia he grew *Eucalypti* and *Chenopodiaceae;* from South Africa he experimented with *Acanthosicyos;* and the flowering and fruiting and hybridisation of palms interested him strongly. To these experiments on Australian plants is doubtless due his connection with Sir Ferdinand von Mueller, which led to a joint *Manuel de l'Acclimateur*.

This must suffice to indicate the direction of his work—work for which the French-speaking people feel a keen gratitude. To us, it is interesting to recall that a few of his later notes appeared in our language in the *Gardeners' Chronicle*, while two of his earlier papers were considered of sufficient importance to merit translation.

I. H. B.

THE NEW BUILDINGS AT SOUTH KENSINGTON.

THE foundation stone of the new extension of the Art Museum at South Kensington was laid by Her Majesty the Queen yesterday. When completed, the Museum will be one of the most imposing structures in London, so far as size is concerned. It will have a frontage on Cromwell Road of 700 feet—almost precisely the same frontage as that of the Natural History Museum—and in the Exhibition Road there will be a frontage of 300 feet. The area of the new buildings will be equal to the whole of that covered by the existing Museum, including the temporary sheds on the west side of Exhibition Road.

The Art Museum thus completed is to be called the Victoria and Albert Museum.

The commencement of the new buildings does not directly concern us except that they are complementary to other buildings to be provided for Science on the ground facing the Imperial Institute. It has generally been understood since the Report of the Duke of Devonshire's Commission, which sat about a quarter of a century ago, that a Science Museum was to be built upon this ground. This being so, the building scheme might appropriately have included an Albert Museum for Science as well as a Victoria Museum for Art. But no provision has been made for such a new Science Museum.

According to the *Times*, the centre of the building which it is proposed to place opposite the Imperial Institute will be occupied by the Science Library, and in the plan given by the *Times* the proposed buildings are called "Royal College of Science." But this is not so. The remainder of the frontage will be taken up by chemical and physical laboratories alone; the other departments of the Royal College of Science—astronomical physics, geology, biology, mechanics, mining and metallurgy—will apparently be left in the same unorganised condition as exists at present. It is indeed generally imagined, and it may even be the view of the Chancellor of the Exchequer, that the new buildings are to accommodate all the departments of the Royal College of Science.

We read, for instance, in Tuesday's *Times*:—

"As regards the Royal College of Science, it will, as already indicated, occupy a position directly facing the Imperial Institute. It is to be of the same length as the Institute, and, in the interests of architectural harmony, it will reproduce several of its leading features. The College will be recessed from the road in the same way; the main entrance of the one will be opposite that of the other, and will be so rounded that between the two a large circular space will be left—in the centre of which a statue may be erected later on—the circle being flanked by the great buildings on each side. The domes or lodges at each extreme of the Imperial Institute will be repeated at corresponding points of the College, and the respective sets connected by a screen across the roadway, thus facilitating passage from one side to the other. The new College of Science will also form a front to the present Science Museum buildings, but there is no idea of the College forming in itself an additional "museum" in the recognised sense of that term. It will rather be devoted to strictly educational purposes, the right wing being occupied by the physical side of the College and the left by the chemical department, while the great laboratories and lecture theatres are to be in the rear, the whole being, further, in direct connection with the present Science Museum."

We repeat, the new so-called "College of Science" will represent only a small portion of the College. That the teaching of some of the subjects now carried on in buildings almost half a mile apart, gains nothing from the new scheme, might perhaps have been borne if it were perfectly certain that ultimately all the teaching would be brought together. But unfortunately this is now very much more unlikely than it has ever been before, unless the Science Museum is to be encroached upon, and its future possibilities of extension for ever wrecked; and the more the architectural effect is to be enhanced by recessing the new buildings from the road, the more, naturally, will the space difficulty be increased for College and Museum alike. We have heard that the plans prepared by the Professors of the Royal College themselves some years ago left the central portion clear primarily for the Museum suggested by the Duke of Devonshire's Commission, the chemical and physical laboratories having their frontage along Prince's Gate. That scheme was far preferable to the present one, so far as providing for the other requirements of both College and Museum are concerned.

In any case it must be acknowledged that the building of the chemical and physical laboratories is only a first step. We shall be glad to know that the future has been considered; and that there already exists a plan showing the condition of things when subsequent stages have been reached, even up to the final one. But we very much doubt whether it has been any one's business to consider any of these things, and responsibility is divided among so many departments that it is scarcely to be wondered at if the future has never been considered at all. But there is one thing greatly to be feared, and it is this. Not only does the plan to be carried out leave the greater part of the teaching in a chaotic state with no chance of betterment while the new buildings are going on; but when they are completed, some future Chancellor

of the Exchequer may decline further aid on the ground that no representation was made in the present year pointing out the exact state of the case.

It is apparently one of the prices we have to pay for the long neglect of Science in this country, and its small representation among those in political office, that so many arrangements touching our scientific institutions give rise to a hopeless feeling among those who are familiar with both the history and the facts connected with them.

NOTES.

M. PRILLIEUX has been elected a member of the Paris Academy of Sciences, in succession to the late M. Naudin.

WE regret to see the announcement of the death of Sir Frederick McCoy, K.C.M.G., F.R.S., Professor of Natural Sciences in the University, Melbourne.

MR. W. H. PREECE, C.B., F.R.S., has accepted the presidency of the eighteenth Congress of the Sanitary Institute to be held in Southampton from August 29 to September 2.

THE foundation stone of a museum of Oceanography was laid at Monaco on April 25. The museum will contain the collections made by the Prince of Monaco during the expeditions of the yacht *Princess Alice*. It will contain not only exhibition rooms, but also laboratories for the use of men of science who wish to work upon the collections.

DR. J. BUCKLEY BRADBURY, Downing Professor of Medicine in the University of Cambridge, will deliver the Croonian lectures of the Royal College of Physicians of England in June, on "Some Points in Connection with Sleep, Sleeplessness, and Hypnotics."

WE learn from the *Botanical Gazette* that the Museum and laboratory building in the New York Botanical Garden is making fair progress towards completion. It is now entirely enclosed, and the partition walls and other rough interior work are nearly finished. It will probably be ready for occupancy late in the spring.

THE Department of Science and Art has received through the Foreign Office an intimation that the Ghent Horticultural Congress has been postponed from June 3 to July 8.

THE projected expedition of the Duke of the Abruzzi, nephew of King Humbert, to the North Pole is exciting great interest in Italy. A Reuter telegram from Rome states that the Duke, who will be accompanied by three officers of the navy, two sailors, four mountain guides, ten Norwegian sailors, and an Eskimo, will embark about the middle of June at Laurvig, Norway, whence he will proceed to Franz Josef Land, trying to attain as northerly a point as possible. The party will winter in the most northerly port attainable, and will spend enforced leisure in making scientific observations and preparing revictualling stations. In the spring the Duke and his companions will proceed towards the North Pole on sledges drawn by dogs, 120 of which he will embark at Archangel, or, if necessary, in a balloon. The expedition takes two balloons. If all goes well, the Prince will be away some eighteen months. The ship in which the Duke of the Abruzzi will sail is called the *Stella Polare*.

THE Rev. T. Neville Hutchinson, whose death occurred on May 6, did much to advance the interests of science by his work some years ago as senior science master at Rugby. Forty years ago Rugby was the only public school in which science was taught at all. Harrow and Eton followed, though not with the same liberality as Rugby, where a few years later a special suite of lecture-rooms and laboratories was devoted to science. It was Mr. Hutchinson who reorganised the science work at Rugby in 1870, and in the first volume of NATURE he described the new laboratories and other buildings erected there for purposes of scientific instruction. Mr. Hutchinson was born in 1826. He was second master at King Edward's School, Birmingham, in 1860-65, and science master at Rugby from 1865 to 1883, when he became vicar of Broadchalke, Wilts. He resigned his vicarage last October, and was made Canon of Salisbury. He was a gifted teacher and lecturer, and old Rugbeians will sincerely regret to learn of his death.

THE death, shortly before completing his sixtieth year, of Mr. Philip Thomas Main, of St. John's College, Cambridge, is announced in the *Athenaeum*. Mr. P. T. Main published "An Introduction to Plane Astronomy" for University use in 1865, and also assisted his father, the Rev. Robert Main, who was for twenty-five years Chief Assistant at the Royal Observatory, Greenwich, and afterwards for eighteen years Radcliffe Observer at Oxford, in his large work on "Practical and Spherical Astronomy," which appeared in 1863. Subsequently he turned his chief attention to chemistry, and for many years held the post of superintendent of the laboratory at St. John's College.

THE Council of the British Medical Association desire to remind members of the profession engaged in researches for the advancement of medicine and the allied sciences that they are prepared to receive applications for grants in aid of such research. Applications for sums to be granted at the next annual meeting must include details of the precise character and objects of the research which is proposed, and must be made on or before June 15 in writing addressed to the General Secretary of the Association. The Council are prepared to receive applications for one of the three research scholarships which is vacant, of the value of 150*l.* per annum, tenable for one year, and subject to renewal by the Council for another year. Applications may also be sent in for a scholarship of 200*l.*, for the study of some subject in the department of State Medicine, in memory of the late Mr. Ernest Hart.

THE thirtieth general meeting of the Institution of Mining Engineers will be held in London on May 25. Among the papers to be read, or taken as read, are the following:—Presidential address, by Mr. J. A. Longden; alternating currents and their possible applications to mining, Part i., by Mr. Sydney F. Walker; metric weights and measures, by Mr. J. Emerson Dowson; Petroleum in Burma, by Dr. Fritz Noetling; mineral resources of Vancouver and adjacent islands, British Columbia, by Mr. Wm. M. Brewer; and a new process of seasoning and preserving timber and other fibrous substances by means of electricity, by Mr. H. Baillie-Weaver.

ARRANGEMENTS are being made for a visit of the Institution of Electrical Engineers to Switzerland in September next. As at present arranged, members will visit the Rheinfelden works on Saturday, September 2, will proceed on the same day to Zürich, and will remain there until September 6. During this time visits will be paid to various industrial works, and to certain power stations and tramway and lighting installations in the district, including, it is hoped, a visit to the Schaffhausen works. The members will then proceed to Lucerne, and, after inspecting the street railways of that town and, if time permit, the Rathhausen works and the Stansstad-Engelberg Railway, will travel, *via* the Brünig Pass, to Interlaken. Here opportunity will be given for visiting both the Jungfrau Railway (*via* the Wengern Alp route) and the Burgdorf-Thun Railway, as well as other places of electrical interest in the neighbourhood; and the visit will end on Saturday, September 9. The annual

conversazione of the Institution will be held at the Natural History Museum, South Kensington, on Thursday, June 15.

A DISASTROUS explosion occurred on Friday at the Kurtz's Chemical Works, belonging to the United Alkali Company, St. Helens, Lancashire. The force of the explosion was so great that it was felt not only at Prescot and Haydock, about four miles away, but also in the suburbs of Liverpool and at Leigh, which is twelve miles distant. Mr. Stewart, managing director of the United Alkali Company, says that about 10 a.m. he saw that the side of the chlorate of potassium crystallising vessel was on fire. These vessels are of wood, but lined with lead, and there were many of them in the crystallising house. The officials were promptly warned, and they brought up the fire extinguishing appliances; but in ten minutes the fire had reached the store containing a considerable quantity of chlorate. The men were instantly sent from the works. When the flames reached the chlorate store a violent explosion resulted, and the refining and the grinding plant was completely destroyed. This was followed by another explosion, which reduced the chemical works to ruins.

FROM the ninth report of the British Association Committee on photographs of geological interest, we learn that the total number of photographs now in the collection is two thousand and one. Amongst the more noteworthy additions referred to in the report may be mentioned an interesting set from Arran, Cumbrae, Ailsa Craig, and the Fifeshire volcanic necks, together with some from Westmoreland and Banffshire; a set from Glenroy and the Scottish Highlands; large series from Westmoreland and Yorkshire, many of them representing glacial phenomena, unconformities, and faults; pleistocene deposits; dykes in the new red sandstone; silurian, cambrian, and igneous rocks of the Midlands; raised beaches in Devon ridge; oolites; a set from the Rochdale district; a set from the Isle of Man; and one of typical specimens of rocks and microscopic slides. The Committee call attention to the small amount of work yet done in such districts as N. and S. Wales, the Yorkshire Dales and Moors, the Malverns, the districts round Oxford and Cambridge, Cornwall, the Southern Uplands, the Central Valley of Scotland, and Central and Southern Ireland.

THE *Société Internationale des Électriciens* have just published an account of a tour, made by *L'École supérieure d'Électricité*, to investigate the power-transmission systems at certain stations in Switzerland. In this tour, of only one week, the students collected a very useful amount of information with regard to the hydraulic machinery and electrical plant. They had special facilities for examining the systems, and in many cases they obtained drawings of details of construction. These drawings now form part of the account of their excursion. We notice with particular interest the description of various methods for regulating turbines and electro-motors. After the various hydraulic installations, the methods of distribution are considered. A chapter on electric traction follows, and then an account of the works of Brown-Boveri and the Oelikon factory. Lastly, there is a note on the manufacture of calcium carbide. Similar tours might with advantage be arranged by English technical schools. In their devotion to "*la belle science*" the railway companies allowed a reduction of fifty per cent. on all fares. Similar reductions might be allowed by British railway companies.

THE *Transactions* of the Swedish Academy of Science, No. 7, 1898, contains a paper, in English, by Mr. John Rhodin, on the theory of storage cells, dealing especially with the phenomena attending the cessation of current as depending upon the concentration of the electrolyte and the amount of active material.

MR. J. ELSTER and Mr. H. Geitel have contributed a joint paper to *Terrestrial Magnetism* of March last, relating to a continuation of their important researches on the electricity of rainfall, perhaps the most difficult of all electrical phenomena; the subject is, in fact, so complicated as to allow but little prospect of establishing fixed rules of the processes concerned. Their previous investigations referred more particularly to the determination of the sign of the potential, while the present paper deals with the measurement of the amount. To carry this out satisfactorily an apparatus is required which will show, in rapid succession, both high differences of potential of several thousand volts as well as small differences of, say, 100 volts, while the capacity of the apparatus must be so small as to exhibit rapid variations of the field from positive to negative extremes. The apparatus devised for the purpose is illustrated and minutely described, and the results obtained, while confirming their previous determinations of the sign of the electricity during atmospheric precipitation, show that this may bring with it very considerable amounts of both positive and negative electricity.

THE Deutsche Seewarte has published the eighth volume of its valuable meteorological observations made at foreign stations. It includes some places in Labrador, from which observations have been regularly published since 1883; these are specially important, because many barometric minima travel across Labrador from Canada to the Atlantic Ocean. We are glad to see that the Seewarte intends to increase the number of foreign stations, by including others which do not belong properly to German Protectorates or Colonies. The present volume contains observations from Mogador, Campinas (Brazil), and Fray Bentos (Uruguay). The observations are in all cases carefully made by German officials, or residents, and in nearly all instances the instruments have been supplied by, or through, the Seewarte, and are therefore thoroughly trustworthy.

A REPORT by Prof. David Hansemann, of Berlin, on the brain of Hermann von Helmholtz, is referred to in the *British Medical Journal*. The great physicist died of apoplexy on September 8, 1894, at the age of seventy-three. The circumference of the head was 59 centimetres, that of the skull 55 centimetres. The breadth of the skull was 15·5, and its length 18·3 centimetres. The cephalic index was therefore 85·25, showing a broad head. Helmholtz's head was about equal in size to that of Bismarck, and rather smaller than that of Wagner, both of whom had big heads. On the other hand, Darwin's head was only 56·3 centimetres in circumference. The weight of the brain, with its blood, was 1700 grams, without the blood 1440 grams, being about 100 grams heavier than the average human brain. The sulci were very deep and well marked, especially in those parts of the brain which Flechsig has shown to be concerned in associations. The frontal convolutions in particular were deeply cut by very numerous sulci. Helmholtz, like Cuvier, was somewhat hydrocephalic in youth. It has been maintained by Perls, and also by Edinger, that hydrocephalus in early life may be an advantage, inasmuch as it enlarges the skull and gives the brain space for growth. Prof. Hansemann appears to be of the same opinion.

A MEMOIR on the geology of the country around Carlisle, by Mr. T. V. Holmes, has just been issued by the Geological Survey. The country described is almost wholly covered with superficial deposits, boulder clay and gravel, peat, alluvium and blown sand. As it has been customary to issue two editions of the Geological Survey map, one with, and the other without drift, it may be inferred that considerable difficulty was felt in interpreting the "solid" geology of this region. The concealed rocks consist largely of the New Red Series, St. Bees sandstone, gypseous shales, Kirklinton sandstone, and Stanwix shales—with an outlier of Lower Lias, but no evidence of the

Rhætic beds. The precise underground extent and the relations of the subdivisions of the New Red Series have been the subject of considerable difference of opinion, but the evidence obtained from borings and river-cliffs is clearly stated by Mr. Holmes.

MR. WILLIAM H. DALL makes some remarks (*Proc. Acad. Nat. Sc. Philad.*, January 1899) on the celebrated Calaveras skull, which was found more than thirty years ago in a bed of gravel 132 feet below the surface of the uppermost lava-bed of Bald Hill, one of the "table mountains" of Calaveras County, California. Mr. Dall was in California at the time of the discovery, and records his evidence in favour of its genuineness.

ONE of the best-known examples of change of level during earthquakes is that of the great Kutch earthquake of 1819, when a large portion of the Rann of Kutch was depressed and immediately flooded by the sea, while at the same time a long mound was seen, which is known as the Allah Bund or Dam of God. With regard to the depression there can be no doubt; but the character of the elevation, whether real or only apparent, is not so certain. The former view, supported by Lyell, was held until 1872, when Mr. A. B. Wynne (followed by Prof. Suess) argued that the Allah Bund represented merely the comparatively steep slope connecting the area which had been depressed from that whose level was unchanged. In a paper in the *Memoirs* of the Geological Survey of India (vol. xxviii., pt. i., 1898), Mr. R. D. Oldham favours the older view, and presents a map and section (made by Captain Baker in 1844), which show that there was an actual upward slope of the ground from the plain on the north to the southern scarp of the Allah Bund.

EFFORTS to determine the molecular structure of certain crystals have been made by means of etching them with hydrofluoric acid or other reagents. The importance to petrographers of etch-figures in the investigations of amphiboles (hornblende, &c.) forms the subject of an elaborate paper by Mr. R. A. Daly (*Proc. Amer. Acad. Arts and Sciences*, March 1899).

THE New South Wales Department of Public Health has just issued a report, by Mr. Frank Tidswell, principal assistant medical officer of the Government, on protective inoculation against tick-fever. The colony, in view of the ravages wrought by this disease in Queensland, are making strenuous efforts to prevent a repetition of the disaster in New South Wales. The subject has been very carefully investigated by American authorities, and the results obtained by Mr. Tidswell confirm those previously obtained in America. It appears that more or less efficient protection from the disease can be procured by inoculating the blood of animals which have recovered from the fever, whereby the disease is produced in a mild form. Such artificial production of the disease is sometimes attended with considerable risk to the animal treated. Experience has shown, however, that it is principally older cattle which succumb, although, curiously, bulls, whether young or old, are extremely susceptible to tick-fever, and the greatest care has to be exercised in carrying out the inoculations. The period over which immunity lasts has not, so far, been accurately determined, but immunity is acquired as early as six days after the subsidence of the fever. The disease appears to be widely distributed, having been identified in America, Jamaica, the Argentine Republic, South Africa, Roumania, and Java. It was first described by American investigators in 1893, and was called Texas or Southern cattle fever, in consequence of the locality where it was originally discovered. In Australia it is usually known as tick-fever, owing to the part played by ticks in transmitting what is now known to be the real cause of the disease, the micro-organism called by its discoverers *Pyrosoma bigeminum*. At present the protective inoculation system is in a very elementary stage, but it is confidently anticipated that with improved methods, based upon further researches, a very valuable measure will be introduced for effectually compassing this ruinous pest.

THE *National Geographic Magazine* for April contains an account, by Mr. Walter D. Wilcox, of two expeditions to the headquarters of the Saskatchewan. The two main branches of the river start from the same ice-fields in the high Rockies, and after diverging several hundred miles unite in the plains 900 miles from the source. Mr. Wilcox reached the region of the sources by ascending the Bow River from Laggan, and amongst other geographical results of interest discovered a pass from the Saskatchewan to the Athabasca.

A NOTE on a harpoon-head found in a whale in the Bering Sea in August 1890, is contributed to the *National Geographic Magazine* by Mr. W. H. Dall. Marks on the iron showed that it belonged to the American whaler *Montezuma*, which was engaged in the North Pacific about the years 1850–54; the whale must, therefore, have carried it for between thirty-six and forty years. Mr. Dall also gives some observations by Captain E. P. Herendeen with regard to whales supposed from similar evidence to have made the north-east or north-west passage.

THE *Comptes rendus* of the Paris Geographical Society (1899, No. 2) contain a note by M. Jules Richard on a series of nine short land excursions made from the Prince of Monaco's yacht *Princess Alice*, during her Arctic cruise in the summer of 1898. A number of observations, chiefly zoological, were made from various points and islands in the neighbourhood of Spitsbergen. Photographs taken at Bear Island, Hope Island, and Sassen Bay are reproduced.

DR. HAGBART MAGNUS, of Bergen, contributes an important paper on the population of Norway to the *Zeitschrift der Gesellschaft fur Erdkunde*, a summary of a larger memoir already published in the Norwegian language. The distribution of centres of population is discussed with reference to the geography of different parts of the country, the inhabited districts being separated into coast regions, fjord regions, and valley regions. The transition from each of these into the uninhabited regions is carefully examined, and the development of unfavourable conditions of various kinds traced. A sketch-map, preliminary to an attempt to construct a map showing the density of population in southern Norway, is appended.

IN an article in the *Botanical Gazette* for April, Prof. W. F. Ganong describes the following appliances for the elementary study of vegetable physiology in use at Smith College, Northampton, Mass.:—A temperature stage, a clinostat, a recording auxanometer, an osmometer, a respiration apparatus, a germination box, a root-pressure gauge.

THE annual report of the Royal Botanic Gardens, Trinidad, for the year 1898 affords evidence of steady work done by the superintendent, Mr. J. H. Hart, and his staff, in the cultivation of economic plants, in the herbarium, and in exchanges with other parts of the world. A newly introduced species of cacao, *Theobroma pentagona*, may possibly be of commercial importance.

IN a paper in the *Biologisches Centralblatt*, Dr. L. Jost argues, from the remarkable tendency in *Linaria spuria* towards the sudden production of anomalies in the flower, which might be regarded as establishing new species, or even new genera, that the differentiation of species and genera may have been a much more rapid process than has generally been assumed by evolutionary naturalists.

WE have received two interesting reprints from the *Memoirs* of the Boston Society of Natural History for 1899:—Localised Stages in Development in Plants and Animals, by Mr. R. T.

Jackson; and the Development, Structure, and Affinities of the Genus *Equisetum*, by Mr. E. C. Jeffrey. The former paper is occupied by illustrations of the law laid down by the author, that throughout the life of an individual stages may be found in localised parts which are similar to stages found in the young, and the equivalents of which are to be sought in the adults of ancestral groups. The investigations of Mr. Jeffrey lead him to the conclusion that the Equisetales are nearly allied to the Lycopodiales, and that they are descended from the Sphenophyllales, with which they agree closely in all important particulars except the structure of the stele.

MR. MURRAY has in preparation, and will publish as soon as possible, Sir William Crookes' reply to the many criticisms evoked by his address to the British Association last year.

THE monthly meeting of the Edinburgh Mathematical Society was held on Friday, May 12, when "The Treatment of Proportion in Elementary Mathematics" was discussed. Dr. Morgan, President, occupied the chair.

THE 143rd meeting of the Yorkshire Naturalists' Union will be held at Dent, on Whit-Monday, May 22, for the investigation of the valley of the Dee, the northern slopes of Whernside, Gragreth, Holme Fell, and the neighbourhood.

MESSRS. MARION AND CO. have just introduced a new hand camera—the Cut-film Swallow Camera—which has several commendable points. The camera takes thirty flat films, without notches, the size being the ¼-plate–4¼ × 3¼. Its weight loaded with thirty films is only 4 lbs. The lens is a single achromatic lens of the fixed focus type and good covering power.

A NEW section of the second edition of Prof. Ostwald's "Lehrbuch der allgemeinen Chemie" has been published by Mr. Wilhelm Engelmann, Leipzig. The pages included in this Lieferung extend from 605 to 828, dealing with chemical equivalents of the second order. Another section on the same subject will bring the second part of the second volume to an end. The third part of the second volume, which will conclude the work, will be concerned chiefly with special chemical dynamics. A supplement will be published dealing with advances made while the work has been passing through the press.

PROF. GATTERMANN, of Heidelberg, has added another to the list of silicon acids. The new compound, which he terms silicomesoxalic acid, is obtained by leaving the chloride Si_3Cl_8 in a platinum dish exposed to the air. Hydrochloric acid is evolved and the octochloride is slowly transformed into a white amorphous mass of silicomesoxalic acid to which the formula $HO.OSi-Si(OH)_2-SiO.OH$ is ascribed. It is very unstable, and on heating decomposes with a flash. When quite pure and dry, a touch is sufficient to effect this change.

THE additions to the Zoological Society's Gardens during the past week include a Ring-tailed Lemur (*Lemur catta*, ♀) from Madagascar, presented by Mrs. Penn Curzon; a Common Badger (*Meles taxus*, ♀), British, presented by Mr. John N. Docwra; an Angolan Vulture (*Gypohierax angolensis*) from North-west Africa, presented by Staff-Sergeant Patten; a Hoary Snake (*Pseudaspis cana*), a Rough-keeled Snake (*Dasypeltis scabra*), two Rhomb-marked Snakes (*Trimenorhinus rhombeatus*), two Crossed Snakes (*Psammophis crucifer*) from South Africa, presented by Mr. J. E. Matcham; a Common Snake (*Tropidonotus natrix*), British, presented by Mr. E. C. Brook; two Common Marmosets (*Hapale jacchus*) from South-east Brazil, a Reticulated Python (*Python reticulatus*) from the East Indies, a Spiny-tailed Iguana (*Ctenosaura acanthura*) from Central America, a South Albemarle Tortoise (*Testudo vicina*) from the Galapagos Islands, deposited; two Crowned Lemurs (*Lemur coronatus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

PARTIAL ECLIPSE OF THE SUN, JUNE 7.—This eclipse will be visible at Greenwich and throughout Northern Europe and Northern Asia. The Greatest Eclipse will be visible in latitude 67° 18′ N., and longitude 99° 5′ W. of Greenwich, on June 7d. 18h. 34·0m.; the magnitude being 0·611 (sun's diameter = 1). The following table gives the details for British stations, Greenwich mean time being used in all cases except that of Dublin, where local mean time is taken.

Station	Begins	Greatest Eclipse	Ends	Magnitude
	h. m.	h. m.	h. m.	
Greenwich	16 42·8	17 17·4	17 53·4	0·188
Cambridge	16 43·2	17 18·6	17 55·5	0·197
Oxford...	16 42·8	17 18·2	17 55·1	0·200
Liverpool	16 43·8	17 21·5	18 0·9	0·233
Edinburgh	16 45·7	17 25·9	18 7·8	0·263
Dublin...	16 18·6	16 57·3	17 37·6	0·253

At Greenwich and approximately throughout the British Isles the contacts are as follows:—

Angle from North Point	First contact	42° towards the	West	For *direct* image.
	Last ,,	29° ,,	,, East	
Angle from Vertex	First ,,	6° ,,	,, West	
	Last ,,	70° ,,	,, East	

COMET 1898 *a* (SWIFT).—The following ephemeris is by Herr H. Kreutz, in *Astr. Nach.*, No. 3556:—

Ephemeris for 12h. Berlin Mean Time.

1899.	R.A.	Decl.	Br.
	h. m. s.	° ′	
May 18 ...	22 34 21 ...	+43 42·9	
19 ...	23 37 ...	45 23·1 ...	1·77
20 ...	22 11 40 ...	47 4·2	
21 ...	21 58 20 ...	48 44·5 ...	1·79
22 ...	43 29 ...	50 22·7	
23 ...	26 59 ...	51 56·5 ...	1·79
24 ...	21 8 40 ...	53 23·9	
25 ...	20 48 31 ...	+54 41·8 ...	1·77

During the week the comet passes through Lacerta without being near any conspicuous stars. On the 21st it enters Cygnus, being about 10° north-east of α Cygni on the 24th.

TEMPEL'S COMET (1873 II.).—M. L. Schulhof gives the following ephemeris for this comet in *Astr. Nach.*, No. 3554):—

Ephemeris for 12h. Paris Mean Time.

1899.	R.A.	Decl.	Br.
	h. m. s.	° ′ ″	
May 18 ...	19 12 16·1 ...	− 3 55 17	
19 ...	13 53·1 ...	3 53 15	
20 ...	15 29·7 ...	3 51 28 ...	0·764
21 ...	17 6·0 ...	3 49 55	
22 ...	18 41·8 ...	3 48 38	
23 ...	20 17·3 ...	3 47 37	
24 ...	21 52·3 ...	3 46 53 ...	0·869
25 ...	19 23 27·0 ...	− 3 46 27	

The comet is moving slowly in a north-easterly direction through the constellation Aquila.

RETURN OF HOLMES' COMET (1892, III.).—The following ephemeris is by Mr. H. J. Zwiers in *Astr. Nach.*, No. 3553.

Ephemeris for 12h. Greenwich Mean Time.

1899.	R.A.	Decl.	Br.
	h. m. s.	° ′ ″	
May 18 ...	0 34 53·2 ...	+ 10 12 50 ...	0·0298
20 ...	38 22·5 ...	10 50 0 ...	·0301
22 ...	41 51·1 ...	11 27 8 ...	·0304
24 ...	45 19·1 ...	12 4 13 ...	·0306
26 ...	48 46·2 ...	12 41 15 ...	·0309
28 ...	52 13·1 ...	13 18 14 ...	·0312
30 ...	55 39·1 ...	13 55 8 ...	·0315
June 1 ...	0 59 4·4 ...	+ 14 31 58 ...	·0318

No information as to any observations of this comet has yet been received. The positions given above would indicate it to be moving to the north-east through Pisces; at the end of the month it will be about half-way between γ Pegasi and β Arietis, but after this it will probably be lost owing to its nearing the sun.

ROTATION PERIOD OF MARS.—Mr. W. F. Denning has recently secured some measures of the times of transit of the Syrtis Major (Kayser Sea), which in conjunction with observations made by him in 1884 and 1869 give a critical value for the period (*Observatory*, May 1899, p. 195). On February 4, 1869, the Syrtis Major was in mid-transit at 11h., while on February 14, 1884, when Mars was similarly situated with reference to the Earth, the transit occurred at 5h. 55m. Other transits were taken as February 15, 6h. 35m.; February 19, 9h. 5m.; February 22, 11h. 4m. Now, after another interval of fifteen years, the transit on March 7, 1899, occurred at 8h. 31m. The whole period between 1869 February 4, 11h. and 1899 March 7, 8h. 31m., comprises 10,987 days, 21 hours, 31 minutes, during which Mars has performed 10,710 rotations. The mean period during this interval thus becomes

24h. 37m. 22·70s.

This value is intermediate between those of Proctor and Bakhuyzen.

AN IMPROVED RESISTANCE-BOX.

MESSRS. GAMBRELL BROS. have recently introduced a resistance-box of improved design, which gives promise of eliminating several of the disadvantages of the usual post-office pattern. Fig. 1 shows the appearance of the box with the cover removed to show the working parts. The coils, which hang vertically in the lower part of the box, are brought up to

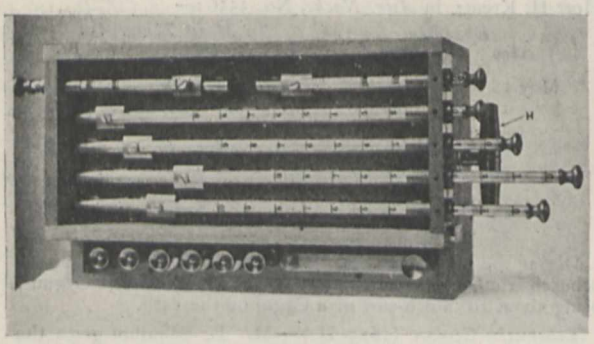

FIG. 1.—General view of the box, from above, showing the numbered slide rods, the contact shoes and the terminal studs of the coils. The handle (H) at the right is for clamping all the contact shoes simultaneously.

terminal studs (T) seen in Fig. 2, arranged in five rows, one of which, in two sections, forms the "ratios" used as two arms of the bridge. The upper surfaces of these studs are semi-circular, fitting the concave surfaces of the sliding contact shoes (S). The four rows other than the "ratios" provided for thousands, hundreds, tens and units, reckoned from the side nearest the terminals and key. Each of these contact shoes slides with slight friction on a brass bar running the length of the box, and supported at each end by metal pillars held down by springs inside the box. To move the shoes from one stud to another other

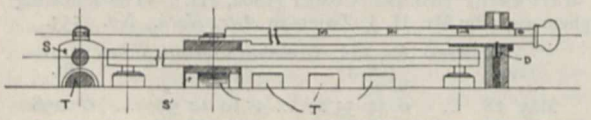

FIG. 2.—Showing construction of slider, spring contact bar, &c.

brass rods are attached, which slide through ebonite bushes on the end of the box. On these rods are engraved the figures giving the amount of resistance in use, the value of any particular resistance in circuit being indicated by the number showing just outside the ebonite bush. To ensure the contact shoe being properly fixed on the studs, a spring detent (D, Fig. 2) is provided under each bar, so that the resistances may be changed without the experimenter needing to watch the bar. All the bars being arranged to give the resistance required, it will be evident that its total amount can be read straight off at the end of the box, being given by the row of figures close to the four ebonite bushes. For example, the reading of the resistance in circuit, as shown in Fig. 1, is 2310. This is itself a great convenience, and will prevent any chance error in adding. As an additional help to maintaining the contacts as constant and perfect as possible, when the proper resistance has been found, all the four shoes are drawn tightly down on to the terminal studs by turning the handle H, seen under the ends of the rods in Fig. 1. This actuates a cam inside, which moves the small pillars at each end of the brass bars passing through the contact shoes. At the same time, the arrangement acts as a clamp, so that while the handle is turned the resistances cannot be changed. All the pillars are held down by springs, so that when not clamped by the handle H the sliding to and fro is accompanied by sufficient friction to keep the contact surfaces clean.

In consequence of the ingenious method adopted for reading off the figures, rendering access to the contacts themselves quite unnecessary, the whole of the system of studs and sliding bars is covered in permanently, so that they and the ebonite insulating block are kept free from dust and corrosion. The studs, being a considerable distance apart, should permit of a very high insulation resistance, while at the same time allowing a large surface contact between the shoe and the stud.

It will be seen that this new form of box has many advantages to recommend it to notice. The simplicity and rapidity of reading, its compactness, and its non-liability to deterioration, should cause it to find favour both in laboratory and testing-room experience.

TRANSPARENCY AND OPACITY.[1]

ONE kind of opacity is due to absorption; but the lecture dealt rather with that deficiency of transparency which depends upon irregular reflections and refractions. One of the best examples is that met with in Christiansen's experiment. Powdered glass, all from one piece and free from dirt, is placed in a bottle with parallel flat sides. In this state it is quite opaque; but if the interstices between the fragments are filled up with a liquid mixture of bisulphide of carbon and benzole, carefully adjusted so as to be of equal refractivity with the glass, the mass becomes optically homogeneous, and therefore transparent. In consequence, however, of the different dispersive powers of the two substances, the adjustment is good for one part only of the spectrum, other parts being scattered in transmission much as if no liquid were employed, though, of course, in a less degree. The consequence is that a small source of light, backed preferably by a dark ground, is seen in its natural outlines but strongly coloured. The colour depends upon the precise composition of the liquid, and further varies with the temperature, a few degrees of warmth sufficing to cause a transition from red through yellow to green.

The lecturer had long been aware that the light regularly transmitted through a stratum from 15 to 20 mm. thick was of a high degree of purity, but it was only recently that he found to his astonishment, as the result of a more particular observation, that the range of refrangibility included was but two and a half times that embraced by the two D-lines. The poverty of general effect, when the darkness of the background is not attended to, was thus explained, for the highly monochromatic and accordingly attenuated light from the special source is then overlaid by diffused light of other colours.

More precise determinations of the range of light transmitted were subsequently effected with thinner strata of glass powder contained in cells formed of parallel glass. The cell may be placed between the prisms of the spectroscope and the object-glass of the collimator. With the above-mentioned liquids a stratum 5 mm. thick transmitted, without appreciable disturbance, a range of the spectrum measured by 11·3 times the interval of the D's. In another cell of the same thickness an effort was made to reduce the difference of dispersive powers. To this end the powder was of plate glass and the liquid oil of cedar-wood adjusted with a little bisulphide of carbon. The general transparency of this cell was the highest yet observed. When it was tested upon the spectrum, the range of refrangibility transmitted was estimated at thirty-four times the interval of the D's.

As regards the substitution of other transparent solid material

[1] A discourse delivered at the Royal Institution on Friday, March 24, by the Right Hon. Lord Rayleigh, F.R.S.

for glass, the choice is restricted by the presumed necessity of avoiding appreciable double refraction. Common salt is singly refracting, but attempts to use it were not successful. Opaque patches always interfered. With the idea that these might be due to included mother liquor, the salt was heated to incipient redness, but with little advantage. Transparent rock-salt artificially broken may, however, be used with good effect, but there is some difficulty in preventing the approximately rectangular fragments from arranging themselves too closely.

The principle of evanescent refraction may also be applied to the spectroscope. Some twenty years ago an instrument had been constructed upon this plan. Twelve 90° prisms of Chance's "dense flint" were cemented in a row upon a strip of glass (Fig. 1), and the whole was immersed in a liquid mixture of bisulphide of carbon with a little benzole. The dispersive power of the liquid exceeds that of the solid, and the difference amounts to about three-quarters of the dispersive power of Chance's "extra dense flint." The resolving power of the latter glass is measured by the number of centimetres of available thickness, if we take the power required to resolve the D-lines as unity. The compound spectroscope had an available thickness of 12 inches or 30 cm., so that its theoretical resolving power (in the yellow region of the spectrum) would be about 22. With the aid of a reflector the prism could be used twice over, and then the resolving power is doubled.

One of the objections to a spectroscope depending upon bisulphide of carbon is the sensitiveness to temperature. In the ordinary arrangement of prisms the refracting edges are vertical. If, as often happens, the upper part of a fluid prism is warmer than the lower, the definition is ruined, one degree (Centigrade) of temperature making nine times as great a difference of refraction as a passage from D_1 to D_2. The objection is to a great extent obviated by so mounting the compound prism that the refracting edges are *horizontal*, which of course entails a

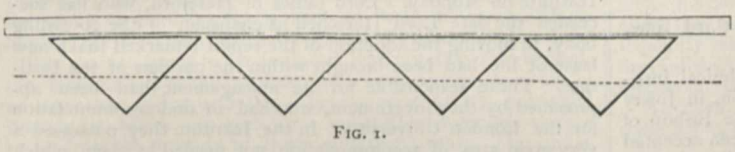

FIG. 1.

horizontal slit. The disturbance due to a stratified temperature is then largely compensated by a change of focus.

In the instrument above described the dispersive power is great—the D-lines are seen widely separated with the naked eye—but the aperture is inconveniently small (½-inch). In the new instrument exhibited, the prisms (supplied by Messrs. Watson) are larger, so that a line of ten prisms occupies 20 inches. Thus, while the resolving power is much greater, the dispersion is less than before.

In the course of the lecture the instrument was applied to show the duplicity of the reversed soda lines. The interval on the screen between the centres of the dark lines was about half an inch.

It is instructive to compare the action of the glass powder with that of the spectroscope. In the latter the disposition of the prisms is regular, and in passing from one edge of the beam to the other there is complete substitution of liquid for glass over the whole length. For one kind of light there is no relative retardation; and the resolving power depends upon the question of what change of wave-length is required in order that its relative retardation may be altered from zero to the quarter wave-length. All kinds of light for which the relative retardation is less than this remain mixed. In the case of the powder we have similar questions to consider. For one kind of light the medium is optically homogeneous, *i.e.* the retardation is the same along all rays. If we now suppose the quality of the light slightly varied, the retardation is no longer precisely the same along all rays; but if the variation from the mean falls short of the quarter wave-length it is without importance, and the medium still behaves practically as if it were homogeneous. The difference between the action of the powder and that of the regular prisms in the spectroscope depends upon this, that in the latter there is complete substitution of glass for liquid along the extreme rays, while in the former the paths of all the rays lie partly through glass and partly through liquid in nearly the same proportions. The difference of retardations along various rays is thus a question of a deviation from an average.

It is true that we may imagine a relative distribution of glass and liquid that would more nearly assimilate the two cases. If, for example, the glass consisted of equal spheres resting against one another in cubic order, some rays might pass entirely through glass and others entirely through liquid, and then the quarter wave-length of relative retardation would enter at the same total thickness in both cases. But such an arrangement would be highly unstable; and, if the spheres be packed in close order, the extreme relative retardation would be much less. The latter arrangement, for which exact results could readily be calculated, represents the glass powder more nearly than does the cubic order.

A simplified problem, in which the element of chance is retained, may be constructed by supposing the particles of glass replaced by thin parallel discs which are distributed entirely at random over a certain stratum. We may go further and imagine the discs limited to a particular plane. Each disc is supposed to exercise a minute retarding influence on the light which traverses it, and they are supposed to be so numerous that it is improbable that a ray can pass the plane without encountering a large number. A certain number (m) of encounters is more probable than any other, but if every ray encountered the same number of discs, the retardation would be uniform and lead to no disturbance.

It is a question of probabilities to determine the chance of a prescribed number of encounters, or of a prescribed deviation from the mean. In the notation of the integral calculus the chance of the deviation from m lying between $\pm r$ is (see *Phil. Mag.*, 1899, vol. xlvii. p. 251)

$$\frac{2}{\sqrt{\pi}}\int_0^{\tau} e^{-\tau^2}\, d\tau,$$

where $\tau = r/\sqrt{(2m)}$. This is equal to ·84 when $\tau = 1{\cdot}0$, or $r = \sqrt{(2m)}$; so that the chance is comparatively small of a deviation from m exceeding $\pm\sqrt{(2m)}$.

To represent the glass powder occupying a stratum of 2 cm. thick, we may perhaps suppose that $m = 72$. There would thus be a moderate chance of a difference of retardations equal to, say, one-fifth of the extreme difference corresponding to a substitution of glass for liquid throughout the whole thickness. The range of wave-lengths in the light regularly transmitted by the powder would thus be about five times the range of wave-lengths still unseparated in a spectroscope of equal (2 cm.) thickness. Of course, no calculation of this kind can give more than a rough idea of the action of the powder, whose disposition, though partly a matter of chance, is also influenced by mechanical considerations; but it appears, at any rate, that the character of the light regularly transmitted by the powder is such as may reasonably be explained.

As regards the size of the grains of glass, it will be seen that as great or a greater degree of purity may be obtained in a given thickness from coarse grains as from fine ones, but the light not regularly transmitted is dispersed through smaller angles. Here again the comparison with the regularly disposed prisms of an actual spectroscope is useful.

At the close of the lecture the failure of transparency which arises from the presence of particles small compared to the wave-length of light was discussed. The tints of the setting sun were illustrated by passing the light from the electric lamp through a liquid in which a precipitate of sulphur was slowly forming (*op. cit.*, 1881, vol. xii. p. 96). The lecturer gave reasons for his opinion that the blue of the sky is not wholly, or even principally, due to particles of foreign matter. The molecules of air themselves are competent to disperse a light not greatly inferior in brightness to that which we receive from the sky.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The honorary degree of M.A. was conferred in Convocation on Tuesday upon Mr. Roland Trimen, F.R.S.

Convocation has passed the decree accepting the offer of the Royal Geographical Society of 400*l.* for five years for the furtherance of geographical studies in Oxford, and providing an equal contribution from the funds of the University.

CAMBRIDGE.—The following is the speech delivered on May 11 by the Public Orator, Dr. Sandys, of St. John's

College, in presenting Prof. Kowalevsky, of St. Petersburg, for the honorary degree of Doctor in Science:—

Russorum ab imperio maximo legatus ad nos subito advectus est vir illustris, qui investigandi rationes novas inter primos secutus, animantium formas quasdam inferiores ex alia in aliam paullatim mutatas identidem indagavit; qui in confinio inter genera vertebris instructa et vertebris carentia iampridem moratus, Amphioxi speciem ambiguam primus explicavit; qui larvae denique Ascidianae cum vertebrato animalium genere affinitatem imprimis indicavit. Atqui, ne talium quidem virorum praeceptis attonitus, larvae illius degeneris propinquitatem reformidabit homo non terrestris tantum sed etiam caelestis originis conscius, qui angelis paullo minor, gloria et honore est coronatus, super oves et boves, super feras omnes, super volucres et pisces, super omnia quae maris per vias pererrant, a Deo constitutus.

Duco ad vos Zoologiae Professorem Petropolitanum, ALEXANDRUM KOWALEVSKY.

The General Board have issued a report recommending that the stipends of the Reader in Botany (Mr. F. Darwin), the Lecturer in Organic Chemistry (Mr. Ruhemann), the Lecturer in Experimental Psychology (Dr. Rivers), and the Curator in Zoology (Mr. D. Sharp), should be increased; and that new Lectureships in Palæozoology and in Physical Anthropology should be established.

A University Lectureship in Applied Mathematics will be vacant at Michaelmas by the resignation of Mr. Love, now Sedleian Professor at Oxford. Candidates are to send their names to the Vice-Chancellor by May 30. The stipend is 50*l.* a year.

The new Professorship of Agriculture, with a stipend of 800*l.* a year contributed by the Drapers' Company, was established by grace of the Senate on May 11.

THE Board of Education Bill was read for a third time, and passed, in the House of Lords on Monday.

THE foundation-stone of a new school and technical institute, connected with the Sir John Cass Foundation, in Jewry Street, Aldgate, was laid on Thursday last by the Bishop of London. The plans of Mr. A. W. Cooksey have been accepted for the new buildings, which will be in English Renaissance style, and will cost 45,000*l.*

MR. ANDREW CARNEGIE has written to the Right Hon. Joseph Chamberlain with reference to the proposed establishment of a University at Birmingham, and the correspondence is published in the *Birmingham Daily Post*. Mr. Carnegie refers in the correspondence to the great advantage which the iron and steel industries of the United States have derived from the Cornell University, and goes on to remark that "if Birmingham were to take that University as its model, where the scientific has won first place in the number of students, and give degrees in science as in classics, I should be delighted to contribute the last 50,000*l.* of the sum you have set out to raise to establish the scientific department." In addition to this Mr. Chamberlain, writing to the Lord Mayor of Birmingham, announces that an anonymous friend who had previously promised 25,000*l.* has agreed to increase his offer to 37,500*l.* on condition that the full amount of 250,000*l.* required for the *minimum* endowment is obtained. There still remains 12,000*l.* to be raised before the quarter of a million required is reached.

AT the annual celebration of Presentation Day of London University, held on May 10, the Earl of Kimberley presided for the first time as Chancellor. Referring to the Act passed last year, the Chancellor remarked that under the provisions of that Act and under the statutes made, the examination part of the University, by which the University had hitherto been known and in which it had done most excellent work, would be duly preserved. What was to be added was very important indeed, and it would become, he hoped, a great teaching University. They were at last beginning to appreciate the great changes which had taken place in the world, and in the advancement of science especially. Those changes had required others in the framing of the highest education. Not that they should for one moment abandon the old system of laying a good broad foundation of education, but that they should add to it the greater cultivation of the sciences, of economic science, and of all those arts which had grown to be of such great importance to this country. What they wanted was to bring together, as far as possible, all those various agencies provided for higher education in the metropolis.

INQUIRIES as to the schools in which leading men in various professions were educated have been made by *The School World*, and the results for men of science are published in the current number. Of 250 representative men of science—mostly Fellows of the Royal Society—chosen for the present inquiry, one-fifth received their early education either in private schools or at home under tutors. The schools which claim the greatest number of old pupils in the selected list are Edinburgh High School, Edinburgh Academy, and Aberdeen Grammar School. The Scotch schools are followed, as regards the number of old pupils of distinguished eminence in science, by the City of London School and King's College School. Eton, Harrow, and Rugby succeed these, and are in turn followed by Liverpool College, Royal Institution School (Liverpool), and St. Paul's. The remarkable point brought out by this comparison is the small part the great public schools have taken in training the leaders in science of the present day. When the men who are now in the foremost rank among philosophers were receiving their early education science was almost, if not quite, omitted from the public school curriculum, with the result that comparatively few boys from such schools have become eminent in the scientific world. The neglect of science in comparison with other subjects is shown by the fact that Eton, Harrow, Rugby, Winchester, Westminster, and one or two other public schools, though comparatively poor in their scientific record, are shown by *The School World* to have furnished the greatest number of leading men in Parliament, the Church, and the Law, Eton leading the way as regards numbers in each of these classes.

THE proposal to utilise the buildings of the Imperial Institute for the purposes of the new London University was referred to in the report read at the annual meeting of the Fellows of the Institute on Monday. Lord James of Hereford, who has succeeded the late Lord Herschell as chairman of the governing body, in moving the adoption of the report remarked that a new lease of life had been brought within the purview of the Institute. Those responsible for its management had been approached by the Government, who had to find accommodation for the London University. In the Institute they possessed a very great area of accommodation not needed by them, which could be devoted with very little adaptation for the purposes of the University. In the first place, to bring a great seat of learning under the roof of the Institute seemed to the governing body to be in accordance with the objects for which the Institute came into existence. But it was only right that he should tell them that in affording this accommodation to the London University they were receiving from the Government a very substantial return. He was not in the position to enter into any details, because all the arrangements had not yet been completed, but he might say that the negotiations were proceeding, and that by the financial return for the provision of the necessary accommodation for the University the governors of the Institute would be relieved of many burdens. The real result would be that they would have all anxiety removed with regard to the future conduct of the Institute.

SCIENTIFIC SERIALS.

Meteorologische Zeitschrift, February.—Results of the international balloon ascent, by Dr. H. Hergesell. This is the first of a proposed series of papers; the present one deals principally with the range of temperature, as shown by observations made in a captive balloon at Strassburg on June 7 and 8, 1898. The results prove that in strata of free air, whose height exceeds a few hundred metres, the temperature possesses an extremely small diurnal range. During the night it scarcely amounts to a few tenths of a degree; while in the daytime a variation of some three or four degrees Centigrade may occur, even at a height of 800 metres, when vertical air currents exist. In the absence of these, the range would, in all probability, sink to a very low value.—On the characteristics of mild winters, by Dr. G. Hellmann. The last two mild winters have induced the author to revise his previous researches upon this subject, and he gives particulars of the 51 mild winters experienced in Berlin during the last 180 years. The principal results arrived at are: that mild winters scarcely ever occur singly, but in groups of two or three; that they are usually of long duration, from November to February or March; severe and long, late winters (February and March) seldom occur after mild mid-

winters; in mild mid-winters the greatest variations of temperature usually occur in January. After a very mild winter, a warm summer is more probable than after a winter which is only moderately mild. Dr. Hellmann pleads for synoptic charts for the whole globe—at least for short intervals, if longer periods cannot be undertaken.

IN the *Journal of Botany* for April and May, Mr. A. Lister describes and figures some new or interesting species of Mycetozoa; Mr. E. A. N. Arber discusses the relationship to one another of the various forms of indefinite inflorescence; Mr. A. Gepp records the detection in Britain of a genus of Saprolegneous fungi, *Apodachlya;* Mr. G. S. West continues his account of the alga-flora of Cambridgeshire; Mr. F. S. Williams, his critical notes on species of *Cerastium;* and Mr. H. C. Hart, his account of a botanical excursion in Donegal.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 16.—"Experiments in Micro-metallurgy:—Effects of Strain. Preliminary Notice." By Prof. Ewing, F.R.S., and Walter Rosenhain, 1851 Exhibition Research Scholar, Melbourne University.

Much information has been obtained regarding the structure of metals by the methods of microscopic examination initiated by Sorby and successfully pursued by Andrews, Arnold, Charpy, Martens, Osmond, Roberts-Austen, Stead, and others. When a highly polished surface of metal is lightly etched and examined under the microscope, it reveals a structure which shows that the metal is made up in general of irregularly shaped grains with well-defined bounding surfaces. The exposed face of each grain has been found to consist of a multitude of crystal facets with a definite orientation. Seen under oblique illumination, these facets exhibit themselves by reflecting the light in a uniform manner over each single grain, but in very various manners over different grains, and, by changing the angle of incidence of the light, one or another grain is made to flash out comparatively brightly over its whole exposed surface, while others become dark.

The grains appear to be produced by crystallisation proceeding, more or less simultaneously, from as many centres or nuclei as there are grains, and the irregular more or less polygonal boundaries which are seen on a polished and etched surface result from the meeting of these crystal growths. The grains are, in fact, crystals, except that each of their bounding surfaces is casually determined by the meeting of one growth with another.

The experiments, of which this is a preliminary account, have been directed to examine the behaviour of the crystalline grains when the metal is subjected to strain.

For this purpose we have watched a polished surface under the microscope while the metal was gradually extended until it broke. By arranging a small straining machine on the stage of the microscope, we have been able to keep under continuous observation a particular group of crystalline grains while the piece was being stretched, and have obtained series of photographs showing the same group at various stages in the process. Strips of annealed sheet iron, sheet copper, and other metals have been examined in this way. We have also observed the effects of strain on the polished surfaces of bars in a 50-ton testing machine by means of a microscope hung from the bar itself, and have further observed the effects of compression and of torsion.

When a piece of iron or other metal exhibiting the usual granular structure is stretched beyond its elastic limit, a remarkable change occurs in the appearance of the polished and etched surface, as seen by the usual method of "vertical" illumination. A number of sharp black lines appear on the faces of the crystalline grains: at first they appear on a few grains only, and as the straining is continued they appear on more and more grains. On each grain they are more or less straight and parallel, but their directions are different on different grains. At first, just as the yield-point of the material is passed, the few lines which can be seen are for the most part transverse to the direction of the pull. As the stretch becomes greater oblique systems of lines on other grains come into view.

The photograph, Fig. 1, taken from a strip of transformer plate (rolled from Swedish iron and annealed after rolling), gives a characteristic view of these lines as they appear after a moderate amount of permanent stretching, but long before the iron has reached its breaking limit.

The appearance of each grain is so like that of a crevassed glacier, that these dark lines might readily be taken for cracks.

The real character of the lines is apparent when the crystalline constitution of each grain is considered. They are not cracks, but *slips* along planes of cleavage or gliding planes.

Fig. 2 is intended to represent a section through the upper part of two contiguous surface grains, having cleavage or gliding planes as indicated by the cross-hatching, AB being a portion of the polished surface. When the metal is pulled beyond its elastic limit, in the direction of the line A B, yielding takes place

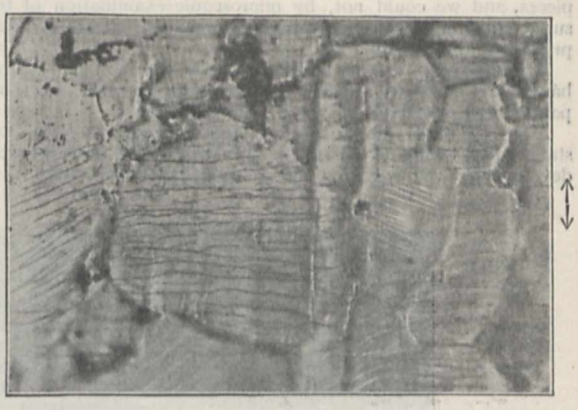

FIG. 1.—Soft sheet iron strained by tension. 400 diameters.

by finite amounts of slips occurring at a limited number of places in the manner shown at *a*, *b*, *c*, *d*, *e* (Fig. 3). This slip exposes short portions of inclined surfaces, and when viewed under normally incident light, these surfaces appear black because they return no light to the microscope. They are consequently seen as dark lines or narrow bands, extending over the polished surface in directions which depend on the intersection of the polished surface with the surfaces of slip.

We have proved the correctness of this view by examining these bands under oblique light. When the light is incident at

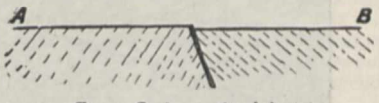

Fig. 2. Before straining.

only a small angle to the polished surface, the surface appears for the most part dark; but here and there a system of the parallel bands shines out brilliantly in consequence of the short cleavage or gliding surfaces which constitute the bands having the proper inclination for reflecting the light into the microscope. Rotation of the stage to which the strained specimen is fixed makes the bands on one or another of the grains flash out successively, with kaleidoscopic effect. In what follows we shall speak of these lines as slip-bands. Fig. 1, through a mixed illumination, shows some of the slip-bands bright and some dark.

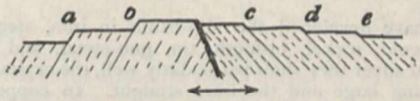

Fig. 3. After straining.

When the metal is much strained a second system of bands appears on some of the grains, crossing the first system at an angle, and in some cases showing little steps where the lines cross. These bands are clearly due to slips occurring in a second set of cleavage or gliding surfaces. Occasionally a third system of bands may be seen.

When the experiment is made with a polished but unetched specimen the slip-bands appear equally well. The boundaries of the grains are invisible before straining; but they can be distinguished as the strain proceeds, for the slip-bands form a cross-hatching which serves to mark out the surface of each grain.

Fig. 4 is another sample of iron strained by pull. The specimen in this case was a bar of Swedish iron, in which a comparatively large crystalline structure had been developed by annealing for some hours at 700° C. The photograph was taken after the bar had been broken in the testing machine, and shows with a magnification of 400 diameters a portion of the surface not far from the place of fracture.

The slip-bands are developed by compression as well as by extension. The bands developed by compression have apparently all the characteristics which they present in stretched pieces, and we could not, by microscopic examination of the surface, distinguish in this respect between the effects of compression and extension.

By twisting an iron bar well beyond the elastic limit the slip-bands are made to appear, for the most part, in directions parallel and perpendicular to the axis of twist.

A strip of sheet metal, such as iron or copper, in the soft state, when bent and unbent in the fingers, shows them well developed by the extension and compression of the surface.

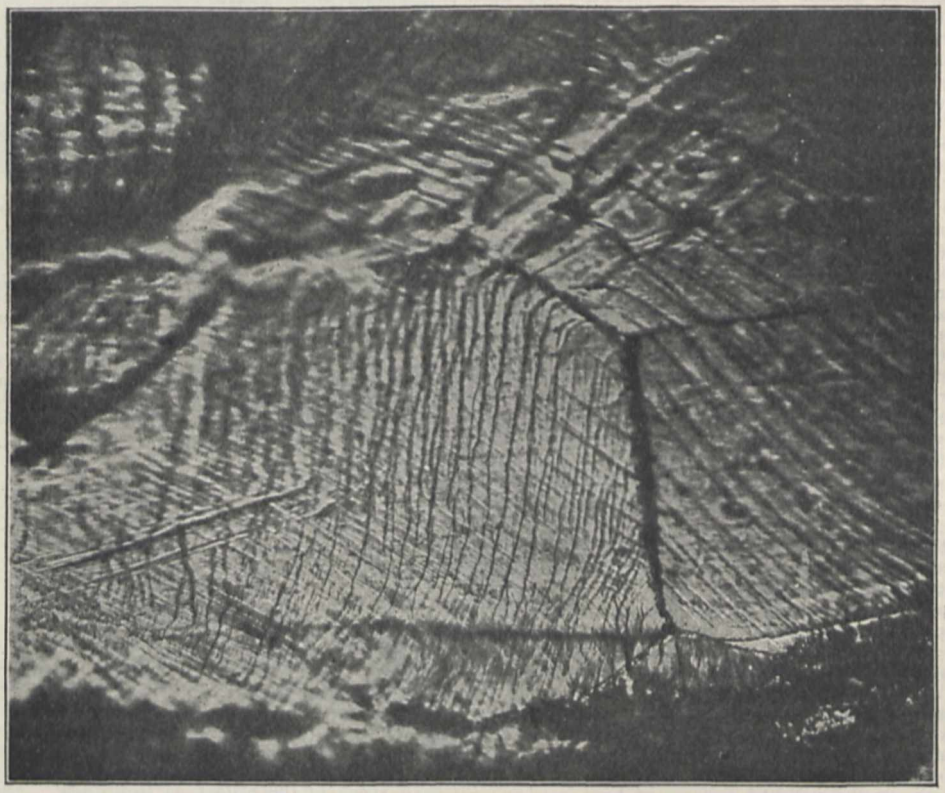

FIG. 4.—Swedish iron, much strained. 400 diameters.

We have developed the slip-bands in iron, steel, copper, silver, gold, nickel, bismuth, tin, gun-metal, and brass. In gold and silver they show particularly well, the crystalline structure being large and the lines straight. In copper also the lines are straighter and more regularly spaced than is general in iron. Most of these metals have been tested in the form of blocks under compression. A beautiful development of slip-bands may readily be produced by pinching a button of polished silver or copper in a vice, or by bending a strip of sheet metal.

In carbon steels we have found the slip-bands considerably more difficult to observe than in wrought iron. The smaller granular structure of steel apparently makes the slip-bands correspondingly minute. In mild steel they are seen readily enough, but in a rather high carbon steel we succeeded in seeing them only with difficulty in the "ferrite" areas under a magnification of 1000 diameters. A cast piece of the nearly pure iron used for dynamo magnets showed a relatively very large granular structure and well marked slip-bands.

These experiments throw what appears to us to be new light on the character of plastic strain in metals and other irregular crystalline aggregates. Plasticity is due to slip on the part of the crystals along cleavage or gliding surfaces. Each crystalline grain is deformed by numerous internal slips occurring at intervals throughout its mass. In general these slips no doubt occur in three planes, or possibly more, and the combination of the three allows the grain to accommodate itself to its envelope of neighbouring grains as the strain proceeds. The action is discontinuous: it is not a homogeneous shear but a series of finite slips, the portion of the crystal between one slip and the next behaving like a rigid solid. The process of slipping is one which takes time, and in this respect the aggregate effect is not easily distinguishable from the deformation of a viscous liquid.

We infer from the experiments that "flow" or non-elastic deformation in metals occurs through slip within each crystalline grain of portions of the crystal on one another along surfaces of cleavage or gliding surfaces. There is no need to suppose the portions which slip to be other than perfectly elastic. The slip, when it occurs, involves the expenditure of work in an irreversible manner.

It is because the metal is an aggregate of irregular crystals that it is plastic as a whole, and is able to be deformed in any manner as a result of the slips occurring in individual crystals. Plasticity requires that each portion should be able to change its shape and its position. Each crystalline grain changes its shape through slips occurring within itself, and its position through slips occurring in other grains.[1]

The experiments were made in the engineering laboratory at Cambridge, and are being continued. The authors express their indebtedness to Sir W. Roberts-Austen and Mr. T. Andrews for advice as to the preparation of specimens of metals for microscopic examination.

[1] Attention should be called in this connection to the experiments of Messrs. McConnel and Kidd on the plasticity of glacier ice (*Roy. Soc. Proc.*, vol. xliv. p. 331). They found that bars cut from glacier ice which is an aggregate of irregular crystals are plastic.

April 27.—"On the Luminosity of the Rare Earths when heated in vacuo by means of Kathode Rays." By A. A. Campbell Swinton. Communicated to the Royal Society by Lord Kelvin, F.R.S.

For incandescent gas mantles it is found that certain definite mixtures of the rare earths are necessary in order to obtain the maximum luminosity. For instance, a mantle consisting of pure thoria or pure ceria will in the Bunsen flame only give about one-eleventh of the light of one composed of 99 per cent of thoria and 1 per cent of ceria, which is the mixture used by the Welsbach Company.

In order to explain this remarkable fact, several contradictory theories have been propounded, and with a view to elucidating matters the author has made experiments in which mantles composed of different pure oxides and mixtures were heated by kathode ray bombardment in vacuo.

The mantles were prepared according to the ordinary Welsbach process, and in order to obtain accurate comparisons the mantles were made in patchwork, each complete mantle being made up of two or four sections separately impregnated with different solutions. The mantles were so mounted in the vacuum tube that the kathode rays impinged equally upon the portions that consisted of different oxides and mixtures, so that an equal amount of energy was imparted to each sample. Under these conditions the Welsbach mixture of thoria plus 1 per cent. of ceria was found to give very little more light than pure thoria, the difference probably not exceeding 5 per cent., but on starting the kathode discharge the mixture heated up to incandescence more rapidly, and on stopping the discharge cooled more rapidly than the pure thoria. At the same time it was found that with an intensity of kathode rays that gave a brilliant light both with pure thoria and with the Welsbach mixture, a mixture of 50 per cent. thoria and 50 per cent. ceria, and also a piece of mantle composed of pure ceria, gave practically no light, becoming barely red-hot.

The maximum luminosities could only be obtained at a critical and highly unstable degree of vacuum, which rendered accurate photometrical measurements impossible, but with pure thoria the amount of light under favourable conditions was estimated at at least 150 candle-power per square inch of incandescent surface, this being obtained with an expenditure of electric energy at about 8000 volts pressure of approximately one Watt per candle.

The kathode rays were found to have a reducing action on the oxides, which became discoloured under the bombardment, the discoloration disappearing owing to re-oxidation on the admission of a small quantity of air. Air so admitted while the tube was working was rapidly absorbed, and after the process of admitting air and absorbing it had been repeated several times, the degree of exhaustion which gave the maximum incandescence was found to have altered considerably, the residual gas having apparently become less conducting.

In place of air, oxygen and hydrogen were separately used as the residual gas, but without any difference in the luminosity.

These experiments show that thoria and ceria, both alone and mixed, behave quite differently when heated by kathode ray bombardment than when heated in a Bunsen flame. In the latter thoria plus 1 per cent. of ceria gives many times as much light as pure thoria alone, while when incandesced by kathode rays of equal intensity the difference, though in a similar direction, is only just appreciable. Again, in the flame, pure ceria gives just about the same amount of light as pure thoria, while with a given intensity of kathode ray bombardment thoria gives a brilliant light, while ceria gives practically none. In arriving at any satisfactory theory of the luminescent properties of the rare earths, these results will have to be taken into account.

"A Quartz Thread Gravity Balance." By R. Threlfall and J. A. Pollock.

The balance is of the horizontal, stretched, quartz thread type. One end of the thread is attached by soldering to a spring of peculiar construction; the other end is attached to the axle of the vernier arm of a sextant. At the centre of the thread a bit of brass wire is attached by soldering, so that the thread crosses the wire, which is about two cm. long, at right angles. The centre of gravity of the bit of wire, which will be referred to as the "lever," lies a little to one side of the thread, so that when the thread is untwisted the lever hangs vertically. The thread is stretched so that, in spite of the weight of the lever, it hangs almost horizontally. To make this arrangement into a gravity balance, it is only necessary to turn the lever round the thread as axis, so that each half of the latter receives about three turns (3×360 degrees) of twist. The lever is adjusted till, under these circumstances, it hangs nearly horizontally. A discussion of the theory of the balance shows that if the twist be now reduced the centre of gravity of the lever will rise and the position of the lever become unstable soon after its centre of gravity rises above the horizontal plane through the thread. The nearly horizontal position of the lever is secured during observation by means of a microscope, which can be focussed upon the end of the lever, and which is rigidly attached to the framework of the instrument. Gravitational attraction on the lever is thus balanced by the torsional rigidity of the quartz fibre, and the observations consist in noting the increase or diminution of twist, as applied at one end of the thread, necessary to bring the lever to its sighted position. The whole apparatus is enclosed in a tube which is air-tight, the vernier axle working through a sort of mercury stuffing-box. Exact thermometry is required, and is supplied by means of a platinum thermometer lying alongside the thread.

The instrument only gives relative values of gravity, referring an excess, or defect, of gravitational force to the difference of gravitational intensity at two stations selected as having known constants, in the present case Sydney and Melbourne.

The difficulties which have been met with during many years' work arise from the warping of the metallic parts of the instrument under changes of temperature and in the imperfect elastic properties of fused quartz threads.

The possible errors of a single observation are shown, from a discussion of the detail of the instrument, to amount to about one part in 300,000 of the value of g at any point, and by a discussion of three journeys between Sydney and Hornsby (N.S.W.), it is shown that the consistency actually realised is about one in 500,000 of g.

Many journeys have been made with the instrument in New South Wales, Victoria, and Tasmania, from which the perfect portability of the instrument has been ascertained, as well as its convenience in practice. A single observation takes only a few minutes after the temperature has arrived at a maximum or minimum, but the packing and unpacking occupy more than an hour—in general about three hours are required. The weight of the total outfit, with ordinary appliances just as they came to hand in the laboratory, is 226 pounds, but this might be halved by making the appliances specially. The paper contains the complete theory of the instrument, working drawings exhibiting its construction, and an account of experiments made with various modifications of the instrument.

"On the Electrical Conductivity of Flames containing Salt Vapours." By Harold A. Wilson, B.Sc. (Lond. and Vic.), 1851 Exhibition Scholar. Communicated by Prof. J. J. Thomson, F.R.S.

The experiments described in this paper were undertaken with the object of following up the analogy between the conductivity of salt vapours and that of Röntgenised gases, and especially of getting some information about the velocities of the ions in the flame itself.

They are to some exent a continuation of the research of which an abstract has already been published in the *Proceedings* of the Royal Society ("The Electrical Conductivity and Luminosity of Flames containing Vaporised Salts," by A. Smithells, H. M. Dawson, and H. A. Wilson, *Roy. Soc. Proc.*, vol. lxiv. p. 142).

The paper is divided into the following sections:—

(1) Description of the apparatus for producing the flame.
(2) The relation between the current and E.M.F. in the flame.
(3) The fall of potential between the electrodes.
(4) The ionisation of the salt vapour.
(5) The relative velocities of the ions in the flame.
(6) The relative velocities of the ions in hot air.
(7) Conclusion.

The current with a large E.M.F. was found to be independent of the distance between the electrodes in the flame, provided both were hot enough to glow; it was much greater when the hotter electrode was negative than when it was positive. When both electrodes were hot, the fall of potential between them was found to be very like that observed in the discharge through gases at low pressure. If one of the electrodes was cool, then nearly all the fall of potential occurred very near to it. Practically all the ionisation of the salt vapours appeared to take place at

the surfaces of the glowing electrodes. The velocities of the ions in the flame were estimated by finding the electric intensity required to cause them to move down the flame against the upward stream of gases. The positive ions of all the alkali metal salts had a velocity of about 60 $\frac{\text{cms.}}{\text{sec.}}$ for one volt per cm. The corresponding velocity of the negative ions was about 1000 $\frac{\text{cms.}}{\text{sec.}}$ In a current of hot air the corresponding velocities were as follows :—

(1) Negative ions of salts of Li, Na, K, Rb, Cs, Ca, Sr, and Ba, 26·0 $\frac{\text{cms.}}{\text{sec.}}$

(2) Positive ions of salts of Li, Na, K, Rb, and Cs, 7·2 $\frac{\text{cms.}}{\text{sec.}}$

(3) Positive ions of salts of Ca, Sr, and Ba, 3·8 $\frac{\text{cms.}}{\text{sec.}}$

The greater velocity of the negative ions enables the phenomena of unipolar conduction &c., to be easily explained.

Physical Society, May 12.—Prof. Perry, Vice-President, in the chair.—Dr. Lehfeldt read a note on the vapour pressure of solutions of volatile substances. The change in vapour pressure of a solvent due to the solution in it of a small quantity of volatile material has been calculated on the basis of Raoult's rule for the corresponding case of a non-volatile dissolved body. The author has interpreted the formula of Nernst in the following words :—When a small quantity of volatile substance is dissolved in a liquid the vapour pressure of the liquid is altered in the ratio of the molecular fractional amount of solvent in the liquid to that in the vapour. In order to test this formula, it has been applied to the results of experiments made on four series of liquids, viz. alcohol with benzene and toluene, and carbon tetrachloride with benzene and toluene. In the case of normal solutions, such as carbon tetrachloride in toluene, carbon tetrachloride in benzene, and benzene in carbon tetrachloride, the agreement between the observed and calculated values of the percentage composition of the liquid was remarkably good. In the case of toluene in carbon tetrachloride the solution contained about 29 per cent. of the dissolved body; and as the range of applicability of the formula had probably been exceeded, the agreement was not so good as in the previous examples. The mixtures containing alcohol show maxima of vapour pressure, and on this account the departure from the formula is so much more marked that it is impossible to apply it except in the case of very dilute solutions. The temperature used throughout the experiments was 50° C.—The Secretary read a note by Prof. W. B. Morton and Dr. Barton on the discussion of their paper, on the criterion for an oscillatory discharge of a condenser. In the discussion which followed the reading of the paper, it was pointed out that the result obtained, viz. that on taking into account the distribution of the current in the wire—a condenser having the critical capacity on the simple theory gives an oscillatory discharge—seems to be contradicted by the well-known fact that the resistance of the wire is greater and the inductance less for oscillatory than for steady currents. The explanation of the apparent paradox is to be found in the effect of the damping on the inductance. When the damping is great and the frequency small, as in the neighbourhood of the critical case, what may be termed the equivalent inductance becomes greater than the steady current value. It is shown that this increase in "L" outweighs the increase of "R" in its effect upon the criterion for oscillatory discharge. An examination of the expression for the equivalent inductance in the case of iron shows that it is greater than the steady current value if the ratio of one amplitude to the next is greater than $e^{\pi/200}$ where n is the frequency of the oscillation. Since the decrease of "L" with maintained oscillations is due to a surface concentration of current, it is suggested that there must be an axial concentration in the case of damped vibrations. Following the method of Maxwell for determining the current density at a distance from the axis of a wire, an expression for the current was introduced containing a damping coefficient. The "quasi-amplitude" of the disturbance at any point in the wire was thus obtained. An examination of the result shows that making the damping zero indicates a surface concentration. If, on the other hand, the damping is great, the expression for the amplitude increases as the distance from the axis decreases, and we get an axial concentration. Assuming sufficient damping to produce this effect, it is shown that as we go through the point $r = \frac{a}{\sqrt{2}}$, where a is the radius of the wire, we pass from a greater value of current density in the inner parts to a less in the outer than would correspond to a uniform distribution throughout the wire. From general reasoning the authors think that if a rapidly damped disturbance is propagated into a wire from its boundary, and if the oscillations are slow enough to allow the current to penetrate to the core, we should expect to find an axial concentration in the latter stages of the phenomenon. Dr. Lehfeldt said that Prof. Lodge had pointed out, at the reading of the paper, that the solution the authors obtained changed character at the critical resistance. As this point had not been considered in the note, he supposed that the change in character made no difference to the results obtained. The Chairman expressed his interest in the proof of the existence of an axial concentration.—Mr. Addenbrooke exhibited and described a quadrant electrometer for application to alternating current measurements. The author has substituted for cylindrical quadrants two sets of flat plates, the top set being adjustable. In this way the range of the instrument is considerably increased. The ability to remove one or more of the top quadrants makes the needle very accessible. By lowering the needle on to the bottom quadrants, and then bringing down one of the top plates, the instrument can be carried with safety. One of the top quadrants can be worked up and down by a worm gear, and by this motion the "electrical zero" of the electrometer is obtained. The suspension consists of a flat phosphor bronze strip, the torsion of which is found to be perfectly uniform, there being no fatigue effect. The case of the instrument contains windows, so that the needle can be viewed from two directions at right angles, and there are screw motions to centre the needle with respect to the quadrants. To reduce the effect of air convection currents upon the needle, the inside of the case is lined with cotton velvet. The quadrants are supported on brass bars passing through long ebonite sleeves in the bottom of the instrument. This gives good insulation without the use of sulphuric acid, and there is no Leyden jar or condenser in connection with the needle. When using the electrometer idiostatically with the finest strip, a light needle, and the quadrants one-tenth of an inch apart, a difference of potential of one volt will produce a deflection of about 5 mms. upon a screen two metres distant. Using the instrument heterostatically with 100 volts on the needle one-fifth of an inch between the quadrants and half a volt acting across them a deflection of 200 mms. can be obtained. This sensitiveness is about twelve times as great as that got from instruments designed by Kelvin, Mascart, and Haga. Mr. Addenbrooke then showed how, in conjunction with a voltmeter and an ammeter, it was possible with his instrument to determine all the factors of an alternating current system. The increased sensitiveness of the electrometer renders it possible to measure currents of any magnitude with a very small waste of energy. Mr. Gaster pointed out that the measurement of self-induction with an electrometer could only be carried out practically if the current curve was a sine curve. He said that in curves obtained from a Ganz motor a correction amounting to 7 per cent. had to be applied. The Chairman said that even if the curve obtained was a sine curve, the electrometer was never used in this country for measuring self-induction. Prof. Herschel asked if it were possible to adjust the quadrants after the needle had been charged Mr. Addenbrooke then purposely disturbed the position of the adjustable plate, and, after charging the needle, reduced the deflection to zero by the worm gear. The author said that for high voltages the curve of calibration was different to that obtained from the ordinary formula. The Chairman said that this discrepancy was probably due to want of perfect symmetry. In a paper read before the Royal Society by Perry, Ayrton and Mather, it was shown that the presence of the guard around the mirror of an ordinary electrometer was sufficient to affect the needle when working with high voltages. In working with the plates very close together he was afraid the symmetry would be liable to be disturbed by a slight tilting of the needle due to electrostatic attraction. The author observed that the plates were only very close together when working with low voltages.

Chemical Society, May 4.—Prof. Thorpe, President, in the chair.—The following papers were read :—On the combustion of carbon disulphide, by H. B. Dixon and E. J. Russell. Carbon disulphide undergoes a phosphorescent combustion in air at temperatures below its ignition point, the lowest observed

value for which was 232°; prolonged heating of carbon disulphide at 230°, or prolonged exposure to bright light, causes slight decomposition. The decomposition of carbon bisulphide vapour by detonation is not propagated as an explosion, and no explosive wave could be propagated in mixtures of the vapour and oxygen containing less than 40 per cent. of the latter.—The action of nitric oxide on nitrogen peroxide, by H. B. Dixon and J. D. Peterkin. A very slight increase of volume occurs on mixing nitric oxide with nitrogen peroxide at 27°, but a considerable expansion attends the mixing of inert gases like nitrogen with the peroxide, owing to dissociation of the latter; these results may be explained by the equation

$$N_2O_3 \rightleftarrows NO + NO_2$$

on the supposition that at 27° the dissociation is nearly complete.—On the mode of burning of carbon, by H. B. Dixon. It is shown that Lang's view that carbon dioxide is the first product of the combustion of carbon, and that carbon monoxide is only produced by the subsequent reduction of the dioxide, is invalid.—Crystalline glycollic aldehyde, by H. J. H. Fenton and H. Jackson. The aqueous syrup containing glycollic aldehyde obtained by heating dihydroxymaleic acid with water, yields a hexose, $C_6H_{12}O_6$, on evaporation; during the latter process a small proportion of crystalline glycollic aldehyde sublimes; when first dissolved in water the aldehyde has the composition $C_4H_8O_4$, but after about twenty-four hours the molecular composition becomes $C_2H_4O_2$.—On the blue salt of Fehling's solution and other cuprotartrates, by O. Masson and B. D. Steele. The blue salt of Fehling's solution when dried *in vacuo* has the composition $K_3C_{12}H_9Cu_4O_{19}$, $4H_2O$, and contains a complex negative radicle of which copper is a part; none of the copper is electropositive.—The preparation of acid phenolic salts of dibasic acids, by S. B. Schryver.—The maximum pressure of naphthalene vapour, by R. W. Allen. The author has prepared, from new experimental data, tables showing the vapour pressure of naphthalene and giving the weight of naphthalene required to saturate a cubic metre of gas at temperatures ranging from 0° to 130°.—Scoparin, by A. G. Perkin. Scoparin, the colouring matter of broom, is probably a methoxyvitexin.—On a new compound of arsenic and tellurium, by E. C. Szarvasy and C. Messinger. The compounds of arsenic with elements of the oxygen-sulphur series which are most stable at high temperatures are As_2O_3, As_2S_3, As_2Se; since the differences between the molecular weights in this series of compounds are 15 and 16, it was thought probable that the compound As_2Te_3 should be formed at high temperatures. The authors have obtained this compound.—The action of hydrogen peroxide on secondary and tertiary aliphatic amines. Formation of alkylated hydroxylamines and oxamines, by W. R. Dunstan and E. Goulding.—The enantiomorphously related tetrahydroquinaldines, by W. J. Pope and S. J. Peachey. The authors have separated synthetic tetrahydroquinaldine into a dextro- and a lævo-rotatory isomeride by crystallising its salts with camphorsulphonic acids.

Entomological Society, May 3.—Mr. R. McLachlan, F.R.S., in the chair.—Dr. A. L. Bennett exhibited various insects which he had collected in the French Congo. They included a species of Mantidæ remarkable for its very striking resemblance in coloration to a piece of bark.—Mr. F. Enock exhibited a living specimen of *Nepa cinerea* infested with a number of minute red *Acari* on the ventral surface of the abdomen. He also showed eggs of *Nepa* and *Notonecta* lying *in situ* in decayed leaf-stalks of *Alisma*, and described the mode of oviposition as observed by himself in both of these genera. He then exhibited a living example of the remarkable aquatic Hymenopteron—*Prestwichia aquatica*, Lubb., and said it was one of a brood of nine, including eight ♀ ♀ and one ♂, that issued on May 1 from a single egg of *Colymbetes* found on September 5, 1898.—Mr. Merrifield showed some specimens of *Hemaris bombyliformis*, Esp., with the scales still covering the central portions of the wings. He said these scales, which are present immediately after the emergence of the insect but soon become detached, may be rendered adherent by allowing a very weak solution of indiarubber in benzoline to run over the wings.—Mr. C. H. Dolby-Tyler communicated a paper on the development of *Ceroplastes roseatus*, Towns. and Cockl.

Mathematical Society, May 11.—Prof. H. Lamb, F.R.S., Vice-President, in the chair.—Major MacMahon, R.A., F.R.S., communicated some results he has obtained in the theory of partitions.—Mr. H. M. Macdonald read a paper on the zeroes of aspherical harmonic, $P_n^m(\mu)$, considered as a function of n.—Mr. W. F. Sheppard gave an account of his paper on the statistical rejection of extreme variations, single or correlated (normal variation and normal correlation).

MANCHESTER.

Literary and Philosophical Society, April 25.—Mr. J. Cosmo Melvill, President, in the chair.—At this the annual general meeting, Mr. R. H. Inglis Palgrave, F.R.S., and Prof. William Ramsay, F.R.S., were elected honorary members of the Society.—The annual report (as amended) and the statement of accounts were adopted, and the following were elected officers and members of the Council for the ensuing year:—President, Prof. Horace Lamb, F.R.S.; vice-presidents, Prof. Osborne Reynolds, F.R.S., Mr. Charles Bailey, Mr. J. Cosmo Melvill, and Prof. W. Boyd Dawkins, F.R.S.; secretaries, Mr. R. F. Gwyther and Mr. Francis Jones; treasurer, Mr. J. J. Ashworth; librarian, Mr. W. E. Hoyle; other members of the Council, Prof. H. B. Dixon, F.R.S., Mr. Francis Nicholson, Mr. J. E. King, Mr. R. L. Taylor, Mr. F. J. Faraday, and Mr. W. H. Johnson.—At the ordinary meeting held afterwards, Prof. Dixon described an apparatus for bringing together nitrogen peroxide and nitric oxide in order to determine whether any combination occurs between the gases.

PARIS.

Academy of Sciences, May 8.—M. van Tieghem in the chair.—On the absolute measurement of time, deduced from the laws of universal attraction, by M. G. Lippmann. The unit of time suggested is based upon the proposition that the numerical value of the Newtonian constant is independent of the units of length and mass, and depends uniquely upon the choice of the unit of time. Inversely, the magnitude of the interval of time taken as unity is determined without ambiguity when the numerical value of the Newtonian constant which corresponds to it is given.—Anatomical and physiological characters of plants rendered artificially Alpine by alternation between extreme temperatures, by M. Gaston Bonnier. Alpine temperature conditions were imitated by keeping the plants in an ice box during the night, and exposing fully to the sun during the day. The petioles of the leaves develop more rapidly under these conditions, and the leaves, which are smaller and thicker, have a more highly developed layer of pallisade tissue, and frequently the reddish coloration of Alpine plants. The flowers are relatively larger and more highly coloured than those grown under ordinary conditions.—M. Prillieux was elected a member of the Botanical section, in place of the late M. Naudin.—On the circumstances which modify the images reflected by a mercury bath, and on the transmission through the soil of vibrations produced at the surface, by M. G. Bigourdan. In the hope of securing a steadier mercury surface, the bath was placed at varying distances from the surface of the earth. It was then found that two quite distinct classes of earth tremors could be distinguished, the one slow and regular, to which the name undulation is given, the other rapid and irregular vibrations.—On the pencils which correspond to the case where the series of Laplace is limited in one direction, by M. C. Guichard.—The groups of the order $p^2\,q^2$, p being a number greater than q, by M. Le Vavasseur.—On the electric capacity of badly conducting bodies, by MM. I. I. Borgmann and A. A. Petrovsky.—On an intense source of monochromatic light, by MM. Ch. Fabry and A. Perot. The new source suggested is the electric arc between two surfaces of mercury *in vacuo*. The mercury is contained in two concentric glass tubes, the inner one only just separating the two mercury surfaces. On giving the tube a slight shock a momentary connection is set up, and the arc starts. For a perfectly stable arc a potential of about thirty volts is necessary, and a current of from two to three amperes. The light is not perfectly monochromatic, but may be easily rendered so by the interposition of cells containing suitable absorption media. Thus, a mixture of didymium chloride and potassium bichromate cuts off all rays except the green ray, the most useful ray for general purposes.—On the ratio of the atomic weights of hydrogen and oxygen, by M. A. Leduc. By taking into account the increase of pressure observed to take place when hydrogen and oxygen gases are mixed, the number for the ratios of the atomic weights deduced from the density of detonating

gas (15·898), is increased to 15·878, a number sensibly in agreement with the 15·88 found by the author by the gravimetric method.—On the increase of pressure produced by the mixture of two gases, and on the compressibility of the mixture, by M. Daniel Berthelot. The formulæ proposed by the author in a previous paper are applied to the gas mixtures, SO_2+CO_2, N_2+O_2, and H_2+O_2, and the results compared with the experiments of Sacerdote, Leduc, Rayleigh, and the author. The agreement is very close.—Researches on the separation of traces of bromine existing in chlorides, by M. H. Baubigny. A strong solution of the chloride, to which a large amount of copper sulphate has been added, is treated with potassium permanganate in the cold, and the whole reduced to dryness *in vacuo*. The whole of the bromine is thus given off, together with a little chlorine; the original method proposed by the author and M. Rivals is then applied to this mixture. Two test analyses show satisfactory results, even when only ·005 gram of bromide was present with 12 grams of chloride.—On the impurities of aluminium, by M. Adolphe Minet.—On magnesium phosphide, by M. Henri Gautier. The phosphide Mg_3P_2 was prepared in a pure state by the direct combination of the elements in a stream of hydrogen. Pure PH_3 is obtained on treating this with water.—On the flame of hydrogen, by MM. Schlagdenhauffen and Pagel. The violet-blue colour of a hydrogen flame obtained when the gas is prepared from zinc is not due to sulphur, as proposed by Salet, but selenium. Some selenium is invariably left behind in the residue, probably as lead selenide.—Hydrogenation of acetylene in presence of nickel, by MM. Paul Sabatier and J. B. Senderens. A mixture of hydrogen and acetylene acts vigorously upon reduced nickel, even in the cold, ethylene, ethane, and liquid hydrocarbons being produced in quantity.—On the dextrines arising from saccharification, by M. P. Petit.—Method for rapidly measuring the dimensions of small objects, independently of their distance. Application to pupillometry and to laryngometry. Illusion due to the muscular sense in the appreciation of the size of objects, by M. Th. Guilloz.—Pathological physiology of pregnancy, by MM. Charrin and Guillemonat.—The influence of freezing upon the development of the hen's egg, by M. Étienne Rabaud. The eggs were not killed by exposure to −15° C., but the development was markedly affected, and that permanently.—Some remarks on the *Haementeria costata* of Müller, by M. A. Kowalevsky.—On the existence of a fauna of Arctic animals in the Charente at the Quaternary epoch, by MM. Marcellin Boule and Gustave Chauvet.—New researches on the caverns of Padirac, by MM. Armand Viré and Étienne Giraud.—On the ascent of the *Balaschoff* on March 24, by M. G. Le Cadet.

DIARY OF SOCIETIES.

THURSDAY, MAY 18.

ROYAL SOCIETY, at 4.30.—Bakerian Lecture: The Crystalline Structure of Metals: Prof. J. A. Ewing, F.R.S., and W. Rosenhain.—The Yellow Colouring Matters accompanying Chlorophyll and their Spectroscopic Relations: C. A. Schunck.—The Diffusion of Ions into Gases: J. S. Townsend.—The Diurnal Range of Rain at the Seven Observatories in connection with the Meteorological Office, 1871–1890: Dr. R. H. Scott, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Electric Locomotives in Practice and Tractive Resistance in Tunnels, with Notes on Electric Locomotive Design: P. V. McMahon.

CHEMICAL SOCIETY, at 8.—Corydaline, Part VI.: Dr. J. J. Dobbie and A. Lauder.—Oxidation of Furfural by Hydrogen Peroxide: C. F. Cross, E. J. Bevan, and T. Freiberg.

FRIDAY, MAY 19.

ROYAL INSTITUTION, at 9.—Runic and Ogam Characters and Inscriptions in the British Isles: The Lord Bishop of Bristol.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—A Study of Enteric Fever in the Netherlands: Prof R. H. Saltet.

TUESDAY, MAY 23.

ROYAL INSTITUTION, at 3.—Recent Advances in Geology: Prof. W. J. Sollas, F.R.S.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Corea: Mrs. Isabella Bishop.

WEDNESDAY, MAY 24.

GEOLOGICAL SOCIETY, at 8.—On the Distal End of a Mammalian Humerus from Tonbridge: Prof. H. G. Seeley, F.R.S.—On Evidence of a Bird from the Wealden Beds of Ansty Lane, near Cuckfield: Prof. H. G. Seeley, F.R.S.—On the Rhyolites of the Hauraki Goldfields (New Zealand): J. Park and F. Rutley.—On the Progressive Metamorphism of some "Dalradian" Sediments in the Region of Loch Awe: J. B. Hill.

THURSDAY, MAY 25.

ROYAL INSTITUTION, at 3.—Water Weeds: Prof. L. C. Miall F.R.S.

FRIDAY, MAY 26.

ROYAL INSTITUTION, at 9.—Climbs and Explorations in the Andes: Sir W. Martin Conway.

PHYSICAL SOCIETY, at 5.—On the Thermal Properties of Normal Pentane, Part 2: Prof. S. Young and Mr. Rose-Innes.—On the Distribution of Magnetic Induction in a Long Iron Bar: C. G. Lamb.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Cours Elémentaire de Zoologie: R. Perrier (Paris, Masson).—Chapters on the Natural History of the U.S.: Dr. R. W. Schufeldt (Gay).—Das Tierreich, 7 Liefg.: Profs. Canestrini and Kramer (Berlin, Friedländer).—Ditto, 8 Liefg.: Prof. K. Kraepelin (Berlin, Friedländer).—Electromagnetic Theory: O. Heaviside, Vol. 2 (*Electrician* Company).—The Tides Simply Explained: Rev. J. H. S. Moxly (Rivingtons).—A Manual of Surgical Treatment: Prof. W. W. Cheyne and Dr. F. F. Burghard, Part 1 (Longmans).—Physique et Chimie Viticoles: A. de Saporta (Paris, Carré and Naud).—The Aborigines of Tasmania: H. Ling Roth, 2nd edition (Halifax, King).

PAMPHLETS.—Die Elemente des Erdmagnetismus, &c.: Dr. H. Fritsche (St. Petersburg).—Man the Microcosm: L. Hall, Part 1 (Williams).—Die Lokalisation Morphogenetischer Vorgänge: H. Driesch (Leipzig, Engelmann).—Die Aufstellung der Tiere in Neuen Museum zu Darmstadt: G. von Koch (Leipzig, Engelmann).—Siebenter Jahres-Bericht des Sonnblick-Vereines für das Jahr 1898 (Wien).

SERIALS.—Science Gossip, May (Strand).—Botanische Jahrbücher, Siebr. Bd. 1 and 2 Heft (Leipzig).—Fortnightly Review, May (Chapman).—Zeitschrift für Physikalische Chemie, xxviii. Band, 4 Heft (Leipzig).—Himmel und Erde, April (Berlin).—Natural Science, May (Pentland).—Journal of Botany, May (West).—Observatory, May (Taylor).—Journal of the Chemical Society, May (Gurney).—Geographical Journal, May (Stanford).—Monthly Weather Review, January (Washington).—Proceedings of the Royal Society of Edinburgh, Vol. xxii. pp. 361–440 (Edinburgh).—Engineering Magazine, May (Strand).—Physical Review, March (Macmillan).—Scientia, No. 3 (Paris, Carré).—Journal of Applied Microscopy, March (Rochester, N.Y.).—L'Anthropologie, Tome x. No. 2 (Paris).—Record of Technical and Secondary Education, April (Macmillan).—Memoirs of the Boston Society of Natural History, Vol. v. Nos. 4 and 5 (Boston, Mass.).—American Journal of Mathematics, April (Baltimore).—Psychological Review, May (Macmillan).—National Geographic Magazine, May (Washington).—American Journal of Science, May (New Haven).—Botanischer Jahrbücher, Sechsr. Band, v. Heft (Leipzig).

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