THURSDAY, OCTOBER 6, 1881

AUSTRALIAN ABORIGINES

Australian Aborigines: the Languages and Customs of several Tribes of Aborigines in the Western District of Victoria, Australia. By James Dawson. (Melbourne: Robertson; London: Macmillan and Co., 1881.)

MR. DAWSON, a settler of old standing in the district west of Melbourne, and his daughter, Mrs. Taylor, who has been familiar from childhood with several native dialects, have in years of careful inquiry collected the present volume of information as to the languages and life of the group of tribes living inland from the coast between Portland Bay and Cape Otway. These tribes form part of the native population described in the "Aborigines of Victoria," compiled by Mr. Brough Smyth for the Victorian Government; but able and extensive as that work is, the anthropologist sees on comparing it with the present volume how far he must still be from thoroughly understanding the native institutions, when a minute study of one district can bring out so many new and difficult points as are to be found here. Take the native marriage laws as set down by Mr. Dawson. The tribes are split up into totem-classes named after animals, both sons and daughters belonging to the mother's class, and not being allowed to marry within it; thus a Pelican youth may not marry a Pelican girl, or a Boa youth a Boa girl, but Pelican may marry Boa. So far, this is like the exogamous rules found in various other parts of the country; but here it is further stated that though the class follows the mother's side, the tribe itself follows the father's side, and the natives are not allowed to marry into their own tribe either, nor may a man marry into his mother's or grandmother's tribe, nor into an adjoining tribe, nor into one that speaks his own dialect. This remarkable set of restrictions, which does not seem to correspond exactly with those of any other district in the world, is considered by the tribes who live under it as intended to prevent marriage between those of "one flesh," and indeed it bars kin-marriage in both the male and female line in a more thorough way than the known laws of any other Australian tribes. No marriage or betrothal is permitted without the approval of the chiefs of each party, who first ascertain that no "illegal" relationship exists. Any symptoms of courtship between those of "one flesh" are put down by rough handling of the culprits, and parents are apt to save their children from breaking the law by betrothing them in proper quarters as soon as they can walk. What can have been the motive which led the ancestors of these savages to carry their prohibited degrees to an extent which our physicians would consider practically absurd? Mr. Dawson speaks of these laws as admirable, and plainly thinks them founded on practical reasons against marrying-in, for he says that where the prohibitions have been disregarded under European influence, the aborigines attribute to this disregard the greater weakness and unhealthiness of their children, and the increase of insanity. This, however, may have got into the native mind from hints by the white doctors, and the whole subject of these marriage-prohibitions is as yet an unsolved problem. This is better seen when one does not look at one particular point, but at the system as a whole, with its network of ceremonial regulations. Among these, the custom of avoiding the mother-in-law is of course described by Mr. Dawson. He gives the usual details how, when a girl is betrothed, her mother and aunts may not look at or speak to the man for the rest of his life, but if they meet him they squat down by the wayside and cover up their heads, and when he and they are obliged to speak in one another's presence, they use a peculiar lingo, which they call "turn-tongue." This queer dialect is not used for concealment, for everybody understands it, and some examples of it are here given which show that it has much in common with the ordinary language. Should the present notice meet the eye of Mr. Dawson, it may be suggested that it would be worth while to find out whether the "turn-tongue" is an old-fashioned dialect kept up for this ceremonial purpose. For the rest of the marriage-customs we must refer to the book itself; but to give an idea of the state of formality into which life has come among these supposed free-and-easy savages, mention may be made of the duties of the bridesmaid and groomsman. When the married pair have been taken to the new hut built for them, for the next two moons the groomsman and the husband sleep on one side of the fire, the bridesmaid and the wife on the other, the new-married couple not being allowed to speak to or look at one another. The bride is called a "not-look-round," and the pair in this embarrassing position are a standing joke to the young people living near, who amuse themselves by peeping in and laughing at them.

Among the interesting questions as to Australian arts and ideas which Mr. Dawson touches on, is whether they had any notion of boiling food. He confirms the general opinion that they had not, and states that there is no word meaning to boil in their native dialects. But it does not always follow that what is true as to one group of tribes is true everywhere. Mr. Brough Smyth gives an account of the fish-hooks of the aborigines in Victoria, but Mr. Dawson declares that in his district they were unknown, though the native fishermen have come so near angling as to use a rod and line with a bunch of worms for bait, with which they pull out the fish before he has time to disgorge. Looking over the grammatical part of the book, we find the list of numerals in the native dialects one of the most perfect examples of the way in which numerals have been developed from counting on the fingers. They say "one hand" for 5, "two hands" for 10, and so on with hands and twenties up to 100. But the unusual and noticeable point is, that though getting so far, they have not worked out words for the intermediate numbers above 10, but fall back on the primitive gestures; thus they have not words for 11 or 12, but they say 10, and hold out one finger or two to make up the number. Mr. Dawson seldom quotes or criticises books, but when he gives the fact that there is a native word for 100 he adds a note that this is wholly at variance with the statement made by Mr. E. B. Tylor ("Primitive Culture," vol. i. p. 220) as to some Australian tribes having no numeral words even so high as 5. To prevent misunderstanding he should have pointed out that the next page of the work in question makes reference to other

Australian tribes reported to have numeral words up to 15 or 20. But the point raised is well worth attention. The statement as to tribes in various districts having no distinct numeral words above three, and only struggling on to four and five by saying "two-two," &c., rests on the authority of Europeans who have studied the native languages, sometimes well enough to write grammars of them. Are we to think that the natives generally had words for large numbers, and yet the Europeans failed to discover them? Or, rather, is it not easy to suppose that some tribes raised themselves (possibly since contact with the white man) above this low level of arithmetic, making, out of their counting on the fingers, numeral words even as high as the words here given for 100? It would be interesting if it could be shown etymologically that the terms here given for 20 and 100 had originally a material meaning, like the word for 5, which still means "hand."

One of the greatest difficulties in studying savages is to know how far to trust or distrust their assurances that what they tell is really their own, and not picked up from foreigners. From this point of view it is worth while to look closely at the story of the lost Pleiad, which here appears among the native myths of the "black-fellows." The author's friends naturally doubted its genuineness, but on further inquiry it was found to be widely known. The tradition is that the Pleiades were a chiefess called Gneeanggar and her six attendants; Waa, the Crow (the star Canopus), fell in love with her, and finding that she and her women were going in search of white grubs, he turned himself into one, and bored into the trunk of a tree, where they were sure to find him. The women, one after another, poked their little wooden hooks into his hole, but he broke the points, till at last his love put in her beautiful bone hook, and he let her draw him out, whereupon he turned into a giant and ran away with her; since then only six Pleiads—the serving-women—have been left. Now between this story and our classical myths there is a difference. Ovid's version seems to carry its origin on its face, agreeing with the fact that only six of the stars in the cluster are bright and plain to common eyes, so the myth tells of a hidden or faint seventh. She is Merope hiding herself for shame at marrying a mortal, or Electra putting her hand before her eyes, not to see the ruin of Troy. But in the Australian tale the vanished star, being the queen, ought of course to be the brightest; so that there is little sense in the story, unless Mr. Dawson is prepared to maintain that the Australians remember a time when there was a Pleiad brighter than the rest, which has now vanished. It would be easier, if more commonplace, to guess that the natives got the idea of a lost Pleiad from some Englishman who had heard the story at home, but missed the point of it.

The anthropological work done by Mr. Dawson and Mrs. Taylor hardly needs praising. It is enough to point out how carefully, not relying on books, they have made their own inquiries on every subject, and recorded them as scientific material. It is to be hoped that they will not cease their researches, for there must still be much valuable evidence to be gleaned in their district, if it is done without delay.

EDWARD B. TYLOR

OUR BOOK SHELF

A Dictionary of Chemistry and Allied Sciences. By H. Watts, F.R.S. Third Supplement. Part II. (London: Longmans, 1881.)

WE have no publication in English strictly corresponding to *Liebig's Annalen* or the *Annales de Chemie et Physique*, and were it not for this now gigantic dictionary of chemistry by Mr. Watts many, both advanced and elementary students of our science, would find their labours considerably increased by the necessity of having to hunt up a great number of facts and records of work done in foreign journals. The chemical record in this volume includes discoveries made in 1880, and in addition a number of exhaustive articles by Professors Armstrong, on Isomerism; G. C. Foster, on Thermodynamics; Schuster, on the Spectium; Thorpe, on Specific Volumes; and others. This part commences with G, the first large articles being Gallium and Gases, the latter being very complete and up to date. A long section is devoted to Heat, which, with the article on Thermodynamics, is very valuable. In the portion on Isomerism we are very glad to notice a slight but still important definition, or rather restriction of the term isomeric. That is, bodies should only be classed as isomeric when their reactions indicate that they are of the same type of structure. This article is of some length, and contains the main points of the hypotheses brought forward by Van l'Hoff and Le Bel and others. We thoroughly agree with the concluding paragraph of the article, and venture to add that probably when we do know a little about the loss or gain in energy in the case of reacting molecules the terms saturated and unsaturated atoms will cease to be employed. The article dovetails into the one on Light, and together they form an important fraction of the book. The greater part of the volume is of course taken up by "organic" and physical chemistry, a considerable number of mineral substances being however described, the section on the metals allied to yttrium being very interesting. The references to the original papers attached to each article render the work even more valuable to those chemikers and physikers to whom a few languages is no difficulty. Although a dictionary, it is very thick, and probably an index would facilitate the search after any particular description; but the want is a minor one.

W. R. H.

LETTERS TO THE EDITOR

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

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

The Madeira Earth-electric Cloud again

WHAT a valuable paper, Mr. Editor, you have published this week from Mr. J. B. N. Hennessey, with its diagram of the new set of sun-spots which broke out suddenly near the centre of the sun's disk, between 4h. and 5h. p.m., on July 25, as recorded by the photo-heliograph of the Indian Trigonometrical Survey, under his able charge, at Dehra.

His enthusiasm at having localised the appearance of the phenomenon in time, as well as space, is unexceptionable; and his long experience as an observer gives his opinion commanding weight, when he further holds forth on the rarity of such an occurrence, on such a scale and so centrally situated on the sun's disk—whence its probable vast importance for the physics of the earth and the foundations of a new science. All that is admirably true and suggestive for the future; but meanwhile I desire to claim the first fruits of the case as the very thing I have been expecting ever since I left Madeira at midnight on July 29.

And why should I have been expecting such an announcement, do you ask? Well, do you remember my letter to you from

Madeira on June 27 (NATURE, vol. xxiv. p. 212, with a sequence on p. 237) describing the extraordinary cloud that appeared there on June 26, alarming all the inhabitants, the typically "oldest" of whom declared they had never seen such a cloud as that before? It was, too, in very truth a most remarkable affair; and seemed to me only to admit of full explanation as a peculiar case of the earth answering by escape of its interior electricity to the sun; where, according to my own daily solar diagrams, there had just occurred an outburst of solar spots very nearly over the ends of the solar radii that were then pointing towards the earth.

Weeks passed on without anything to interfere with, or undervalue, that explanation; when lo! on July 26 (the very same day, curiously enough, of the next month) another cloud appeared over Madeira, of just the same peculiar physical character as that of June 26. "Why," were inclined many visitors to ask, "is this kind of cloud, in spite of the asseverations of the 'oldest' inhabitants, no very great rarity after all in this part of the world?" There had been certainly thus two cases of it occurring with a very short interval between them; but nevertheless, I was inclined to respect the assertions of the greybeards; and said, "Something unusual must again have happened in the sun; but as my observatory was dismantled on July 23, and the component parts of it packed up ready for shipment on July 25 and 26, I had not then any knowledge of what it might be." Now, however, see how perfectly Mr. Hennessey's Indian solar photographs fulfil all that was required to make this second Madeira cloud phenomenon an exactly similar cosmical case to that of its mensual predecessor; or to testify that an extraordinary, unusual, most sudden outbreak of solar spots did take place over the very part of the sun's surface turned towards the earth late on July 25, and within twenty-four hours afterwards the earth-electric cloud made its appearance above Madeira, where it was thus noted in my pocket journal:—

"Tuesday, July 26.—During this afternoon there was a great cloud-structure formed to the west, with all the characteristics of smooth-rimmed lenticular strata under strata, and the topmost visible one breaking out into fringes of cirro-cumuli, that marked the still grander cloud of June 26." This one was however very splendid after sunset, and when the red tints thereof had faded from it they were replaced by the richest and purest browns, of the burnt-umber variety, I have ever beheld in the sky. The cloud was vertical over the lower southern slopes, almost the southern sea-shore of Madeira; not over the high peaks of the island, in so far at once pointing to a different origination from Dr. Muirhead's (of Cambuslang) cloud in NATURE, vol. xxiv. p. 237. That cloud was an affair plainly of the cold of a snow-covered mountain-top in Britain, and is just such an ordinary local production as any one can see for a large part of the year on the South African hills round about Table Mountain and Table Bay—whenever the south-east trade-wind blows over that country. For there, day after day, it produces very clumsy-shaped masses of vapour either on, or vertically over, the tops of the hills, according to their respective absolute elevations. But never once, during ten years, did I see any approach in the arrangement of the constituent particles of those clouds to the neat, refined, peculiar shapes of what formed the most conspicuous characteristic of the two successive Madeiran earth-electric clouds of June 26 and July 26. They had each been preceded by as peculiar, as rare, a central outburst of solar activity, and probably required no less for their due manifestation, as well as the performance of their functions in cosmical electric radiations and exchanges.

PIAZZI SMYTH,
Astronomer-Royal for Scotland
15, Royal Terrace, Edinburgh, September 30

American Cretaceous Flora

I HAVE only just read Prof. Newberry's clear and concise account of the American Cretaceous series (NATURE, vol. xxiv. p. 191). I regret that I am still unable to agree with him that the relative ages of American and European Cretaceous beds are satisfactorily correlated. I should not again venture to insist so strongly on what must seem to Dr. Newberry to be but an individual opinion, except that he seems to expect a reply, and I have further some new evidence to bring forward. Of my opinions the one to which he takes most exception seems to be that "no American or European so-called Cretaceous land flora can be proved to be as old as our White Chalk." It is this statement therefore which I must substantiate.

In America the plant-beds of Vancouver's Island contain many Angiosperms, and are said to be of the age of the Gault or Upper Greensand, and the Dakota group, which has yielded one hundred distinct species of Angiosperms, is said to be older than our Chalk. The Colorado group is said to represent not only our Grey and White Chalk, but the Mästricht beds. Even the Laramie group or "Lignite series" is placed in the Cretaceous system. I have unfortunately not the books requisite to re-examine critically the American evidence, and must therefore confine myself to stating that which on this side of the Atlantic tends to show the relative age of the American series to be very considerably overestimated. I would propose, however, to Prof. Newberry an exchange of the more abundant Cretaceous mollusca, in order that they may be compared together; after which I might possibly find myself able to visit some of the American sections. This I should the more like to do, as I happen to be acquainted both with the Cretaceous and Eocene mollusca, and with the floras, of England—the very evidence, in fact, upon which the respective ages of the series is to be decided.

In the first place I am able to assure Prof. Newberry most positively that on plant evidence the Laramie series must be bracketed, if anywhere, with our Middle Eocene. Not only is the facies of the flora identical, but identical species appear in both continents in these series. I cannot yet give a list, but I would particularly point to such highly characteristic species as *Lygodium Kaulfussi*, Heer (syn. *L. neuropteroides*, Lesq.), and *Anemia subcretacea* (Saporta) (syn. *Gymnogramma Haydenii*, Lesq.), which were identified by Lesquereux himself after comparison with actual specimens which I forwarded to him. These are fully described in the Palæontographical Society's publications, which I hope Prof. Newberry will glance through. We have beyond all question, in the first stage of the great "Lignite series," a common line to work from, and the age of this line is, assuredly, according to the plants, that of our Middle Bagshot series. Below our Middle Bagshot there is, in France and England, a vast series of Eocene deposits containing many distinct floras of most dissimilar types, and about which, in many cases, scarcely anything is known. Even at the base of these we are very far from the age of our Chalk, we have still an obscure series of local deposits which to some extent bridge the gap between our Secondary and Tertiary periods. Some of the most noted of these deposits I have recently visited.

The highest, I believe, of these so-called Cretaceous beds in Europe is the coral deposit of Faxoe. Its solitary claim to be considered of Cretaceous age is a *Pleurotomaria!* It has no Cephalopods except *Nautilus* and *Aturia zic-zag*, and not even the persistent *Inoceramus*. Except Pleurotomaria, the mollusca are all more of Eocene than Cretaceous type. *Cypræas* are abundant, and there is a *Mitra*, *Triton*, *Voluta*, *Turbinella*, a *Rostellaria* and *Ampullaria*, &c.

In the underlying "Faxœlaget" the Cretaceous element is reinforced by *Baculites* and *Scaphites*. In the Greensand of Bornholme, *Belemnites* and *Inoceramus* are added; and finally, in the Chalk of Moen, a smooth *Ammonite*, one or more large *Hamites*, and a variety of other Cretaceous types appear. We have thus a clear passage downward into the Cretaceous series; but even the age of the Moen's Chalk is not quite definitely known, for the supposed *Belemnitella*, which apparently fixed its zone, is in reality a *Belemnite*. A few forms, however, seem to link it slightly with the Greensand of Aachen, whose age I shall now consider.

The highest of the Aachenian series is Chalk with flints. In this mollusca are few; but this is of less importance, since the Chalk rests upon Greensand, in which they abound. The fossils are in much the same condition as at Blackdown, and among them are about sixteen apparently Gault and Blackdown species. The greater part of the latter are however carried up into our Grey Chalk, where they cease simply, as far as we know, because the succeeding beds were not fitted to preserve them. These shells are mixed with others, about thirty species, of Tertiary aspect, including *Voluta*, *Murex*, *Turbo*, *Fusus*, *Pyrula*, *Borsonia*, *Bulla*, *Turritella*, *Corbula*, *Tellina*, *Cytherea*, *Lucina*, *Pectunculus*, &c., and *Clavagella*. The presence of *Bellemnitella mucronata* and *B. quadrata*, together with *Baculites*, also point to its being at least younger than the Lower Chalk. Below these are the sands with Dicotyledons. The flora these contain, while mainly unlike that of the Eocene, possesses nevertheless some types of leaves which appear identical with Eocene forms, and is of the highest importance in comparing the American

Cretaceous series. I need not refer to the Mästricht beds, except to notice that a mixture of Tertiary and Cretaceous types of mollusca is also apparent in them. One circumstance, however, lessens the value of the evidence presented by the mollusca and the flora; we are so little acquainted with either the Gastropods, the Dimyaria, or the plants of the White Chalk age, that it is possible these may have inclined more to Tertiary types than those of the Grey Chalk would lead us to suspect.

I believe that in the American Cretaceous molluscous faunas there is precisely the same mingling of types described above, and if so, they should surely be bracketed together, rather than with our Neocomian Gault, or even Grey Chalk, which present no such mixture and contain few Tertiary types, except in unimportant groups, as Dentalium. Further, we must not overlook the oft-repeated negative arguments that we have no dicotyledonous plants of these ages in Europe, and that *Baculites*, &c., may have survived longer in America than in Europe. The whole series in America forms, so far as I gather, a natural sequence, the age of one part of which, the Laramie, can be fixed as Middle Eocene, and I think, before correlating the remainder with the older Cretaceous beds of Europe, with which neither their fauna nor flora agrees, the position occupied in the American series by the older Eocene, and the transition beds which I have enumerated, should be as far as possible ascertained. The matter is thus still, and must remain for the present, in an unsatisfactory state; but the importance of removing all doubt as to the relative position of those American beds which have yielded such magnificent palæontological data, and of the more typical British strata, is so great that I hope Prof. Newberry will not let the subject drop.

J. S. GARDNER

Gradations between Hermaphroditism and Gynodiœcism

ABORTION of the stamens in some portion of the flowers occurs in different species of the genus Dianthus. *D. superbus* has been shown to be gynodiœcious in my work on "Alpenblumen" (p. 202, Fig. 79). *D. deltoides*, the only species growing near Lippstadt, has lately been examined by myself, and has been found under certain circumstances to become gynomonœcious and gynodiœcious. Of *D. Carthusianorum* among 167 flowering stalks sent me from Thuringia by my brother, Wilhelm Müller, there were two producing female flowers with greatly aborted stamens. *D. deltoides* near Lippstadt offers interesting gradations from hermaphroditism to gynodiœcism. On the border of a meadow of some hundred stems examined by myself, all flowers, without exception, proved proterandrous, with normal development of anthers and stigmas. In the grass-grown slope of a sandy hill ("die Weinberge") likewise all stems produce proterandrous flowers, but on many stems the stamens, although emerging above the petals before the development of the styles and stigmas, bear diminished whitish anthers not opening at all, and containing only some shrivelled pollen grains. Lastly, in a barren sabulous locality ("Schützenplatz") many of the stems produce female flowers, with stamens aborted in the same degree as shown in *D. superbus* ("Alpenblumen," Fig. 79 D), and not unfrequently such female flowers and proterandrous hermaphrodite ones are found on the same stem.

Lippstadt HERMANN MÜLLER

Red Stars

DR. DOBERCK, who has paid particular attention to colour in his observations of Doubles, has kindly sent me the following list of red stars found by him in 1880. The first column gives the number, and the second and third the positions (for 1855) in the B.D.:—

No.	α h. m.	δ ° ′	Colour.	Date in 1880.
+ 4°·877	... 5 7	... 4 59	... Red	... Jan. 30
*	... 3 12	... ±64	... Glowing red	... Feb. 8
5·1790	... 7 40	... 5 46	... Ruddy	,, 14
20·1775	... 7 13	... 20 42	... Pale red	,, 14
22·1198	... 6 1	... 22 13	... Pale red	,, 14
26·2250	... 11 37	... 26 2	... Red	... March 8
33·4456	... 22 6	... 33 53	... { Red, but very pale ... }	Sept. 10
20·5386	... 23 45	... 20 51	... Pale red	,, 10

* Dr. Doberck does not give the number of this star, but it seems to be, probably, 64°·391.

Dr. Doberck remarks that the two stars on both sides of η *Draconis* are pale red; and in *Coma Ber.* and south of it are several ruddy stars.

J. BIRMINGHAM

Millbrook, Tuam, September 18

Bombay Rainfall and Nile Floods

IN looking over data of the rainfall at Bombay and comparing them with the ebb and flow of the Nile for the corresponding years from 1849 to 1880 inclusive, I was so struck with the similarity, almost identity, of magnitudes, that I have been led to copy them out, and perhaps you may consider them worthy of publication in your most valuable journal. Within a trifling fraction the whole of the annual rainfall at Bombay happens in the months of June, July, August, and September. Very rarely a little falls in May, perhaps a little more frequently, some in October, but these small quantities but slightly augment the sum total. They are included in the four months' totals in the following table:—

Year.	Rainfall of June and July in Bombay.	Ditto June, July, and August in Bombay.	Ditto June, July, August, and September in Bombay.	Variation from mean atmospheric pressure.	Lowest ebb of the Nile.	Highest flood of the Nile.	Wolf's sun-spots.
	inches.					feet.	
1849	74·5	88·16	118·88	− ·011	1·64	22·31	95·4
1850	36·5	43·11	51·15	− ·001	1·64	18·47	69·8
1851	77·7	101·3	106·14	− ·013	1·8	23·13	63·2
1852	49·59	60·25	75·46	− ·004	2·59	16·73	52·7
1853	52·71	61·27	69·65	+ ·005	·9	23·01	38·5
1854	55·23	74·43	89·79	− ·005	1·8	22·81	21·0
1855	24·98	28·13	35·10	+ ·015	2·85	16·5	7·7
1856	52·40	62·93	71·08	− ·003	1·3	22·81	5·1
1857	38·92	60·93	79·23	− ·001	1·42	18·7	22·9
1858	37·92	49·37	61·9	+ ·003	·32	19·52	56·2
1859	59·86	75·57	81·84	+ ·003	·29	19·65	90·3
1860	57·69	66·88	74·65	− ·003	·08	23·42	94·8
1861	66·43	102·95	106·08	− ·012	1·8	23·32	77·7
1862	38·35	62·0	76·56	− ·026	1·8	16·53	61·0
1863	58·33	71·8	80·33	− ·017	4·13	21·78	45·4
1864	39·37	51·39	56·60	+ ·023	4·59	14·43	45·2
1865	30·6	69·61	73·46	+ ·002	3·11	18·47	31·4
1866	64·63	88·5	92·39	+ ·013	2·54	23·2	14·7
1867	44·93	62·06	73·57	+ ·015	2·29	19·3	8·8
1868	47·83	71·78	78·43	+ ·027	2·16	17·1	36·8
1869	58·49	87·2	115·39	+ ·005	1·57	23·01	78·6
1870	53·39	64·48	81·06	− ·012	1·88	22·81	131·8
1871	30·37	39·33	47·2	− ·004	2·29	21·98	113·8
1872	60·59	71·21	67·61	− ·014	1·23	22·7	99·7
1873	38·69	75·61	87·42	+ ·002	1·64	19·35	67·7
1874	67·54	78·78	93·56	+ ·001	·98	25·82	43·1
1875	42·79	58·70	88·08	·0	1·31	21·8	18·9
1876	40·87	52·81	58·93	+ ·007	− 1·88	21·37	
1877	51·99	55·9	70·96	+ ·037	− 1·96	16·8	
1878	73·73	95·63	123·1	− ·011	− ·72	26·18	
1879	36·95	66·22	73·41			25·03	
1880	38·79	43·55	71·23			21·45	

The floods of the Nile are mainly caused by the heavy rains which descend upon the high tablelands of Abyssinia, a range of mountains on the opposite side of the Indian Ocean to that of the Ghauts, but parallel to them and under the same latitudes. The inference to be drawn is obvious. The great south-west monsoon which sweeps over the Indian Ocean in the summer months produces a like effect in both cases, inducing fertility and plenty, alike on the plains of the Concan of India and the Delta of Egypt. It may be mentioned that the lowest ebb of the Nile always happens in June, and the highest flood about the end of September and the beginning of October. I have included in the table a column showing the variations of the mean barometrical pressure, and a column giving Wolf's observation of sun-spots, taken from NATURE, vol. xxi. pp. 477–82.

MORGAN BRIERLEY

Port Said, September 8

THE INTERNATIONAL EXHIBITION AND CONGRESS OF ELECTRICITY AT PARIS[1]

II.

THE most crowded place in the Exhibition is the *Théâtre de l'Opéra*. Here from eight to eleven on three evenings in the week are to be seen four long *queues* waiting for their turn to enter one of the four rooms where the mysterious music is to be heard. Round the walls of each room are hung telephones in pairs, some twenty pairs in all, and the same number of persons are admitted. On putting the telephones to your ears you hear the music which is being performed at the opera-house more than a mile distant. Some of the singers seem to be on your right hand, others on your left, and it sometimes happens that a particular voice is quite piercing in its loudness. There are in fact ten transmitters disposed along the front of the stage, near the footlights, and ten wires leading from them, two of which are connected with the telephones intended for your two ears. Special precautions are taken to prevent the action of the transmitters from being disturbed by the tremors of the boards under the feet of the actors, the transmitters being supported on india rubber and loaded with lead. The telephonic apparatus employed is that of the Ader system.

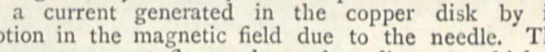
The greatest novelty as regards principle is exhibited in Dolbear's telephone, in the United States department. The receiver has no magnet, but has two parallel metallic plates near together, and electrically insulated from each other. One of them is connected with the line wire, and the other (in the specimen here exhibited) with the return wire. These two wires are connected with the terminals of the secondary coil of a small Ruhmkorff at the sending station; and the voice of the speaker produces variations in the primary current, on the usual plan of varying the resistance in the circuit of a local battery by variations of pressure. The secondary circuit is not completed, inasmuch as the two plates do not touch; but the opposite electricities which are transmitted to them attract each other on electrostatic principles, and the plates are thus made to vibrate in unison with the voice of the speaker at the sending station. The instrument exhibited is very effective, and reproduces a whisper with greatly increased intensity. It is claimed that this invention does away with the disturbance experienced in other telephones from currents in neighbouring wires, inasmuch as such currents will not affect the attraction between the plates. We should add that the instrument exhibited speaks fairly even when the plate next the ear is disconnected from the wire intended for it, but of course less loudly than when the connection is made. This is just what one would expect from electrostatic attraction, the attraction of a charged for an uncharged body being less than that between two bodies oppositely charged.

We have had an opportunity of seeing the system adopted by Mr. Edison for the measurement of the quantity of electricity consumed in each house which receives a supply from one of his mains. A definite proportion (one thousandth part) of the whole current which goes through the house is shunted through a cell containing two copper plates in a solution of sulphate of copper. The positive plate loses, and the negative plate gains, an amount of copper exactly proportional to the quantity of electricity which passes. There are two such cells in series, one serving as a check upon the other, and the whole arrangement is kept under lock and key, to be opened only by Mr. Edison's agents when they come round to inspect the meters. As the lamps supplied (of a given type) are almost precisely alike in their resistance, and the current, when flowing, is always nearly the same, this arrangement gives a practically accurate measure of the illuminating power supplied.

Much interest has been excited by the exhibition of three magneto-electric machines constructed by Prof. Pacinotti of the University of Cagliari. One of these, constructed at Pisa in 1860, is the earliest example of the principle of the ring-shaped armature, since embodied in the machines of Gramme and Brush. It was originally constructed as an engine to be driven by a current from without; but it was also used as a generator of electricity, and both these uses of it were described in a paper in the *Nuovo Cimento* in 1864. The machine contains an iron ring like an anchor ring, round successive portions of which are wound coils of insulated copper wire in depressions cut in the ring to receive them. The intervening portions of the ring are thus (as in the Brush machine) enabled to come very nearly into contact with the surrounding fixed magnets. These consist of two half rings which are the pole pieces of two straight electro-magnets. The coils above mentioned are connected in a series, and their junctions are in connection with the several segments of a commutator, as in the Gramme machine.

The second machine was constructed in 1873, and described in the *Nuovo Cimento* in 1874. It is a generator of electricity, of the kind now known as the shunt dynamo, that is to say, the current generated is divided in parallel circuit between the fixed electro-magnet and the external resistance. This is done by means of two pairs of brushes making contact with different sections of the revolving commutator. The ring is replaced by a flat cylinder, across which the successive coils are wound in depressions made for the purpose, the directions of winding being the same as in Siemens' continuous current machine, which was invented about the same time. The connections of the successive coils with one another and with the segments of the commutator are the same as in the first machine.

The third machine, which was constructed in 1878 on a model dating from 1875, is of a type of which, so far as we know, it is the only example. The idea of it is taken from the well-known experiment (Arago's rotations) in which a revolving horizontal copper disk causes a large magnetised needle balanced above it to revolve in the same direction. The explanation of the effect was first given by Faraday. It depends on the action of a current generated in the copper disk by its motion in the magnetic field due to the needle. The strongest current flows along that diameter which is parallel to the needle, and the current is completed through the circumferential portions of the disk. Pacinotti virtually cuts away all except the diametral portion and one of the two circumferential portions; in other words, he takes a wire and bends it into the shape of the letter D. This is one convolution of his revolving coil; the next is like the same D tilted a little; the next is tilted a little more, and so on; so that some of the convolutions have the positions—



the straight part of the wire passing through or nearly through the axis of the coil, and the curved part being in the circumference. There is no room for a core in the ordinary sense, as the wires occupy nearly the whole interior space; but pieces of iron are so disposed partly within and partly without the coil as to serve the purpose of a core, by increasing the induction of the fixed magnets.

(*To be continued.*)

[1] Continued from p. 512.

ILLUSTRATIONS OF NEW OR RARE ANIMALS IN THE ZOOLOGICAL SOCIETY'S LIVING COLLECTION[1]

IV.

8. *THE White-nosed Saki* (*Pithecia albinasa*).—The peculiar American monkeys which belong to the closely-allied genera *Pithecia* and *Brachyurus* of naturalists, and are generally known as "Sakis"—a name probably derived from some Indian term—are restricted to the forests of Guiana and Amazonia, and seem to have in the case of each species a very restricted geographical area of distribution, one of these monkeys not intruding within the limits of another. As regards the genus *Brachyurus*, which is little more than *Pithecia* with a shortened tail, Mr. W. A. Forbes has lately shown this to be the case, in an article published in the Zoological Society's *Proceedings*,[2] wherein, after describing the anatomy of *Brachyurus rubicundus*, he has given a map to illustrate the distribution of this and the two allied species of *Brachyurus*. Each of them is limited to a peculiar district of Amazonia, one (*B. melanocephalus*) to the forests of the Rio Negro, a second (*B. calvus*) to those lying between the Putumayo and the Japurá, on the north bank of the Amazons, and the third (*B. rubicundus*) to the district contained between the main stream and the Rio Ica.

In like manner the few particulars which have yet been recorded as to the exact localities of the *Pitheciæ* seem to tend to similar conclusions. Although we must suppose them, in obedience to the laws of descent, to have originated in common ancestors, they now occupy restricted areas cut off from one another, and in some cases rather widely separated. Why, in this as in similar cases, the form should have ceased to exist in the intermediate districts, is a subject on which it is at present difficult even to offer a conjecture.

The *Pitheciæ* are easily divisible into two sections—one embracing the curly-haired species, such as *P. leucocephala*, *P. monachus*, and their allies, and the other the smooth-haired forms, such as *P. satanas* (commonly called by the dealers the Jew-Monkey), and *P. chiropotes*. The White-nosed Saki, of which a figure is herewith given (Fig. 8), belongs to the latter group, and is one of the rarest and least known of the South American monkeys. A single example of it was obtained by the French collector Deville, on the Upper Amazons, during his descent of that river in company with de Castlenau's celebrated expedition, and is now in the Paris Museum. It was first described by Deville and Isidore Geoffrey St. Hilaire jointly, in 1848, and subsequently figured in the "Zoologie" of Castlenau's expedition, but the exact locality where it was procured was unfortunately left unrecorded.

Fig. 8.—The White-nosed Saki.

The example of this monkey, lately living in the Zoological Society's collection, was purchased of a dealer in January last. It is uniformly, but rather sparingly covered with black hairs. The nose is broadly naked, and of a bright fleshy red, but shows a few white hairs between the nostrils, which are sufficient to justify its scientific name. The long hairs on the head fall on both sides of the head and over the front. The length of the body is about fifteen inches, of the tail eighteen inches. The latter organ, although clothed with elongated hairs, appears to be slightly prehensile. The specimen is of the female sex, apparently not fully adult.

9. *The Mountain Nestor or Kea* (*Nestor notabilis*).—Whatever may have formerly been thought to the contrary, there can be now no doubt that animals are continually changing their habits in order to suit themselves to the altered circumstances of their existence. A very familiar instance of this is that of the common swallow, which, in Europe at least, usually builds its nest in chimneys. Before chimneys were invented it must obviously have affixed its nest to some other chimney-like structure—probably to the inside of a hollow tree. But a much more striking and less laudable change of habit has of late years taken place in a New Zealand bird, of which we herewith give an illustration (Fig. 9). Parrots, though varying much in the details of their diet, are generally considered to be altogether frugivorous. Fruit and seeds, and in certain special cases moss and honey, are, no doubt, their proper food. But since the introduction of the domestic sheep into New Zealand the Mountain Nestor, which was previously content with a modest repast of an entirely vegetable character, has developed a taste for mutton. Many instances have now been recorded of this bird attacking not only sick and dying sheep, but, it is alleged, even those that are strong and healthy, though we should hardly suppose that this parrot exists anywhere in sufficient numbers to be likely to do the flock-masters any serious injury.[1]

[1] Continued from vol. xxiii. p. 489.

[2] "On the External Characters and Anatomy of the Red Ouakari Monkey (*Brachyurus rubicundus*); with remarks on the other species of that Genus." By W. A. Forbes, B.A., F.L.S., Fellow of St. John's College, Cambridge, Prosector to the Society.—*P. Z. S.*, 1880, p. 627.

[1] From the interesting article by Mr. Potts on the habits of this parrot just

The individual of this species now in the Regent's Park collection, from which the drawing has been taken, was transmitted as a present to the Society by Dr. A. de Lautour of Otago, New Zealand, along with the subjoined particulars concerning it, contained in a letter addressed to the secretary:—

"I have the pleasure of informing you that I am sending home an example of the Kea (*Nestor notabilis*), or Mountain Parrot, a bird celebrated, or rather notorious for its sheep-destroying proclivities.

"Many abler pens than mine have already written about their habits; but I was fortunate enough to be perhaps the first to send home a specimen of their work in the shape of the colon and lumbar vertebræ of a sheep, in which colotomy had been performed by one of these birds.

"This specimen was shown at a meeting of the Pathological Society by my friend and former master, Mr. John Wood, F.R.S., and is now in the Museum of the Royal College of Surgeons of England.

"The bird which I am now sending home has been in my possession for nearly two years. It was caught in the act of attacking some sheep which a shepherd was bringing down off the tops of some ranges in the back country. He luckily succeeded in knocking it over with a stone, cut its wings, and brought his captive down. In effecting the capture the shepherd suffered considerable loss as to his trousers and other garments, and not a little injury in scratches from its formidable beak and claws. These same scratches had not entirely healed when he came down here under my care some ten days later, suffering from a broken leg (this by the way was not done by the Kea).

"While I have had the Kea, his diet has consisted mainly of mutton, raw; he does not care for cooked meat, but will take it if very hungry. Occasionally he will take beef, and he is fond of pork. Popularly he is said to prefer fat, but in confinement he chooses the lean and leaves the fat; he does not care for biscuit, but he likes the seed of the sow-thistle."

Again, in his excellent work on the birds of New Zealand, Dr. Buller tells us that the "*penchant* for raw flesh exhibited by this parrot in its wild state is very remarkable. Those that frequent the sheep-stations appear to live almost exclusively on flesh. They claim the sheeps' heads that are thrown out from the slaughter-shed, and pick them perfectly clean, leaving nothing but the bones." An eye-witness has described this operation to Dr. Hector as follows:—"Perching itself on the sheep's head or other offal, the bird proceeds to tear off the skin

FIG. 9.—The Mountain Nestor.

and flesh, devouring it piecemeal after the manner of a hawk,

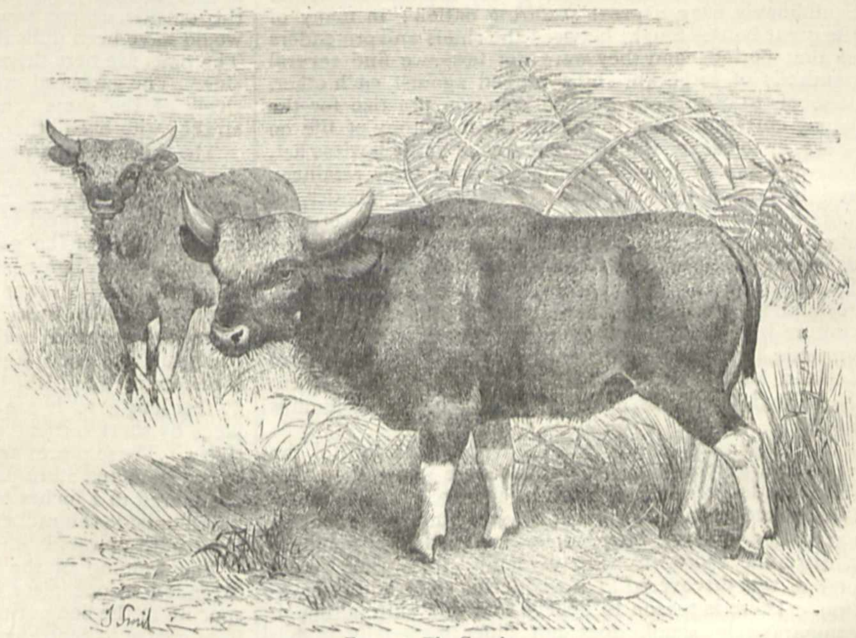


FIG. 10.—The Gayal.

or at other times holding the object down with one foot, and with the other grasping the portion it was eating, after the fashion of ordinary parrots. The plan usually adopted on the stations for alluring this bird is to expose a fresh

published (in the *Zoologist* of the present month), it would seem, however, that the losses sustained by the attacks of the Kea are in some cases very serious.

sheepskin on the roof of a hut; and whilst it is engaged in tearing up the bait it is easily approached and snared."

10. *The Gayal* (*Bibos frontalis*).—In the mountainous districts of the oriental region three fine species of wild cattle occur which do not belong strictly to the genus *Bos*—the supposed progenitors of our domestic herds—but to a slightly modified form, *Bibos* of naturalists. One of these—the *Gaur*—inhabits the Ghauts of Central India, and is the well-known "Bison" of Anglo-Indian sportsmen. The Gaur is very intolerant of captivity, and although many attempts have been made to rear young specimens for transmission to Europe, none of them have ever proved successful. A second species of *Bibos*, the Bantang (*B. javanicus*), is found only in the hills of the Malay countries. It is more tractable, and examples of it have occasionally reached Europe alive, though they have not done well in this country.

Of the third *Bibos*, the Gayal (*B. frontalis*), we give a figure taken from a fine pair of these animals now in the Zoological Society's Gardens, which were received from the sister Zoological Society of Calcutta. The Gayal, as Jerdon tells us, in a state of nature inhabits the hilly tracts to the east of the Brahmapootra and at the head of the Valley of Assam, extending into the Mishmi Hills and adjacent ranges. It is caught and kept in captivity by the natives very extensively, and to this fact is no doubt due the comparative ease with which specimens of it are brought to Europe.

The Gayal breeds readily with the different forms of Domestic Ox. Many hybrids between the Zebu and Gayal have been produced in former years in the Zoological Society's Menagerie.

SHIPBUILDING A THOUSAND YEARS AGO

MR. COLIN ARCHER read an interesting paper on this subject at the recent meeting of the Institution of Naval Architects, as also at the York meeting of the British Association.

It is a well-known historical fact that as far back as the early part of the Middle Ages, the inhabitants of Scandinavia were a great seafaring nation: in many of the great battles fought between the chiefs and pretenders of that period—and they were not few—we find several hundreds of large war-ships ranged against each other. It seems to have been quite a common practice for the young chiefs, in order to relieve the monotony of life on shore, or to escape the consequences of some lawless act, to equip one or more ships, manned by their retainers, and to launch forth in quest of adventure, plunder, or "the bubble reputation." And these excursions were not always confined to home waters; they were frequently extended not only to the coast countries of the north of Europe, but also to the shores of the Mediterranean. Iceland was discovered about the middle of the ninth century by Norwegian adventurers, and there are good grounds for believing that an expedition starting from Iceland landed and established a colony in the present New England States nearly 500 years before Columbus lived.

But the descriptions which the old Sagas afford of the vessels in which these expeditions were undertaken, and these battles were fought, are very meagre. It was therefore looked upon as an event of great interest when, on excavating a large grave-mound near the entrance to Christiania Fjord, a ship, evidently from the Viking period, was discovered in a wonderful state of preservation. There is reason to believe that this ship, although comparatively small, does not differ materially in her manner of construction or in shape from the more powerful war-ships, or from those used for long voyages. She is probably a true model of the ships which carried Rollo and his brave followers to the coast of Normandy; and it may therefore be assumed that a brief description of her, as she now appears from a shipbuilder's point of view, may not be without interest.

It was not to be expected that a delicate structure such as this Viking ship could remain for eight or ten centuries buried many yards under ground without sustaining some damage, or that she should perfectly retain her original form. It is rather a matter of surprise that the damage is so small as it is. Thanks to careful handling and a judicious arrangement of supports, there is reason to believe that, apart from local strains and contortions of form, the hull as it now stands represents very closely the ship as she appeared when put into the ground. Mr. Archer has taken off her lines with as much accuracy as circumstances would permit, and, referring to these lines, he explains the chief peculiarities of the construction.

The principal dimensions are:—

	Feet.	Inches.
Length between the rabbets at gunwale	77	11
Breadth, extreme	16	7
Depth from top of keel to gunwale amidships	5	9

The vessel is clinker built, and the material all oak. There are sixteen strakes of outside planking, the ordinary thickness 1 inch, average breadth amidships 9½ inches, including 1 inch land. The lengths vary from 8 to 24 feet. The scantling is not, however, uniform throughout; thus the tenth plank from the keel is about 8 inches broad and 1¾ inches thick, and forms a shelf for the beam-ends. The fourteenth plank from the keel, or third from the top, is about 10 inches broad and 1¼ inch thick. This plank, which we may call the "main wale," is perforated with holes for the oars, sixteen on each side, about 4 inches diameter, and provided with a slit at the after and upper edge to allow the blades of the oars to be passed through from inboard. The two upper strakes are the thinnest of all, being scarcely more than ¾ inch. The gunwale, 3 inches by 4½ inches, is placed in the usual manner inside the top strake. The boards are throughout united to each other by iron rivets about the thickness of an ordinary 3 inch spike, spaced from 6 to 8 inches, with large flat heads 1 inch diameter. The riveting plates are square or nearly so, ¾ inch. The nails are driven from the outside, except near the ends, where riveting inside would have been difficult from the sharpness of the vessel. The nails are here driven from the inside and riveted outside. The garboard strake is fastened to the keel with rivets of the same kind as those used for joining the strakes with each other.

The keel is of a peculiar shape; it is about 14 inches deep, of which 11 inches are below the rabbet, 4½ inches thick at the lower edge, and only 3 inches at the rabbet. The top of the keel is 7 inches broad, thus affording a large surface for the garboard strake, besides combining strength with lightness. Possibly also the increased thickness of the lower edge may have been adopted to improve weatherliness under sail. It is difficult to say where the keel ends and the stem and sternpost begin, as these run into each other with a very gentle sweep; but the piece of wood which may be called the keel proper is 57 feet long; to it are joined a short forefoot and heel piece by short vertical scarfs secured by double rows of rivets. These pieces again are fitted in a similar manner to the stem and stern-post. The posts are sided 3 inches, chamfered to 2 inches outside edge. They are 15½ inches broad outside the rabbet just above the scarf, decreasing in breadth upwards.

The framing of the bottom consists of grown floors extended in one piece from shelf to shelf. The average spacing in the body of the vessel is about 3 feet 3 inches from centre to centre, greater at the ends: there are nineteen frames in all. The floors are neatly finished, of a shape which combines strength with lightness and elasticity. The lower surface has a flat projection in which are holes for receiving the fastenings for the plank. The way these fastenings are managed is very peculiar. The planks are evidently worked down from stout slabs, and in doing so a ledge an inch high has been left on the inner surface running along the middle of the plank. The floors are not fayed down on the boards; they have only two points of contact with them, the upper edges and the ledge above mentioned, in which are two holes bored transversely, one on each side of the timber. Through these holes and corresponding holes in a fore and aft direction through the timbers are passed ties made of the tough roots of trees. These ties are very slight, scarcely ¼ inch diameter; they are crossed over the ledge on the board, only passing once through each hole. The ledge has been removed in the spaces between the timbers, so that the remaining parts under the timbers look like cleats fastened to the plank. With the exception of a nail driven through the "shelf" and riveted on the extreme end of the floors, these ties seem to be the only fastenings used at this part of the vessel. The floors are only about 4 inches diameter, a foot from the garboards, and taper, siding as well as moulding, down to 3 inches or even less at the shelf. They are not fastened to the keel.

As already stated, the beams, which are sided 7 inches, moulded 4 inches, rest on what Mr. Archer has called the "shelves," which however only differ from the ordinary planking by being ¾ inch thicker, and of greater lengths, the longest piece being about 48 feet. The beam-ends also rest on the ends of the floor timbers. They are secured by knees extending down the ship's side from the upper edge of the "main wale" with an arm on the beam. These knees are fitted close to the planking at the side, and fastened with oak trenails. Being a little narrower than the beams, a ledge is formed on each side for the bottom boards or flooring, which is made to fit into these ledges from beam to beam, thus forming a continuous platform. A strip of wood is nailed on top of the beams in continuation of the knees where these are too short to welt from opposite sides. The beams are supported amidships by pillars resting on the throats of the floors. The top sides, consisting of the two thin boards already mentioned, are connected with the body of the ship by independent timbers intervening between the knees, and extending from the under side of the gunwale some distance down the side, but not so far as the platform. There are no timbers in the upper part of the vessel, overlapping or making a shift with the floors.[1]

It will be seen that by this system of construction the upper portion of the ship is altogether unconnected with the bottom part, so far as framing is concerned, an arrangement which would scarcely be safe where much ballast or a heavy cargo is carried on the ship's bottom. No doubt heavy weights when carried were placed above the platform, in which case there would not be the same tendency for the two sections to part company.

Perhaps the most singular part of this singular ship is the arrangement for stepping and supporting the mast. The step is a solid log of oak 11 feet long and 19 inches broad by 14 inches deep at the middle, tapering to the ends. It is counter-sunk over the throats of the floors, to which it is fastened by means of small knees on either side. From this trunk a branch grows out vertically in front of the mast and quite close to it. This branch, which is nearly 12 inches thick, is fastened to what Mr. Archer has called the "fish."

The fish is a ponderous piece of oak lying along the middle line of the vessel, on top of the beams, and extending over five spaces. It is 16 feet long, 38 inches broad, and 14 inches deep at the middle. This block is modelled so as to represent the tails of two fishes or whales resting on a flat slab or sole piece about 4 inches thick. The slab is counter-sunk over the beams and well secured to them by knees. A large slice is taken off the back of the fish, the upper surface thus forming two planes inclining to either end. The extreme ends of the tails are only about 3 inches thick above the slab. A slot 5 feet 9 inches long and 12½ inches wide (the diameter of the mast) is cut in the fish from a point a little in front of the middle towards the stern. The mast is stepped through the forward end of this slot, and when erect kept in its place by a heavy slab fitted into the slot. In the end view this slab is shown with the after end raised level with the forward end. By removing the slab and slacking off the fore-stay the mast would be free to fall aft in the slot, and could thus easily be lowered. In order that the beam nearest the mast should not interfere with this manœuvre there is a depression in it which enables the mast to fall back the whole length of the slot.[1] There is a stanchion about 8 feet high, with a cross-beam at top in which are semicircular depressions for the spars to rest in when not in use. There have been three such stanchions.

The mast, which is 12½ inches diameter, has been cut about 10 feet from the foot. The extreme top of one of the spars found in the ship, corresponding in size to the part which remains, has rotted away; but if this spar, as seems probable, is the upper portion of the mast, the whole length may have been 40 feet. There is another spar which looks as if it might have been the yard. It is broken off near the middle, but Mr. Archer estimates its full length at 35 feet, diameter at slings 8½ inches, at arms 3½ inches. Abreast of the forward end of the fish, strong pieces of wood, one on either side, each with two circular sockets, are fitted down between the timbers just above the platform. Possibly one of these sockets may have served as a step for a squaresail boom. The other may have received a pair of shears to give elevation to the fore stay when raising or lowering the mast.

With regard to the rudder, a conical piece of wood sufficiently long to keep the rudder clear of the ship's side is fitted with its base to the outside planking; through a hole bored through the centre of the cone, and a corresponding hole in the rudder, a stout rope is rove, provided with a knot at the outer end and made fast inboard. This rope acts as a pivot, allowing the rudder to be twisted by means of the tiller fitted athwartships. An iron staple near the lower extremity of the rudder, and a small ring bolt at the upper end may have been fitted with guys leading aft to steady the rudder and keep it immersed when the ship was under way. The rudder-head or stem is round, 6 inches diameter. At the pivot it is 7 inches thick, thence decreasing in thickness downwards. The breadth is 15 inches at pivot, increasing to 22 inches at foot. Both edges are bevelled off, particularly the front one, which is reduced nearly to a feather edge. The rudder is all of one piece of wood.

The extreme ends of the vessel are unfortunately gone, so that it is not easy to see how she has been finished off here. The lower planking takes a very decided turn upwards as it approaches the ends, running in fact almost parallel with the posts. If therefore all the wood ends have joined the posts, these must have been very high. It seems not improbable that part of the planking has been received into a rabbet in the gunwale, or in a breast-hook connecting the gunwale with the stem or sternpost. This however is merely a conjecture.

If the old ship can be looked upon as a fair sample of the ships of her time, it is evident that shipbuilding a thousand years ago was something very different from what we now understand by that term. What strikes one most forcibly on seeing this vessel as she now stands is the extreme lightness of her scantling and the total absence of anything in the shape of lining, longitudinal stringers, or similar contrivances for giving what we

[1] This mode of binding the two sides together by means of beams half-way between gunwale and keel is still practised in the west and north of Norway. Even small skiffs are tied together in this way, loose thwarts being placed over the beams, only resting in a notch cut in the knees which secure the beams, while the floor-timbers merely butt up against the beams.

[1] In the Scandinavian languages the technical term for the framing which now takes the place of this colossal structure in our modern ships—the mast partners—is still *Fisken*, the fish.

should consider the strength and rigidity necessary in a sea-going vessel. It would however be unfair to compare her with a ship of modern build of the same size. Even the designation "ship," as applied to her, is apt to convey a false idea. She is in fact a very large sailing rowing-boat.

These ancient vessels may be considered as consisting of two distinct sections, each having its special use and function. The portion above the beams is the hold proper, the useful space. Here the crew had their abode, and here was carried probably all that the vessel had to carry, and this portion is comparatively strong. The material is no doubt here also of small dimensions, but what there is has been judiciously distributed, is of good quality, and has been well put together. It should also be remembered that the weight carried was small in quantity as compared to the carrying capacity, and consisted principally of live cargo, and this kind of loading is much less trying to a vessel in a seaway than a similar loading of dead weight would be. The lower portion of the ship, on the other hand, had a different kind of duty to perform. It had to supply the "form" necessary for small resistance and rapid locomotion, and to float the upper section : keeping this in mind it will be found that her construction gives evidence of a great deal of practical skill and ingenuity. Every part of the vessel is sufficiently strong for the duty expected of her, while at the same time economy of weight of material has been studied throughout. It will be seen that the weight of the superstructure is taken entirely by the floor timbers, the ends of the beams resting on them, while the beams are supported amidships by the props stepped in the throats of the floors. There would therefore be very little stress on the ties of the bottom planking, which latter, there being no counteracting pressure on it from the inside, would always tend to cling to the timbers by the pressure of the water outside. The only weight of any moment which would tend to separate the two sections of the boat is the mast, and this tendency is met by the "branch" of the step being secured to the "fish." Still there can be no doubt that this boat must have possessed a pliancy and mobility in a heavy sea which we should look upon as ominous in a modern sea-going craft. Her real safety consisted in a tough and elastic outer skin, which would be the more invulnerable from not being made unduly rigid at any point. Thus her apparent weakness was her real strength. Mr. Archer has not been able to discover anything deserving the name of a bolt in the whole structure. The stoutest iron fastenings are the rivets in the scarfs of the keel and the nails securing the inside knees, and they are no stronger than ordinary 4-inch spikes.

It seems probable that such a boat would be capable of great speed, even under oars alone; with a fair wind she must have been very fast. Mr. Archer has assumed a low water-line, and finds that at this trim her displacement is 994 cubic feet, or 28·4 tons; area of immersed midships section 24 square feet; extreme length on load-line, 73 feet 3 inches; and draft of water 3 feet 8 inches. Allowing 10 tons for her complement of 100 men with their accoutrements, leaves 18·4 tons for the vessel, with inventory, stores, and equipment, and this allowance is probably ample. The areas of cross-sections are obtained by multiplying the ordinates of the curve by 4 feet.

LEARNED SOCIETIES IN JAPAN

It is now a little more than ten years since Japanese students began to flock in large numbers to the various schools of Europe and America, after the great revolution which completely altered the political, and in many respects the social, organisation of the country. Many of these young men travelled and studied at their own expense; but the majority was selected by the principal Government departments, and the expenses paid from the Imperial funds. For six or seven years the numbers continued without diminution; but soon after the commencement of the Satsuma rebellion in 1877, when the heavy strain on the Imperial Exchequer caused by the suppression of that outbreak began to be felt, it was decided to economise the public expenditure in various ways, and amongst others by reducing the number of those studying abroad at Government expense. The result of this measure, which was forced on the Ministers by unfortunate circumstances, was that many Japanese young men who spent some years in the principal educational establishments of western countries, returned to their own land with a sound training in their respective branches of study. It would not be desirable, even if it were possible, to enter here into the question how far they have fulfilled the hopes with which they were first sent abroad. Many of them have had brilliant careers amongst their foreign fellow-students, and, on the whole, we believe they have done as much as any body of English students, similarly placed, could have in the same time; but it is another question whether they are fitted to assume the places held by the foreign professors and instructors in the various educational institutions of the country. It was to this that the Government looked when they were first despatched to Europe; but, from a combination of causes, it is doubtful whether the laudable and patriotic desire to be, as far as possible, independent of extraneous assistance, has been so completely fulfilled as was originally anticipated.

One result has undoubtedly attended this great influx of men trained after western methods, namely, the thirst for scientific knowledge of all kinds amongst the educated classes in Japan. It is hardly an exaggeration to say that Japanese literature, as an indigenous product, is for the present almost in abeyance. If we examine the monthly catalogue of books for which licence to print is granted by the Censorate in the Home Department in Tokio, it will be seen that a very large proportion is composed of translations or adaptations of European or American scientific or literary works. Besides translations made at the expense of the public departments, we find private individuals throughout the country utilising their knowledge of a western language by translating from it, for the benefit of their countrymen. Thus, not to mention innumerable "Lives" of Wellington and Napoleon, or translations of "Gulliver's Travels," "Robinson Crusoe," and other books of this description, the works of Huxley, Carpenter, Peschel, Darwin, Tyndall, Quatrefages, Lyell, Buckle, Mill, &c., &c., have all been translated or adapted with more or less success for the Japanese reader. Societies, on the European model, have also been formed, and it is with these that we are chiefly concerned at present.

Centuries before the Royal Society of Great Britain was founded men interested in the pursuit of some study or accomplishment in Japan had formed themselves into societies, some of which still exist. Collectors of antiquities, of coins, of the handwriting of celebrated men of ancient times, met at stated intervals to exhibit and discuss the authenticity of their treasures; *go*-players had their own organisation, with branches in all the chief towns throughout the country, and headquarters in the capital, where the leaders met for trials of skill. These latter even had a kind of magazine in which problems for solution were set, and the moves in remarkable games recorded. These meetings generally took place in the evening, at some well-known house of entertainment. There was no formal reading of papers, with discussions afterwards; a member exhibited some new object, related briefly all he knew about it, and asked for any further information that could be afforded by those present. Frequently also these meetings were used for effecting sales or exchanges amongst the members. Some of these old societies still flourish in undiminished vigour, unaffected by the changes which have passed over the country and altered all around them. Amongst these are the *Kō-butsu-sha*, or Antiquarian Society, the Numismatic Society, the Association of *Go*-players, and many of the old assemblies for literary and poetical contests. But the new era has been productive of societies of a more scientific kind, based on the models of learned associations in Europe and America. Founded by students fresh from abroad, they have received the support of men of wealth and eminence, and, judging from the experience of the past few years, they seem in a fair way to attain permanent success.

The most important of these associations is the Geographical Society of Tokio, which now numbers about 200 members. The subscriptions, which are very small, are largely increased by donations from the wealthy members. It is under the patronage of several of the imperial princes, and among its members are the chief personages of the Empire. The *Transactions* are neatly printed in small pamphlets of about 100 pages each, and contain much matter which would be valuable even to European geographers. With the exception of China, Japan is the only foreign country having intercourse with Corea. Our information respecting this peninsular kingdom is limited to the imperfect accounts of the Jesuit priests; but the Japanese Geographical Society has already had several interesting and important papers on the subject from its members. The difficulties of the language seriously restrict the circulation of these and other papers, but we believe the Committee are contemplating the publication of translations of their *Transactions*.

During his too brief stay in Japan as occupant of the Chair of Zoology in the University of Tokio, Prof. Morse of Salem, Massachusetts, was instrumental in establishing a Biological Society which attracted much attention. It is now being conducted successfully by Prof. Yatabe, a Japanese gentleman educated in the United States.

Another association, which is, we believe, unique among the societies of the world, is the *Kojunsha*, or Society for the Circulation of Knowledge. Its head-quarters are at Tokio, but there are branches in every town of importance in the Empire. It possesses a secretary and staff of clerks, and a member desiring to obtain information on any subject applies to the secretary. The latter has on his books the names of all the members likely to be able to satisfy the applicant, and immediately transmits the question to them. The answers are forwarded in due course to the inquirer, and should the subject be deemed by the Committee of sufficient general importance, the whole is printed in the weekly *Journal* of the Society. The pains which are taken to obtain satisfactory replies to queries are, we can vouch from personal experience, almost incredible. It is not surprising to learn that this Society has nearly 3000 members scattered throughout the Empire, and even in Europe and America. As a device for bringing together the active and inquiring minds of the country, it is almost unequalled. The subscription, which includes the use of reading-rooms and the numbers of the *Journal*, is about half-a-crown per month.

The Numismatic Society, to which we have already referred, is also very active. It publishes a periodical describing new and strange coins that have been exhibited at its meetings, and supplies other information interesting to collectors.

We need not refer here to the English and German Asiatic Societies founded in Yokohama and Tokio. They are under the control of foreign residents, their papers are in a foreign tongue, and, although their work has been most valuable, they are outside the scope of the present article. Nor need we give more than a passing reference to the innumerable political societies which have sprung up like mushrooms in all parts of the country during the past few years. If the objects of the promoters of these organisations were less palpably selfish, and more in accordance with their high-sounding titles, they would be very important instruments in the education of the people.

But we cannot pass over the latest scientific association of Japan. The Seismological Society, as its name indicates, is founded for the purpose of investigating volcanic and earthquake phenomena of all kinds. Japan is particularly well situated for this object. There are numerous active and extinct volcanoes throughout the island. Mild earthquakes are of very frequent occurrence, so that the student has not, on the one hand, to wait months for his subject, as in most parts of Europe, or, on the other, to run for his life when it does come, as in South America. This society was founded chiefly through the energy of its vice-president, Mr. Milne, professor of geology in the Engineering College at Tokio, who has long made seismic phenomena a special study. A Japanese, Mr. Hattori, himself a student of the subject, is President of the Association, which numbers many foreigners amongst its members. The Central Government have throughout taken a warm interest in the success of the Society, and have, we believe, placed the telegraph lines at its disposal, and ordered the local officials all over the country to report all occurrences connected with earthquakes and volcanic eruptions in their districts. A few months since, under the auspices of the Society, an exhibition of seismological instruments of various kinds—one of them as ancient as A.D. 126—took place in Tokio. The number of visitors in one day to the rooms was over 2000, a fact which attests the interest taken in this study by the Japanese. The *Transactions* of the Society are published in English in the *Japan Gazette* newspaper of Yokohama.

The army, navy, and other professions have their own societies and newspapers, very much as in England. One of the most curious of these class or trade journals is the dancing-girls' paper, containing portraits and biographies of the chief *danseuses*. We have not advanced so far yet in England as to have an organ-grinders' gazette!

On the whole it must be pronounced that the outlook for the propagation of scientific knowledge in Japan is hopeful; and there seems no reason to fear that science will suffer greatly after the approaching and inevitable departure of all foreign instructors in the country. They will leave behind men who, although possibly not such efficient teachers, are animated by all the thirst for knowledge that animates the bulk of scientific men in western lands.

NOTES

Dr. C. W. Siemens has received from the French Government a formal document nominating him "Officier de l'Instruction Publique," the nomination being accompanied by the insignia of the order, which corresponds, we believe, to the Prussian order "Pour le Mérite."

It is proposed to open an International Electrical Exhibition at the Crystal Palace in December.

The anatomical department of Edinburgh University has lost a valuable servant in the death, at the age of seventy, of Mr. A. B. Stirling, the assistant conservator of the Anatomical Museum. He was born in 1811 at Milngavie, Stirlingshire, where his father was a shoemaker. Stirling early evinced a decided liking for natural history studies; he was a born naturalist. His love of natural history brought him into contact with the late Prof. John Reid and Dr. Adamson of St. Andrews, who employed him to arrange the University Museum there. In 1856 he was introduced to the late Prof. Goodsir, who recognised his aptitude for anatomical work, and saw in him one who would be a congenial helper in the work which he had in view; and Mr. Goodsir appointed him assistant conservator of the Edinburgh Anatomical Museum—a museum which he has enriched with hundreds of anatomical preparations (normal and morbid), and also many comparative anatomy specimens, which are all characterised by great taste in the way in which they are mounted. He soon acquired an extensive knowledge of anatomy, human and comparative; he had so remarkable a mechanical turn, and so inventive a mind, that he devised many new methods for preserving the human body for dissection, for mounting anatomical preparations, for cutting microscopic sections, and for mounting the same. He was an accomplished microscopist and a keen fisher, and this led him to take a great interest in fish, especially the Salmonidæ; and, when the "fungous disease" broke out amongst the salmon in the Tweed and other rivers, he investigated this matter, and communicated his results to the Royal Society of Edinburgh—results which are said to contain by far the best description yet given of the pathological conditions of this remarkable disease. Not only did Mr. Stirling encourage and aid others, but, in turn, he was the esteemed and highly valued friend of the late Prof. Goodsir and of Prof. Turner, both of whom gave him every facility for carrying on his investigations.

THE Royal Commission on Technical Instruction visited Saltaire and Keighley on Tuesday, and were present at the annual meeting of the School of Science and Art in the Keighley Mechanics' Institute. Mr. Slagg, M.P., speaking of the objects of the Commission, said that their great aim would be to develop a plan by which their system of primary education should be linked to a higher system, comprising a higher training and leading up to the highest scholastic education the country could afford. For his own part he did not see anything at the present moment in foreign competition to appal them in the slightest degree, and substantially he believed that they held their ground very well indeed. Mr. Samuelson, M.P., said that it was impossible that they as a nation could continue to hold the superior rank which they had taken among manufacturing countries if they did not cultivate the industrial intelligence of their population, and it was on that account that he thought the Commission would result in great good.

A REMARKABLE phenomenon occurred in New England on September 6, almost exactly similar to one that occurred in the same region on May 19, 1780. The *Springfield Daily Republican* describes it as follows:—In this city the day began with a slow gathering of fog from all the watercourses in the early hours, the thin clouds that covered the sky at midnight seemed to crowd together and descend upon the earth, and by sunrise the atmosphere was dense with vapour, which limited vision to very short distances, and made those distances illusory; and as the sun rose invisibly behind, the vapours became a thick, brassy canopy, through which a strange yellow light pervaded the air and produced the most peculiar effects on the surface of the earth. This colour and darkness lasted until about three o'clock in the afternoon, once in a while lightening, and then again deepening, so that during a large part of the time nothing could be done conveniently indoors without artificial light. The unusual complexion of the air wearied and pained the eyes. The grass assumed a singular bluish brightness, as if every blade were tipped with light. Yellow blossoms turned pale and gray; a row of sunflowers looked ghastly; orange nasturtiums lightened; pink roses flamed; lilac-hued phlox grew pink; and blue flowers were transformed into red. Luxuriant morning-glories that have been blossoming in deep blue during the season now were dressed in splendid magenta; rich blue clematis donned an equally rich maroon; fringed gentians were crimson in the fields. There was a singular luminousness on every fence and roof-ridge, and the trees seemed to be ready to fly into fire. The light was mysteriously devoid of refraction. One sitting with his back to a window could not read the newspaper if his shadow fell upon it—he was obliged to turn the paper aside to the light. Gas was lighted all over the city, and it burned with a sparkling pallor, like the electric light. The electric lights themselves burned blue, and were perfectly useless, giving a more unearthly look to everything around. The darkness was not at all like that of night, nor were animals affected by it to any remarkable extent. The birds kept still, it is true, the pigeons roosting on ridge-poles instead of flying about, but generally the chickens were abroad. A singular uncertainty of distance prevailed, and commonly the distances seemed shorter than in reality. When in the afternoon the sun began to be visible through the strange mists, it was like a pink ball amidst yellow cushions—just the colour of one of those mysterious balls of rouge which we see at the drug-stores, and which no woman ever buys. It was not till between five and six o'clock that the sun had sufficiently dissipated the mists to resume its usual clear gold, and the earth returned to its everyday aspect; the grass resigning its unnatural brilliancy and the purple daisies no longer fainting into pink. The temperature throughout the day was very close and oppressive, and the physical effect was one of heaviness and depression. What was observed here was the experience of all New England, so far as heard from, of Albany and New York city, and also in Central and Northern New York. In reference to this phenomenon the New York *Nation* suggests that it may be worth the while of weather-observers to note the approximate coincidence between the interval separating the two dark days in New England (May 19, 1780, and September 6, 1881) and nine times the sun-spot cycle of eleven years.

THE ceremony of cutting the first sod of the Giant's Causeway and Portrush Tramway was performed the other day at Portrush, in presence of the directors and a large company of the local gentry and visitors at Portrush. Interest was attached to the ceremonial owing to the fact that it is intended to work the tramway by electricity, the company thus being the first to introduce into the United Kingdom electricity as a motive power for tramway and railway propulsion. The chairman of the company, Dr. Traill, said that not many years would elapse before this dynamo-electric power would be supplied, not alone to tramways suitably situated for it, as this one undoubtedly was, but also to railways. To shareholders in a company such as this they could easily see what an important thing such a revolution in locomotive power would represent. The working expenses for haulage on a tramway such as theirs with horses would be about 11*d.* per mile, and by steam power about 7*d.* per mile, but there was every reason to suppose that the working expenses of their motive power need not reach 1*d.* a mile.

SOME time ago we gave an account of the nature and uses of celluloid. Among other things it may be used for preserving typographical *clichés* and stereotypes. The process employed for this purpose, we learn from *La Nature*, consists in taking an impression of the engraved block by means of a special cement, which receives the impression and rapidly hardens. After about twenty minutes the cement can support a pressure of 250 kilograms. The presses used to take the first impression ought to be heated; and the celluloid in sheet is then used to take the counter-impression from which to print. Celluloid shows the typographical reproduction of specimens of lace in a marvellous fashion, by the actual impression of the lace itself. *La Nature* gives an illustration of a piece of lace engraved in this manner, and the reproduction of the pattern is perfect.

A TELEGRAM from Constantinople of September 30 states that an earthquake had occurred at Changeri, in Anatolia, which caused the death of eleven persons and great injury to the Grand Mosque and numerous dwelling-houses. The amount of damage done in the neighbouring villages is not known.

A GEOGRAPHY of the almost unknown kingdom of Corea has been compiled by a member of the suite of the Japanese envoy to that country. Several valuable papers containing accounts of travels in Corea have been read before the Geographical Society of Tokio, and have appeared in its *Transactions*. As they are written in Japanese they are unfortunately all but inaccessible to European geographers.

THE Prefect of the Seine has established a course of six lectures for the teaching of micrography. An examination has been instituted for inspectors intrusted with the care of detecting trichinæ in the substance of pork and ham of American or German origin.

A CURIOUS experiment will be tried this week at La Villette gasworks, Paris. Two balloons of equal size will be sent up at the same time; one of them will carry an experienced sculler, who is confident that he will produce some effect with a long oar of his invention.

UNDER the title of "School Physical and Descriptive Geography" Mr. Stanford has issued a smaller and cheaper edition of the late Keith Johnston's "Physical, Historical, Political, and Descriptive Geography," reviewed in these pages at the time of its appearance. In the school edition the historical sketch and the elaborately-printed maps have been omitted, while all the strictly geographical information has been retained. In this form it ought to find wide acceptance among all teachers who aim at making geography both interesting and thorough. No better text-book could be recommended.

THE subject of the address by Shadworth H. Hodgson, LL.D., before the Aristotelian Society on Monday evening will be "The Practical Bearing of Speculative Philosophy."

WE have received from Rothschild of Paris an interesting little volume on Pisciculture in France. It consists of two parts—Pisciculture, Fluvial and Maritime, by Jules Pizzetta; and Oyster-Culture, by M. De Bon.

IN its summary of colonial intelligence the *Colonies and India* mentions the discovery of a valuable coal-seam near Victoria, Huon, Tasmania, which has been traced on the surface for about twenty yards, and increased in width from three to four feet, when it was lost in a hill. The coal has been tried and found to be of good quality.

A VALUABLE archæological discovery, which may be said to equal that of the celebrated Kertch antiquities at the Hermitage of St. Petersburg, has recently been made near the Cossack village of Sewersk in the Sakuban district, in one of the *kurdans*, *i.e.* the old tombs, in the steppes of Southern Russia. A number of objects were found, but special attention was drawn to two glass vessels, unfortunately broken, but the pieces of which still give evidence of their remarkable ornamentation. They are profusely covered with gold, the hoops containing large rubies and bearing golden chains, by which heart-shaped pearls are suspended. Another object of cylindrical shape, evidently a cup-holder, consists of pure gold, and shows two griffins in bas-relief. Another important object is a gold plate six inches in diameter, with a fine bas-relief representing a whole episode. M. Felizin, an eminent Russian archæologist, is of opinion that the tomb in question must have been that of an important personage of the Bosphorean kingdom, and that its origin dates back as far as the period of King Perisad II., who began to reign in the year 284 B.C. A gold coin which was found confirms this view.

AN important discovery of very good rock-salt, affording a sheet seventy-five feet thick, was made some days ago in the district of Bakmut, in the Russian government of Ekaterinoslav, at a depth of 430 feet. The discovery was made according to the indications of the geologist, Prof. Erofeeff.

THE anniversary address of the Hon. Prof. Smith, president of the Royal Society of New South Wales, contains an interesting sketch of the history of the Society, both under its old name of Philosophical Society as well as under its present designation.

MESSRS. BLACKWOOD AND SONS have issued a twelfth edition of the "Elements of Agricultural Chemistry and Geology," by the late Prof. J. F. W. Johnston and Dr. C. A. Cameron.

IN the report sent us of the meeting of the Natural History Society of the Friends' School at York, and printed among our Notes a fortnight ago, the Rev. T. A. Preston is referred to as science master at Marlborough College. Of course this is a mistake; Mr. G. F. Rodwell has long held and still holds the post referred to.

THE additions to the Zoological Society's Gardens during the past week include a Tennant's Squirrel (*Sciurus tennanti*) from Ceylon, presented by Mrs. S. A. Cottrell; a Common Marmoset (*Hapale jacchus*) from South-East Brazil, presented by Mr. J. N. Palmer; a Chacma Baboon (*Cynocephalus porcarius*) from Sout Africa, presented by Mr. W. H. L. Long; a Leucoryx Antelope (*Oryx leucoryx*) from North Africa, presented by Mr. John M. Cook; two Leopards (*Felis pardus*) from Ceylon, presented by Mr. Eustace L. Burnside; a Green Lizard (*Lacerta viridis*) from Jersey, presented by Mr. James Thorn; a Tarantula Spider (*Mygale*, sp. inc.) from California, presented by Mrs. John Leechman; five Robben Island Snakes (*Coronella phocarum*) from South Africa, presented by Rev. G. H. R. Fisk, C.M.Z.S.; two Greater White-crested Cockatoos (*Cacatua cristata*) from Moluccas; two Common Cormorants (*Phalacrocorax carbo*), British, deposited; two Blossom-headed Parrakeets (*Palæornis cyanocephalus*) from India, a Nose-horned Viper (*Vipera nasicornis*), a Crocodile (*Crocodilus*, sp. inc.) from West Africa, purchased.

OUR ASTRONOMICAL COLUMN

COMET V., 1863.—With reference to a remark in this column at p. 111 of the present volume of NATURE, suggesting that a further and more minute discussion of the elements of this comet might be desirable, Prof. Valentiner, director of the Observatory at Carlsruhe, has been good enough to draw our attention to a memoir by himself upon the subject which we had overlooked; it is entitled "Determinatio orbitæ Cometæ V. anni 1863," and was published at Berlin in 1869. The observations, about 130 in number, extend from 1863, December 28, to 1864, March 1, and Prof. Valentiner forms nine normal positions upon them. The perturbations of the earth and Jupiter are taken into account (the comet having approached the former at the end of January within about 0·18) and the following parabolic elements result:—

Perihelion Passage, 1863, Dec. 27·79992 M.T. at Berlin.

Longitude of perihelion	60° 24′ 26″·4	M. Eq.
,, ascending node ...	304 43 23·2	1864·0
Inclination	64 28 44·2	
Log. perihelion distance	9·8873326	

Motion—direct.

The agreement with the observations is so close as to prove that the orbit did not sensibly differ from a parabola; the conjectured identity with the comet of 1810 is therefore shown to be inadmissible, notwithstanding the striking similarity of the elements, as will appear from the comparison at p. 111.

THE NEW COMET.—Mr. S. C. Chandler, jun., has telegraphed to Lord Crawford's Observatory approximate elements of the comet discovered by Mr. Barnard last month, from which it appears that the orbit does not resemble that of any which has been previously computed. Expressed in the form usual in our catalogues the elements are:—Perihelion passage, September 15·01 G.M.T.; longitude of perihelion, 250° 4′; longitude of ascending node, 260° 43′; inclination, 72° 33′; log. perihelion distance, 9·70535; motion, retrograde. The intensity of light is diminishing.

MINIMA OF ALGOL.—The under-mentioned Greenwich times of minima of this variable are from Prof. Winnecke's ephemeris, in the computation of which correction depending upon recent observations has been applied:—

	h. m.		h. m.		h. m.
Oct. 9 ...	15 52	Nov. 1 ...	14 23	Dec. 11 ...	17 48
12 ...	12 41	4 ...	11 12	14 ...	14 37
15 ...	9 30	7 ...	8 1	17 ...	11 26
18 ..	6 19	21 ...	16 5	20 ...	8 14
		24 ...	12 54	23 ...	5 3
		27 ...	9 43		
		30 ...	6 32		

There would appear to have been perturbations in the period during the last few years which are not reached even by Prof. Schönfeld's formula involving two inequalities, which would make the above times about thirty-five minutes later.

A PROBABLY VARIABLE STAR.—Prof. Pickering notifies his observation of a red star, with banded spectrum, the place of which on September 14 was in R.A. 16h. 31m. 32s.; Decl. + 72° 32′. On September 17 its magnitude was 8·6. It is not found in the "Durchmusterung," nor in Federenko, Schwerd, or other circumpolar catalogue. Its variability is therefore suggested.

CERASKI'S VARIABLE, U CEPHEI.—Mr. Knott informs us that he obtained a good observation of the minimum of Ceraski's variable of short period on the night of October 2; time of min. 11h. 47m. G.M.T., mag. 9·2. Prof. Schmidt's ephemeris in *Astron. Nach.*, No. 2382, has 11h. 37·5m. The star did not fall quite so low, as in the minima which Mr. Knott observed in March, April, and May last.

[ERRATUM.—In last week's "Astronomical Column" (p. 520), *for* "add *p*" *read* "add P."]

CHEMICAL NOTES

MM. SCHUTZENBERGER AND COLSON describe (*Compt. rend.*) several new compounds of silicon. When crystalline silicon is strongly heated in a current of carbon dioxide the compound $(SiCO)_x$ is produced When nitrogen is passed over a hot mixture of silicon and carbon $(Si_2C_2N)_x$ is formed. The authors regard these compounds as the oxide and nitride respectively of the radicle *carbo-silicon* $(Si_2C_2)_x$. The nitride of silicon $(Si_2N_3)_x$ is also described: it is obtained by the direct union of nitrogen and silicon.

IT is well known that certain metallic chlorides, *e.g.* sodium chloride, are precipitated from aqueous solution by hydrochloric acid; attention has been drawn in these Notes to recent work of Ditté and others on this subject. M. Sabatier describes several hydrates of ferrous and ferric chloride (*Compt. rend.*) produced by this general reaction.

MANY years ago Graham drew attention to the change in properties produced in certain oxides by the action of heat, *e.g.* ferric oxide is soluble in hydrochloric acid, but when strongly heated it becomes almost insoluble. This "department of corpuscular philosophy"—to use Graham's phrase—has not been much studied. The experiments detailed in *Archiv Néerland* by M. van Bemmelen form an interesting contribution bearing on this subject. It is shown that the amount of water of hydration taken up by the oxides of tin, silicon, and manganese at the moment of the formation and precipitation of the hydrates of these oxides from aqueous solutions, is dependent on the molecular state, *i.e.* on the as yet unknown conditions of molecular equilibrium, of the solid hydrates. The molecular state being the same, the amount of water of hydration rises with temperature and humidity of the surrounding air; to each temperature and degree of humidity corresponds a certain equilibrium of oxide and water; the relations between the weights of the oxide and water are generally too complex for expression by a simple formula. From an examination of the phenomena attending the action of the amorphous hydrated di-oxides of the above-named elements on acids, alkalis, and salts, M. van Bemmelen concludes that weak double compounds are produced, but that these are very easily dissociated; the amount of dissociation varying with the chemical nature and the mass of the reacting substances, and with the temperature. In most cases stable compounds are produced simultaneously with these series of unstable and largely-dissociated compounds. The formation and dissociation of such unstable compounds depend also on the conditions of molecular stability of the hydrated oxides themselves. By arranging these conditions so as to insure considerable molecular stability—*e.g.* by heating the hydrates—the power of forming the unstable compounds is much diminished. That a force of the same nature as chemical affinity is concerned in the formation of some of these weak compounds is shown by the decomposing action exerted by hydrated MnO_2 on the stable compounds K_2SO_4, KCl, and KNO_3, compounds which do not show signs of dissociation in aqueous solution. M. van Bemmelen would thus extend the sphere of chemical phenomena, and would see no sharp division line between the actions of the so-called physical forces—adhesion, absorption, &c.—and the force of chemical affinity.

AN ingenious method for determining the total solid matter in solution in different waters is described in *Chem. Soc. Journal* by Dr. Mills. The method is based on the fact that if a small glass bead with an attached weight is allowed to ascend in a saline solution of known strength, it will rise more slowly, the greater the amount of solvent present. Experiments are given showing that the rate of ascent is also dependent on the nature of the soluble matter, *i.e.* on the viscosity of the solution. For detecting variations in the solids in the same water, for preparing standard solutions, &c., the bulb method is likely to be useful. Experiments detailed in the same paper lead Mills to regard the specific gravity of a potable water as a direct indication of the quantity of total solids in solution.

ANALYSES of the mud deposited round the Buxton thermal spring, by T. C. Thresh (*Chem. Soc. Journ.*), show that when dried at 120° this mud contains about 71 per cent. Mn_3O_4, with oxides of Pb, Cu, Fe, Al, Zn, Ba, Sr, Mg, and Mo, and closely agrees in composition with many specimens of "wad" or "bog manganese." Analyses of the gas evolved at the spring and of the gases dissolved in the water closely confirm those made by Playfair in 1852: the gas evolved at the spring consists of about 99 per cent. nitrogen and 1 per cent. CO_2, that dissolved in the water of about 60 per cent. N and 40 per cent. CO_2. The water in the baths contains as much gas as could be forced into water at a pressure of 1·64 atmospheres.

A LONG and important paper by W. H. Perkin, on "Isomeric Acids obtained from Coumarin and the Ethers of Hydride of Salicyl," appears in the same number (August) of the *Chem. Soc. Journ.* Perkin has obtained two series of compounds, differing in properties, but generally convertible, one into the other, by the action of heat. He thinks that the ordinary theory of isomerism, according to which this phenomenon is traceable to the occupation of different relative positions by the atoms in two molecules, fails to explain the cases of isomerism now described by him. He favours the view that the atoms in the molecules of any pair of the newly-described compounds occupy the same relative positions, but are at different absolute distances from each other. It is, however, to be remembered that the present theory of isomerism is applicable only to gaseous molecules; the molecular phenomena of liquid and solid bodies are too complex to find, as yet, any general explanation. Perkin's new compounds seem to belong to this rapidly-increasing group of "physical isomerides," *i.e.* to liquid or solid bodies whose chemical properties are to be traced to the binding together of molecular groups, the individual members of which occupy relatively different positions, and which groups react as chemical units. The facts concerning molecular volumes of metameric compounds are also, on the whole, opposed to that theory of isomerism favoured by Perkin in his important paper.

A SERIES of papers on the photo-chemistry of silver bromide by Herr Eder has appeared in *Chemisches Centralblatt*. It is shown that silver bromide prepared with an excess of silver nitrate is much more sensitive towards light than when prepared with excess of potassium bromide, provided the silver bromide is disseminated through an indifferent substance, *e.g.* collodion pyroxylene. When disseminated through an easily oxidisable substance, *e.g.* gelatin or gum, silver bromide prepared with a slight excess of soluble bromide is from four to six times more sensitive than when disseminated through indifferent collodion with excess of silver nitrate. An emulsion of silver bromide in gelatin with a slight excess of the soluble bromide after several days digestion at 30°-50° becomes much more sensitive than any other known body. Herr Eder regards the photo-chemical decomposition of silver bromide as the result of partial reduction with loss of bromine.

THE GERMAN ASSOCIATION

THE fifty-fourth meeting of the Association of German Naturalists and Physicians was held at Salzburg on September 18–24. The number of Members and Associates in attendance was 760. There were also present Foreign Members from Switzerland, the Netherlands, Russia, Denmark, and Japan. The first general meeting, on Sunday, September 18, was opened by the First Secretary, Dr. Günthner (Salzburg), who in his hearty address of welcome mentioned the fact that Salzburg was the last retirement of the celebrated physician and naturalist, Theophrastus Paracelsus. After short addresses given by the Governor and Burgomaster, Prof. Pettenkofer (Munich) read a paper "On the Soil and its Connection with the Health of Man." He pointed out that it was previously believed that the state of the air and water exerts an important influence upon the origin and propagation of epidemics, but this view could not be proved by experiments recently made. The contamination of air and water is caused by products of decomposition of bodies putrefying on or in the soil. The progress of epidemic diseases, especially of cholera, is influenced mainly by the soil. The immunity of special localities against cholera is shown by the example of Lyons, which, notwithstanding communication with infected places, remained free from cholera, though filtered Rhone water was used there. Versailles and Salzburg also were exempt from this disease. It is now generally assumed that cholera is due to the action of schizomycetes, which develop at localities where the soil is impregnated with decomposing organic bodies. The contamination is drawn up by diffusion through the porous soil into the interior of houses, where it becomes dangerous to the health of man.

On Monday the work of the sections was commenced. There were twenty-three sections, eleven of them medical. On Tuesday an excursion was made to Reichenhall (Bavaria), with its salt-mines, where the Congress was addressed by Graf Pestallozza. On Wednesday the second general meeting was held. Prof. Weismann (Freiburg-im-Breisgau) read a paper on the duration of life. After enumerating many examples of longer and shorter duration of life among animals, he pointed out that size, constitution, temper, sex, and growth are not critical for the duration of life. In general the duration of life of an individual represents the minimum of time necessary to insure the existence of the species; it is governed by adaptation and heredity. The death caused by wasting and consumption of the cells, of which the (animal) body is composed, is the result of adaptation. The capacity of unlimited life has been lost, since it has become useless. There is no death at the division of lower animals (Amœba). In higher animals the propagating cells are separated from the somatic cells; only the former preserve unlimited productiveness. The limitation of individuals in time and in space is based on the same principle. At the same meeting Prof. Meyners (Vienna) gave an address on the laws which govern human thoughts and actions. In the conclusion of his very interesting discourse, in which he mainly dealt with feelings, sensations, and the experiments of Munk and Goltz, he expressed the opinion that the phenomena of bodies do not disclose to us their essence, and that there is only a phenomenon of freedom of will. Eisenach (Thuringia) was chosen as the town in which the fifty-fifth meeting of the Association should be held.

On Thursday an excursion was organised to Zell-am-See. On Saturday the third general meeting was held. Prof. Oppolzer (Vienna) read a paper on the question: Is Newton's law of gravitation sufficient for the explanation of the motion of heavenly bodies? Are there reasons for regarding it only as approximately true? In consideration of the theories of the moon, of Mercury, and of Encke's comet, he cannot find the theories based on Newton's law in its present form sufficient, but it would suffice under the (hypothetical) assumption of a cosmic matter surrounding the sun. After an address given by Dr. Kirschensteiner (Munich), on Theophrastus Bombastus Paracelsus, the sitting was closed by Dr. Günthner. We give a list of the papers read in the sections of Natural Science.

Section II. Physics: Walter (Tarnowitz), on the molecular kinetic laws of specific heat and the heat of vaporisation of bodies in different states; Sacher (Salzburg), on a direct measure of the attraction between earth and a determined electric current; Kurz (Augsburg), on dispersion of light and measuring the index of refraction; Spörer (Potsdam), results obtained by observations of the sun; Grunmach (Berlin), on the electro-magnetic rotation of the plane of polarisation of radiant heat; Grunmach (Berlin), comparisons of mercury-thermometers with air-thermometers; Sacher (Salzburg) demonstrated some new physical experiments relating to the theory of the formation of the earth (balls of sulphur and spermaceti with crater-formations); Waltenhofen (Prague) spoke on his apparatus for demonstration of the different action of hollow and solid electro-magnets; Günther (Ansbach), on the parallelogram of forces.

Section III. Chemistry: Brühl (Lemberg), on the connection between the optic and thermic properties of liquid organic bodies; Brauner (Prague), contributions to the chemistry of the rare earths, and on the progress of the system of periodicity of elements; Schwarz (Gratz), short communication on the preparation of nearly perfect alum-cubes by a new method; Zorn (Heidelberg), on hyponitrous acid; Bernthsen (Heidelberg), on the nomenclature of the proper derivates of carbonic acid, taking special notice of isomers.

Sections IV. and V. Geology, mineralogy, palæontology, geography: Bernáth (Budapest), on the mineral waters of Hungary; Gümbel (Munich), on the geological structure of the Untersberg (near Salzburg); Hauer (Vienna) presented a new geological map of Montenegro (designed by E. Tietze); Zittel (Munich), on Spongiæ as rock-forming materials, and on Plicatocrinus; Baltzer (Zurich), on curved strata; Neumayer (Vienna), on fresh-water Conchylia from China; Alth (Krakau), on the Jurassic formation of Niezniow; Hauer (Vienna), on the Arlberg; Tschermak (Vienna), on the definition of species in mineralogy; Hoernes (Gratz), on earthquakes in general; Woehner (Vienna), on the earthquake of Agram; Richter (Salzburg), on observations made at the Obersalzbach glacier; Doelter (Gratz), on the Cape Verde Islands; Dücker (Bückeburg) on the occurrence of petroleum in Northern Germany.

Section VIII. Botany: Kraus (Triesdorf), communications on the sap-pressure of plants; De Bey (Aachen), report on five new and peculiar genera (Coniferæ) of the Aachen chalk-flora; Holzner (Weihenstephan), on agrostological theses; Hildebrand (Freiburg-im-Breisgau), some observations on the flowering and the fruits of plants; Woronin (St. Petersburg), contribution to the knowledge of Ustilagineæ; Kirchner (Hohenheim), on the longitudinal growth of plants.

Sections VIII. and IX. Zoology, comparative anatomy, entomology: Troschel (Bonn), classification of Gastropods; Fraisse (Leipsic), on cell-division and free nucleus-formation; Weidersheim (Freiburg), on the genesis of Jacobson's organ; Grobben (Vienna), on the variation of generations of Doliolum.

BIOLOGY AS AN ACADEMICAL STUDY[1]

I.

IT is told of the late Dr. Norman Macleod that, on paying his first visit in his first parish, he was peremptorily desired to sit down and "go over the fundamentals." I feel that some such demand may, not unreasonably, be made of me to-night.

Five-and-twenty years ago one's position in this respect would have been a comparatively easy one, for then biology may be said to have had no "fundamentals" at all. In spite of the labours of Buffon, Erasmus Darwin, and Lamarck, the great bulk of naturalists at that time believed in the immutability of species; as a natural consequence botany and zoology remained mere "classificatory sciences," and the extraordinary facts of comparative anatomy, of embryonic development, of geographical distribution, of palæontology, were incapaple of rational explanation. Indeed, classification itself was nothing more than a logical expression of likenesses and unlikenesses, and was devoid of all real meaning.

But with the publication of the "Origin of Species," in 1859, a better day dawned for biology. The whole history of science has been a succession of attempts to bring group after group of natural phenomena within the scope of some natural law; and Charles Darwin's great service to science lies in the fact that, although not himself the discoverer of the doctrine of descent, he succeeded, by the immense array of well-arranged facts and sound generalisations contained in his epoch-making book, in

[1] Inaugural Lecture delivered in the University Library, May 2, 1881, by T. Jeffery Parker, B.Sc., Lond., Professor of Biology in the University of Otago.

bringing those natural phenomena which have to do with living things within the all-embracing law of evolution, thus making belief in the theory of special creation once for all impossible to the student of nature.

One may say then that since the publication of the "Origin of Species" evolution has taken its legitimate place as the central doctrine of biology, the key to the infinite number of problems with which the study of animals and plants brings us face to face. Without evolution these problems are incapable of explanation, and any attempt to explain them is little better than a roundabout acknowledgment of ignorance; but with the doctrine of descent as a standpoint, problem after problem yields to patient investigation, biology thereby gradually growing into a perfect and harmonious whole, as did astronomy when once the law of universal gravitation was established.

Not that the real mystery of things is in any way diminished by this, any more than by other great discoveries. As Herbert Spencer finely says: "Positive knowledge does not, and never can, fill the whole region of possible thought. At the uttermost reach of discovery there arises, and must ever arise, the question, What lies beyond? As it is impossible to think of a limit to space, so as to exclude the idea of space lying outside that limit, so we cannot conceive of any explanation profound enough to exclude the question, What is the explanation of that explanation? Regarding science as a gradually increasing sphere, we may say that every addition to its surface does but bring it into wider contact with surrounding nescience."

But the fact that no explanation of natural phenomena can ever be final has no right to diminish our profound thankfulness for every proximate explanation which the genius of a Newton, a Dalton, or a Darwin gives us. To the true man of science these explanations come like a revelation, and he feels that his most cherished beliefs, his most ingrained prejudices, must be brought into harmony with the new light that is in him, or be cast aside as no longer tenable.

A few years ago—even at the time when this University was founded—something more than a bare statement of belief in evolution would have been required from a professor of biology giving his inaugural lecture. For then the doctrine of descent was only just emerging from the fiery trial through which all great truths, scientific or otherwise, have to pass, and it was honestly believed by many estimable persons that "Darwinism" was in direct and necessary opposition to religion and morality, and was the secret ally of atheism, socialism, and the like. But, like the fundamental doctrines of astronomy, physics, and geology, evolution has survived all attacks: I believe I am correct in saying that there is now not a single naturalist of any repute, under the age of sixty, who is not also an evolutionist; indeed, with Louis Agassiz and Von Baer, intelligent opposition to the general doctrine of transformism is practically dead.

Even among the non-scientific public, opinion has undergone a wonderful and rapid change. An evolutionist is no longer looked upon as a dangerous visionary; it is no longer thought necessary to hold "that nature's ancient power was lost" when she had to do with living things, and that the power which could form worlds out of a nebula was unable to evolve a horse from a hipparion, or even a speck of living protoplasm from the elements of the primæval sea.

Under these circumstances it would be superfluous, almost impertinent, for me to make any attempt to repeat the arguments which go to show that the animals and plants living on the earth at any period of its history are the lineal descendants of those which existed during the preceding period, and that the origin of any living thing by direct creation is, in the first place, entirely unsupported by evidence, and, in the second place, unthinkable. I proceed, therefore, to the main subject of this lecture—the position which biology should occupy in the curriculum of our schools and of our University; in other words, its place as one of the natural sciences in a rational scheme of education.

Educational subjects may be divided into two classes, the directly educational—those which serve as a true discipline, which train the mind, leading to clear thought, accurate reasoning, and a high intellectual tone; and the indirectly educational, which primarily serve to impart a certain amount of useful information, and only secondarily, by interesting the student and starting him off on a certain track of thought, serve as an actual means of mental culture. Perhaps the best examples of the two classes are furnished by mathematics on the one hand, and on the other by English history as usually taught in schools. A boy who has once grasped the idea that two and two make four and can never by any possibility add up anything else, has made a long stride in his educational career; but the boy who learns that the battle of Hastings was fought in the year 1066, or that Henry VIII. had six wives, has simply gained two comparatively unimportant concrete facts, the possession of thousands of which would never make him anything more than a well-informed person.

According to the theory of education which was almost universal in the last generation—the English public school system—there were two educational subjects, and two only, Greek and Latin, perhaps with "a shadowy third" in the shape of mathematics, but certainly nothing further than that. As a natural reaction against this time-honoured method of trimming down all minds to one dead level of scholarly dulness came the modern private school system, the principle of which is to try and cram into a boy's head a little of all the subjects of which it is supposed he ought to know something when he arrives at man's estate—divinity, Latin and Greek, modern languages, mathematics, natural science, history, geography, drawing, music, and even bookkeeping. The wretched child is "everything by starts and nothing long"; his masters, chosen for knowing something of as many as possible of these subjects, are usually eminently superficial, and he leaves school well informed perhaps, but profoundly and distressingly ill-educated.

The private school system is now, very naturally, producing in certain quarters a counter-reaction towards the exclusively classical and mathematical method of education, the plea being that the modern plan has been tried and found wanting, that neither natural science nor any of the other recent innovations have any direct educational value whatever, and that these subjects should therefore never form more than a very subordinate part of either a school or a university course.

This cry for a return to the old paths has lately found expression in an article by Dr. Karl Hillebrand,[1] who, however, makes certain very important concessions to his opponents. In the first place, what he is fighting against is not so much scientific education—I mean instruction in the natural sciences—as superficial education; and in this every honest teacher of science will be at one with him. Then again he advocates the postponement of the study of Latin grammar—the chief instrument of culture in his eyes—to the age of twelve or thirteen, and the employment of the first three years of high school life to training the powers of "observation, comparison, memory, and all the elementary functions of the understanding." In this also the advocate of science teaching and the opponent of the English public school system in its purity will be altogether in accordance with Dr. Hillebrand. But when he goes on to advocate as the best training for these "elementary functions of the understanding" the learning of texts and dates by rote, and, by way of science, the "simple classifications of zoology and botany," illustrated by the "exhibition" of real animals and plants, one cannot but wish that before printing such crudities he had tried to understand in what the elementary teaching of science really consists, and how far such teaching would supply the training in observation, comparison, memory, and so forth, to which even he would devote the earlier years of school life. To him, as to many, strict teaching means classical and mathematical teaching, and instruction in science is, if educational at all, only indirectly so.

This opinion as to the educational value of natural science arises, I am inclined to think, from an utter misconception as to what is meant by science teaching: by assuming, in fact, that science can be taught by the ordinary educational apparatus of books and lectures. The fallacy of this is only now beginning to be perceived, even by professed teachers of science. It is true that the chemists have long had their laboratories and the human anatomists their dissecting-rooms; but the notion that no course of lectures on physics, biology, or geology is complete without a corresponding course of practical work, is the product of the last few years, and is even now unrecognised in some British universities and in the large majority of schools.

And yet, one would think, nothing could be more obvious. The whole end and aim of science teaching is to bring the student into direct contact with nature; to insure his knowing, as he knows his multiplication table, the main laws upon which natural phenomena depend, and to make him see, without any possibility of mistake, the relation of those laws to the facts of the universe as he is able to observe them. What would be thought of a mathematical teacher who relied entirely on lectures, and never

[1] "Half-Culture in Germany," *Contemporary Review*, August, 1880.

dreamed of insisting that his pupils should apply what he had taught by working out examples for themselves? Or what of a teacher of art who ignored the necessity of making his students draw or paint? Every one sees the necessity of practical, and the uselessness of exclusively theoretical teaching in these instances, yet the fact is generally ignored that the case is precisely the same with scientific subjects, and that a man who lectures to beginners day after day and year after year on, for instance, the intricacies of animal structure and the problems connected therewith, without making his students see, by actual dissection, what an animal is, is in great measure spending his strength for naught.

Until this important fact is recognised and proper provision made for it, natural science never will and never can be a power in education. As Mr. Matthew Arnold puts it, "To say that the fruit of classics, in the boys who study them, is at present greater than the fruit of the natural sciences; to say that the realists have not got their matters of instruction so well adapted to instruction as the humanists have got theirs, comes really to no more than this: that the realists are but newly-admitted labourers in the field of practical instruction, and that while the leading humanists . . . have been also schoolmasters, and have brought their mind and energy to bear upon the school teaching of their own studies, the leaders in the natural sciences . . . have not. When scientific physics have as recognised a place in public instruction as Latin and Greek they will be as well taught."[1]

When these remarks were written (in 1868) they were applicable to science-teaching not only in schools, but also, in great measure, in universities and colleges. But since that time great changes have taken place, and in biology, of which science alone I am competent to speak, the improvement is due, first of all, to my honoured master, Prof. Huxley, and next to his co-worker, Dr. Michael Foster, both of them brilliant examples of the fact that an eminent man of science may be at the same time a laborious practical teacher. The classes begun by Prof. Huxley, with the co-operation of Dr. Foster, at South Kensington, and since continued at the School of Mines by Prof. Huxley and Mr. Thiselton Dyer, at Cambridge by Dr. Foster and his pupils, at Oxford and University College, London, by Prof. Ray Lankester, have now fairly put the teaching of biology upon a sound footing, and may be said already to have proved the value of that science as a true mental discipline, an educational instrument of very high order.

At any rate this is proved as far as University education is concerned. The battle has still to be fought in the secondary schools, and, as every one must see, the circumstances there are so different that victory in the one case is no criterion of victory in the other. It is evident, in fact, that the strict training in observation and experiment, without which, I cannot insist too often, science teaching is valueless as a mental discipline, is very difficult of application in schools, and that the consequences of setting a large class of young boys to make oxygen, or take a specific gravity, or cut up a rabbit each for himself, might prove rather subversive of order than conducive to improvement. But it has been amply proved that there is no difficulty in the case of senior boys taken in comparatively small classes; and even in large classes the practical teaching of elementary botany is quite feasible, as is shown by the experience of our own High School. Botany, indeed, lends itself more than any branch of science to school-teaching, from the simple fact that by its means the pupil can be brought face to face with Nature with comparatively little trouble, with no apparatus beyond a pocket-knife, and perhaps a simple magnifying-glass, and with no mess unremovable by a duster and broom.

For these reasons I am inclined to think that botany should be made the staple science subject for the junior classes in schools. If taught thoroughly, it necessitates the introduction of a good deal of elementary chemistry and physics, since the principles of vegetable physiology, which should on no account be omitted, cannot be explained without reference to the composition of air, earth, and water, the diffusion of gases, capillarity, chemical decomposition, and so on. Theoretically, no doubt, the foundation of a scientific training should be laid with mathematics, physics, and chemistry. As to the first of these there is no difficulty; but unless the two latter can be taught practically, it seems to me that the best thing is to be content with something less than the ideally perfect, and, with mathematics as the necessary introduction to abstract science, to take as our basis for the concrete study of Nature the facts and phenomena of plant-life.[1]

[1] "Higher Schools and Universities in Germany."

There is one consideration of the first importance, which every science teacher must keep in mind if he wishes his subject to have its proper value as an educational instrument, and that is the absolute necessity for demanding as much and as hard work from his pupils as the classical or the mathematical master. Unless this is done scientific subjects must always hold an inferior position, and the teaching of them can never be followed by adequate results. It behoves every one of us to remember that—

> "Von der Stirne heiss,
> Rinnen muss der Schweiss,
> Soll das Werk den Meister loben,"

and that, if we are satisfied with a minimum of work from our pupils, we must also be content with a minimum of respect for our teaching. As long as in our Matriculation and Junior Scholarship examinations a pupil can pass creditably in a scientific subject by getting up a text-book, while to obtain distinction in classics or mathematics requires prolonged and thoughtful work, so long will science-teaching in schools fail to have any real educational value.

I should like to make it perfectly clear that I am not making the slightest attempt to uphold the absurd notion that science should replace the strict study of language and literature, or of mathematics. All that I plead for is that it should be put on equal terms with them, and should no longer be handicapped by a totally inefficient method of teaching, and then condemned as wanting in the essentials of a strictly educational subject. Those who advocate a return to purely classical instruction because of the acknowledged failure of book-science are comparable to politicians who can see no remedy for the excesses of a revolution save a return to despotism. The whole case as between scientific and literary instruction is so admirably put by Mr. Matthew Arnold that I cannot resist the pleasure of quoting the passage:—"The aim and office of instruction, say many people, is to make a man a good citizen, or a good Christian, or a gentleman; or it is to enable him to do his duty in that state of life to which he is called. It is none of these, and the modern spirit more and more discovers it to be none of these. These are at best secondary and indirect aims of instruction; its primary and direct aim is to enable a man *to know himself and the world.* Such knowledge is the only sure basis for action, and this basis it is the true aim and office of instruction to supply. To know himself a man must know the capabilities and performances of the human spirit; and the value of the humanities, of *Alterthumswissenschaft*, the science of antiquity, is that it affords for this purpose an unsurpassed source of light and stimulus. . . . But it is also a vital and formative knowledge to know the world, the laws which govern Nature, and man as a part of Nature. This the realists have perceived, and the truth of this perception, too, is inexpugnable. Every man is born with aptitudes, which give him access to vital and formative knowledge by one of these roads; either by the road of studying man and his works, or by the road of studying Nature and her works. The business of instruction is to seize and develop these aptitudes." And again: "The grand thing in teaching is to have faith that some aptitudes of this kind every one has. This one's special aptitudes are for knowing men—the study of the humanities; that one's special aptitudes are for knowing the world—the study of Nature. The circle of knowledge comprehends both, and we should all have some notion, at any rate, of the whole circle of knowledge. The rejection of the humanities by the realists, the rejection of the study of Nature by the humanists, are alike ignorant."

Until within the last few years the position of science, and especially of biology, in universities and colleges, was quite as unsatisfactory as in schools. In the days when zoology was taught merely by lectures, and a man to insure success in examinations had only to "cram" his notes or a text-book and perhaps be able to tell a mammal's skull from a bird's, or a bivalve shell from a coral, it was not unnatural for the votaries of the older forms of culture to look upon "science" as a sort of academic Alsatia—a useful-enough refuge for the stupid, the lazy, and the eccentric, but something quite

[1] For this reason I cannot but regret that in the regulations for Junior Scholarships approved by the Senate at their recent meeting, biology is only counted as of equal examination value with a single branch of physics: so that while a candidate can take up physics alone of science subjects, he is obliged, if he select biology, to take in addition either chemistry or a branch of physics or mechanics.

beneath the notice of a man with a fair share of intellect and diligence.

And this opinion was quite justified by the facts. In my own University—London—until quite recently, there was no evidence of practical knowledge required in any branch of science except botany, for the degree of Bachelor of Science. A fair amount of mathematics and mathematical physics were demanded; but the chemical standard was miserably low, and the zoology, physiology, botany, and geology were such that no experienced examinee would wish for more than a month's reading for each, with perhaps an extra fortnight in the case of botany to enable him to learn enough of the art of describing plants. But now that a searching practical examination is enforced in these subjects, the degree has a real value—it is evidence that a man has done real work.

The case is very similar at Cambridge. Formerly, the Natural Science Tripos was a bye-word—a sort of back-door to a university degree. Now, thanks in great measure to Dr. Foster, the chances are that a man who takes high honours in that Tripos will be the intellectual equal of a high wrangler or of a high classic.

Considering that this regeneration of biological teaching began only about ten years ago in London and Cambridge, I think New Zealand is distinctly to be congratulated upon the fact that the first professor of biology in the Colony—my predecessor in this Chair, Captain Hutton—was also the first to inaugurate the true method of teaching that science in the Australian Colonies. It is by no means the least important debt which the Colony owes to Prof. Hutton, that he, having made his reputation as a systematic zoologist, voluntarily undertook the labour—no light one—of organising, in connection with his lectures, a class for regular practical instruction in comparative anatomy. I must confess to a slight feeling of disappointment at finding, on my arrival here, that the revolution I had expected to initiate was already well under weigh.

(*To be continued.*)

THE ELECTRICAL DISCHARGE, ITS FORMS AND ITS FUNCTIONS[1]

I.

If we knew as much about electricity as we know about sound or light, we should be still a long way from having learnt all that we could wish, but we should know far more than we do now.

For instance, in the matter of sound, we know, in most cases, the nature of the air disturbance to which it is due, and the mechanism whereby that disturbance is effected; and we have ascertained the magnitude and character of the aërial waves on which sound is carried. We know, in fact, what it is which is transmitted, and the velocity and direction in which that transmission takes place.

Again, in the matter of light, although we do not know the exact nature of the disturbance to which luminosity is due, nor the mechanical process by which that disturbance is effected; although we are not even certain whether the ætherial waves, to which light is attributed, have an actual existence or not, we nevertheless do know that something which is capable of being represented by wave motion is transmitted along a ray of light; its direction is a matter of simple observation, and we have determined the velocity with which it travels.

But when we come to electricity our knowledge is much more at fault. We know, it is true, how to produce electricity or electrical action, as well as how to transmit it, by means of wires, to a distance; we know also that there is a dissymmetry at the two ends or "terminals" of a battery or machine, or other source of electricity, implying a directional character either in that which is transmitted, or in the mode of its transmission. But we know neither what electricity really is, nor the process whereby it is transmitted. And although, on account of the dissymetry above mentioned, we cannot divest ourselves of the idea of direction, yet we have as yet no certain clue to the actual direction in which the transmission can be said to take place. It has, indeed, been shown, by the late Clerk Maxwell and others, that the mathematical expressions for the properties of a medium, whose vibrations are capable of representing the phenomena of light, are the same as those of a medium whose vibrations are capable of representing those of electro-magnetism; and that, on the supposition that light is an electro-magnetic phenomenon, the velocity of propagation of electro-magnetic disturbances is the same as the velocity of light. But an identity in the mode of mathematical representation does not decide anything about the physical facts in either case, nor does it even prove that the facts are the same in both cases. And lastly, even granting that there is actual motion along the wires, neither the mathematical formulæ nor the experimental facts can as yet decide whether the motion, or "current" of electricity, is to be considered as starting from one terminal and arriving at the other, or as starting from the second and arriving at the first; or, indeed, whether the motion may not be in some sense double, in both directions at once.

In this somewhat unsatisfactory state of ignorance we approach the subject of this evening's discourse. And although I cannot hope in any adequate sense to resolve these difficulties, I propose to explain what progress has been made towards a solution of them, and to indicate the direction which appears to offer the best promise of success in the prosecution of further research.

Into the various modes of producing electricity it is not my intention now to enter. I shall use them indifferently as may be most convenient, explaining only in general terms any differences which may be of consequence for understanding the various experiments shown in illustration of my argument. It will, in fact, be assumed that electricity has been produced by some known means or other, and our object will be to examine it in the course of its passage, with a view of obtaining some information as to its nature and its mode of transmission.

As a matter of fact we have here as our sources of electricity, first, a Holtz machine, or, rather, Prof. Töppler's modification of it), which produces electricity in a condition similar to that given off by the ordinary frictional machines, although it effects this by a different method; secondly, a battery, or arrangement of metallic plates and acid, wherein a flow or "current" of electricity is produced by the action of the acid upon the metal; thirdly, a dynamo-machine, such as those invented by Gramme, Siemens, Brush, or others, which produces a current similar to that from the battery, but by means of the expenditure of mechanical force in moving coils or other closed circuits of wire within the influence of an electro-magnet, or, as it is usually termed, within a magnetic field; fourthly, a magneto-machine by De Meritens, producing, on a principle similar to that involved in the dynamo-machine, a series of currents, but with permanent magnets, and in this case in alternate directions; fifthly, an instrument called an induction-coil, the object of which is to produce from currents of one character currents of another, in a way to be presently described; and, lastly, we have Leyden jars or condensers for accumulating large charges in a manner which will allow of their being discharged all at once.

Now, in the first place, suppose we make use of the battery, or of the dynamo-machine, producing a direct and practically uniform current; then, if the wires carrying the current be closed, no directly visible effect is produced. I say "directly visible" because indirectly we can prove that a wire carrying a current is in a condition different to one not carrying a current. One way in which this may be shown is the following:—If we bring an ordinary piece of copper wire into the neighbourhood of some iron filings, the filings are indifferent to its presence when it is in its natural state; but as soon as the wire is made part of a circuit through which a current is flowing, the filings are attracted by it as if by a magnet. When the circuit is broken, so that the current is interrupted, the filings drop, and the wire resumes its ordinary condition. This property of a wire carrying a current is, however, beside our present purpose, and I mention it only in order to show that the passage of an electric current is not without its effect on a closed circuit, even when no result is directly visible.

The magnetic effect which we have just seen is not, however, the only effect which a current produces in a closed circuit. If in a galvanic circuit, supposed to consist otherwise of copper wire, we interpose a piece of different metal of a kind called refractory on account of its bad conductive power, such as platinum or iron, or a sufficiently thin piece of the same wire, we shall find that when the current is passing, the interposed wire becomes hot; and if we increase the strength of the current, or reduce the thickness of the wire—in other words, if we increase the quantity of electricity flowing through the platinum, or diminish the size of the platinum conductor which has to carry it—we shall find that the temperature is proportionally increased. A similar increased temperature will be produced by

[1] A Lecture delivered before the British Association at York on September 5, 1881, by William Spottiswoode, D.C.L., LL.D., President of the Royal Society.

shortening the wire, although the explanation of the phenomenon is not quite so simple. If the same process be carried further, the platinum will become white-hot, and if it be carried still further, the platinum will be fused. The Swan, the Maxim, the Lane-Fox, and the Edison lamps, in which the light is due to the incandescence of a fine thread of carbon, are beautiful instances of the application of this principle.

The platinum, which does not allow the electricity to pass along it with the same facility as the copper, is said to offer "greater resistance" than the copper of the same thickness to the passage of the current; and if we were to measure by a suitable instrument the quantity of electricity which passed through the circuit when the platinum was interposed, and were to compare it with that which passed without the platinum, we should find that the quantity was diminished by the interposition of the platinum. The energy which, as electricity, disappears in its passage through the platinum is, however, not really lost, but reappears in the form of heat.

Instead, however, of interposing in the circuit a length of resisting metal, we may break the circuit altogether, or (to express the same thing in different words) we may interpose an interval of air. In such a case the electricity will no longer flow freely as it does through copper, or even push its way as it does through platinum, but it will traverse the interval only in a disruptive manner in the form of a flash or spark; and it is to be noted that the interval over which the passage can be made to pass, or length of spark, does not depend, at least in a direct manner, on the quantity of electricity employed or "strength of current," but rather upon the quality of it. This quality is called "tension," and it is measured by the strength of current which it can maintain, or cause to flow, through a given resistance. The force called into play in the process is called "electro-motive force." Without attempting to go fully into the subject, we may illustrate the relation of quantity or strength of current to tension or electro-motive force in general terms by reference to the instrumental means requisite for their production. Thus it is usually stated that in a battery the quantity depends upon the size of the plates employed, and the tension upon the number of cells; and similarly, that in a magneto- or a dynamo-machine, the quantity depends mainly on the thickness of the wire used in its construction, and the tension upon the number of convolutions or length of the wire in the coils for a given speed of working, or for a given number of convolutions, upon the speed at which the machine is driven.

In further explanation of this, however, it should be pointed out that the current generated has, independently of the external circuit, to pass through the cells of the battery, or through the wires of the machine, both of which offer resistance. When a strong current is required, this resistance may be diminished by increasing the size of the plates in the case of the battery, or by increasing the diameter of the wires in that of the machine. In the latter case it must be borne in mind this increase in diameter usually involves a diminution of length on account of the necessary limitations in the dimensions of the machine, and consequently also of electro-motive force. This must be compensated either by increasing the speed of the machine or by augmenting the strength of the field magnets.

With the Holtz machine the matter is a little different. The quantity of electricity produced depends on the amount of surface of the revolving plates passing in front of the collectors in a given time, and consequently for a given machine upon the speed at which it is driven. Thus there is nothing either in the construction of the machine nor in its internal working which can alter anything except the quantity of electricity produced, and we must therefore look to the circumstances and mode of discharge for a determination of the tension of the electricity evolved.

The induction-coil is an instrument for producing from currents of large quantity and low tension others of high tension, but of small quantity. It consists mainly of two parts, viz. a primary coil of thick wire and few convolutions, through which intermittent currents are sent from a battery or machine; and a secondary coil outside, but not connected with the former, of fine wire and many convolutions, through which by a kind of sympathetic or "inductive" action temporary currents are set up every time a current begins or ceases in the primary. The tension of the induced currents depends fundamentally upon the length of wire or number of the convolutions in the secondary coil. There are several other parts of the instrument which are important for its working, which, however, it is not necessary for our present purpose to particularise.

From this digression we may now return to our main subject; and taking it up again at the point where we left it, viz. the heating of resisting metals, we may vary the experiment by taking a piece of iron wire, and bringing to bear upon it some of the induced high tension currents from the induction-coil. It will now be found that if the sparks follow one another with sufficient rapidity, the wire will not have time to cool during the interval between two successive sparks, and that it will burn like a match or other combustible substance.

If, however, we use, instead of iron, some metal very difficult of fusion, or "refractory," as it is called, such as iridium, the consumption of material will be extremely small; and in the incandescent terminals we shall have a source of light of considerable power. And further, if the terminals be inclosed in an envelope impervious to air, and either well exhausted or partially filled with suitable gas other than oxygen, nitrogen for example; then the loss by oxidation will be reduced to an insignificant amount. On this principle Mr. Gordon has constructed a lamp, which consequently has, at all events, the scientific interest of occupying a position intermediate between the incandescent and the arc lamps.

Lastly, if we accumulate a large quantity of electricity in a Leyden jar, and discharge it all at once through a thin wire or film of badly conducting metal, we shall cause the metal (in this case a strip of gold leaf) to be not only fused but to be shattered or deflagrated, in the manner which you will immediately see. The image of the gold leaf is now thrown on the screen, the jar is charged by currents from the induction coil, and is discharged through the metal. The gold leaf is now shattered by the passage of a high tension charge, the quantity of which is greater than it can carry; and in the image of its remains we may trace indications of the forces which have been at work in the process of destruction. Observe, in particular, how the particles have been thrown laterally outwards, as if by an explosion from inside the gold leaf. In the alternations of range of the laterally scattered particles Mr. De La Rue traces an analogy to the phenomena of striation described below. And if these alternations are not due to diversities in the conducting power of the wire at various points, but to resistances set up periodically by the discharge itself in its passage, the two phenomena must certainly have something in common.

I do not, however, propose to pursue these forms into greater detail, because the subject to which I wish more particularly to draw your attention, as the most fruitful both in results actually obtained and in promise for the future, is the passage of the discharge through air and other gases. And I have adduced these experiments with metallic substances in order to show that the discharge through them is capable of various modifications, analogous to those which we shall presently see in gaseous media.

Turning then our attention to gases, it will be convenient, for instrumental and other reasons, to invert the order of experiments, so as to begin with the form of discharge which corresponds to the deflagration experiment, and to proceed thence to less violent forms.

We will now make use of the Holtz machine. If, while the instrument is in action, we separate the terminals to any moderate distance, the discharge will take the form of a bright spark extending usually in an irregular line from one terminal to the other. If, instead of discharging the machine or coil in this manner, we charge a Leyden jar, and then discharge it; or if, what is substantially the same thing, we insert a Leyden jar in the circuit, allowing it to become charged and to discharge itself, then the discharge is of a character similar to that above described, except that it is shorter in span, and at the same time more brilliant in illumination. This is due to the greater quantity of electricity discharged at once. It is moreover to be observed that, however great the quantity of electricity passing in this manner, the discharge appears to be absolutely instantaneous. It is moreover a curious circumstance, attested by many experiments, that the form of discharge in which a Leyden jar is used appears to be incompetent of itself to communicate heat to even inflammable bodies. Thus, such a discharge will pierce a card without leaving any signs of charring behind; and it will disperse a heap of gunpowder, through which it passes, like a heap of sand, without exploding it. It may be added that gun-cotton itself, even in a state favourable to explosion, when exposed to a discharge of this kind, is not only not ignited, but merely shows signs of perforation like the card, without any blackening or indication of combustion. Whether these facts point merely to shortness of duration in the discharge such as to preclude the communication of heat-vibrations to the bodies traversed, or whether they imply some mode of motion with which heat has nothing to do, are questions which have been thrown out by those who have studied the subject.

In favour of the former view it should be stated that the spectrum of the spark proper, whether with or without the jar, shows bright lines, indicating the presence of metallic vapours. These of course imply a high temperature, although not necessarily any great quantity of heat. And if the duration of the spark itself be extremely small compared with that of the interval between two successive sparks, the period of cooling will be extremely long compared with that of heating, and the observed result is exactly what we might expect.

There is, however, one feature of the spark discharge proper which is perhaps especially deserving of remark, namely, the similarity, in appearance at least, of its passage through air with that of a spark through glass or other solid and non-conducting substances. In the latter case we are familiar with the manner in which it rends its way by a shattering and dislocation of the substance in its immediate path, while it leaves the other parts of the substance untouched, very much as does a bullet when shot through a pane of glass. The path, however, if of any considerable length, is never quite straight, and it sometimes divides itself into two branches. The analogy above suggested will be complete, and the phenomenon will be brought into harmony with other known facts, if only we regard the spark as being so rapid, so instantaneous, in its passage that the particles of air have not time to exercise their mobility during the period occupied by the spark in its passage through them. In this view, air itself in the presence of the electric spark is to be regarded as exhibiting a rigidity and brittleness comparable with that of glass itself.

If, the Leyden jar having been removed, the terminals of the

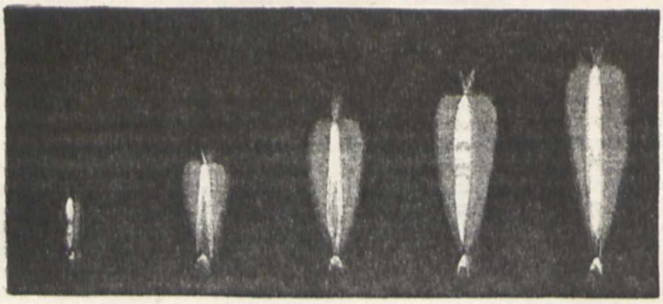


Fig. 1.

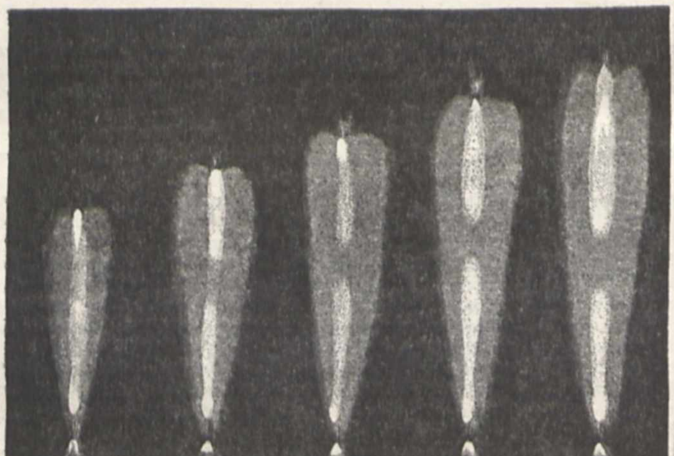


Fig. 2.

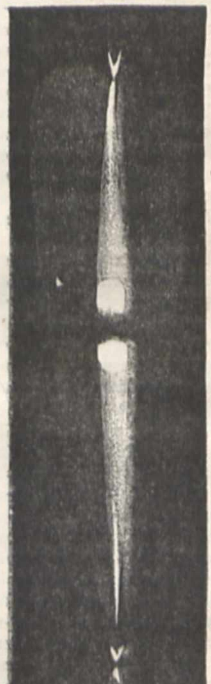


Fig. 3

Holtz machine be separated to a distance greater than that over which the spark will leap, a hissing or crackling noise is heard, indicating a rapid intermittence in the discharge, and a delivery, so to speak, of small quantities of electricity at a time. A minute examination of the phenomena occurring with terminals of different forms, and at different distances, has led to a classification of types of discharge under four main heads :—

1. The glow discharge : presenting a glow on the positive terminal, and a pencil of light issuing from the negative, and consisting of two portions with a dark space between them.

2. The brush discharge : consisting of a brush, viz., a stem and branches at the positive terminal, a pencil of light at the negative, and a dark space as before.

3. The band discharge : consisting of a band of light proceeding from the positive terminal, sometimes stratified, and separated from the negative glow by a dark space.

4. The spark discharge : showing in the spectroscope bright lines at both terminals. Two brushes of metallic vapour, that at the positive terminal being the longer, that at the negative the shorter and thicker. Two dark spaces are to be noticed in this form of discharge.

On the other hand, if the terminals be brought nearer together than they were at first, nearer, that is to say, than is suitable for the production of the spark proper, it will be noticed that the sharp cracking noise is replaced by a sound similar to that heard when they were beyond striking distance. The intermittence of the discharge becomes very rapid, and its colour assumes a reddish hue.

A full explanation of this almost abrupt change in the character of the discharge would probably involve a more profound acquaintance with the nature of electricity than we at present possess. But there is reason to think that something like the following takes place :—The path between the terminals once opened offers for a very short time considerable facility for the electricity to traverse it again. But the distance between the terminals being very small, the electricity coming from the machine soon attains the requisite quantity and tension, and the discharge is repeated before the facilities due to the preceding discharge are lost. The shortness of the interval between the terminals consequently acts in a double manner to facilitate the discharge, and thus renders the transition from one form to the other more rapid than it would otherwise have been.

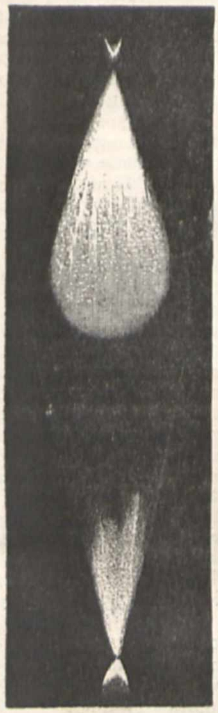


FIG. 4.

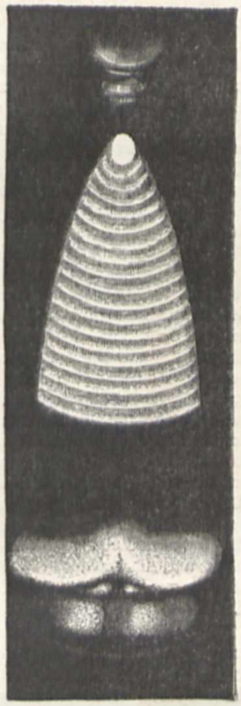


FIG. 5.

Observations with the spectroscope indicate that heating here takes place, and the revolving mirror shows that either in the discharge itself, or in the heating effects due to it, there is a manifest duration, all of which tend in the direction of the explanation suggested above.

The character of the discharge from the induction-coil both when the terminals are widely separated and when they are near together, is generally similar to that from the machine; but the durational character of the former is very much more marked than that of the latter; so much so, in fact, that with large coils the duration extends over a fraction of a second, perfectly appreciable by the eye without any auxiliary apparatus. This is due to the nature of the instrument, and is dependent both upon the time occupied by the core in losing its magnetism, and also upon the mutual induction of the convolutions of the secondary coil. The flame which accompanies the spark proper is the part of the discharge which persists; and it will have been noticed particularly when the coil is excited by the De Meritens' machine. The discharge produced from the secondary through the instrumentality of this machine is so remarkable, that it has been considered worth a special study. It has also been of great assistance in the examination of the action of a magnet upon a discharge; but the results of the latter experiments have not yet been published.

The form of discharge which we have now reached is substantially that which is known as the "arc," or comparatively quiet and continuous discharge between two terminals near to one another.

Turning to the arc, let us take the form most familiar to our minds, viz. that used in electric lighting. I now project on the screen an image of the arc as used in what are called "arc lamps." The whole consists essentially of two rods of carbon placed end to end, with a short interval between them. The interval is of a length capable of being traversed by the current, at all events after the discharge has been once established. By the passage of the current, which, in fact, constitutes the arc, the carbon becomes heated to a high degree. And it is important to understand that the main source of the light is to be found, not in the arc proper, but in the heated carbons. It will be noticed that, when a machine giving direct currents is used, the two carbons are not equally heated, and that during the combustion they acquire dissimilar configurations. This dissymmetry at the terminals is found to obtain in almost every species of electrical discharge.

With the construction and outcome of the various machines employed for producing the current, and with the mechanical contrivances used for maintaining the arc at its proper length and in its proper position, we are not here concerned. All that need be here mentioned is that the carbon which would be connected with the copper element of a Grove battery, if such were used, and which is called the positive, is the one more rapidly consumed. It becomes hollowed out, and incandescent particles may be seen occasionally traversing the arc, and landing upon the second or negative carbon. In the meantime the arc proper flows steadily between the carbons, the colour being determined by the nature of the terminals, or by that of any substance placed on their ends; and partly also by the nature of the gas in which the discharge takes place.

Let us now regard the terminals merely as parts of our apparatus, subsidiary to the main purpose, and fix our attention almost exclusively on the arc itself. If we had been working in the laboratory, I should have asked you to examine, with the aid of a microscope, the minute structure or anatomy of the arc. As it is, I must beg you to accept as a substitute for the phenomenon itself the following series of photographs, for which we are indebted to the skill and kindness of Mr. De La Rue, who has done so much with his unrivalled battery in this field of research.

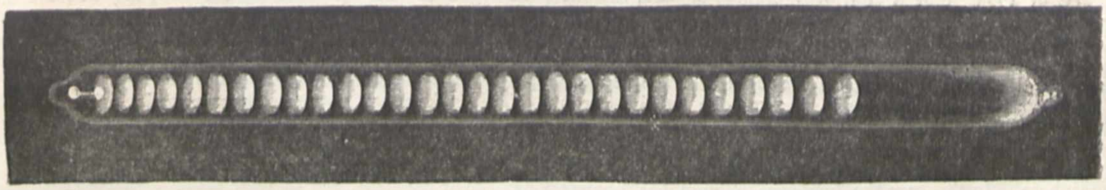


FIG. 6.

Figs. 1 to 5 are, in fact, magnified representations of the discharge through air at different pressures, beginning with that of the atmosphere, and extending in a series of decreasing pressure to about one 30th part of it. In Fig. 6 the pressure has been reduced to about a 2000th part of an atmosphere. In all these instances it will be noticed that there is a tendency on the part of the luminosity to break up into disconnected blocks, and that at an early stage it begins to separate from the negative, and to cling to the positive terminal. Also, that when the pressure is considerably reduced, these blocks are replaced by the beautiful system of flakes or "striæ" delineated in the last figure of the series. At this stage the dyssymmetry on which I have already insisted is complete.

The actual length of the discharges of which you have just seen the representations, varies in a tolerably regular manner with the pressure, from half an inch to ten inches or more. From this we may gather the important fact that in the discharge through gases at low pressures we have a magnified image of the discharge at higher pressures. By this statement it is not of course intended that every detail that is observable in the former cases can be distinguished in the latter; for the very nature of the gas, its viscosity or other properties, may prevent this. But all the characteristic features which prevail at high pressures are found also at low pressures, on a larger scale and in more marked delineation. From this consideration, as well as from others to be noticed below, we are led to the conclusion that rarefied gases form a promising field for future research into the nature of the electrical discharge.

Proceeding on this basis, I now desire to present to you the actual discharge in two or three tubes from which the air has

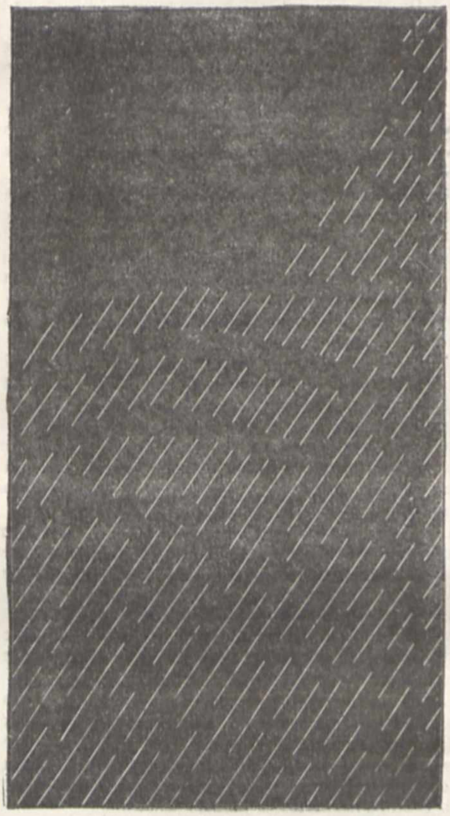


FIG. 7.

been exhausted in various degrees. In the first, where the pressure is that of about 3 or 4 mm. of mercury, or ·004, say one twenty-fifth part, of that of the atmosphere, the discharge takes the form of a column of light, slender in breadth and flexible in shape, extending throughout the entire length of the tube. The colour of the discharge depends on the nature of the residual gas. In the present case that gas is air; and the reddish hue is due to its constituent, nitrogen.

In the next tube the exhaustion has been carried further, viz., to a pressure of about 2 mm., or ·0026, say one-fortieth part, of an atmosphere. In this case the luminous column has become thicker; there are traces of a dark interruption towards the negative end; while beyond this break, and about the negative terminal, the light is no longer red, but of a deep blue colour. This strong contrast of colour at first sight appears inexplicable, and as a matter of fact the difficulties of explanation have not yet been altogether surmounted. But these difficulties are much diminished by a spectroscopic examination of the phenomena, from which it appears that, notwithstanding the contrast between the light near the negative terminal and that in other parts of the tube, the spectrum of the former differs from that of the latter, generally, not in its fundamental character, but mainly in the addition of certain strong lines in the blue and violet. Besides this, there is occasionally a weakening of the lines in the less refrangible part of the spectrum seen in the light of the positive column. The extension of a spectrum in the direction of the more refrangible end is known generally to depend upon an increase of temperature; and as there are other grounds for attributing a higher temperature to the region near the negative terminal than to the other parts of the tube, it would seem that we must look to thermal conditions for an explanation of the contrast in question.

But, besides the contrast just described, some tubes show a diversity of colour in the same striated column. Or perhaps, more strictly speaking, there coexist two, or even three, columns (usually pink and blue, with an occasional intervening green) blended together near the positive, but more separated towards the negative end. At the negative end they are in some cases completely separated; in others they are united so as to give the appearance of parti-coloured striæ. In every case, however, the blue striæ are found nearer to the negative end than the green or pink.

In the next tube the pressure is about half a mm., or ·00065, say one 160th part of an atmosphere; and here we find the dark space near the negative terminal, observable in the previous case, greatly increased. But besides this, the whole column is no longer continuous, but is broken up into striæ with dark intervening spaces.

As the exhaustion proceeds the striæ become more and more separated, as well as individually thicker. At first mere flakes of light, they gradually increase in thickness, until they assume the proportions of blocks of light sometimes of larger dimensions in the direction of the axis of the tube than in that of the diameter. At the same time the main dark space between the head of the column and the solitary luminosity about the negative terminal, as well as the dimensions of that luminosity itself, increase in length. A dark space immediately surrounding the negative terminal, and limited by the solitary stria, also begins to show itself, and to increase with the exhaustion. This space has been named after Mr. Crookes, who first made a study of it. As we proceed yet further, the column retreats towards the positive terminal; and at the last stage the solitary luminosity shares the same fate. The Crookes' space occupies the whole tube, and no gaseous illumination whatever remains. To the phenomena which arise in this condition of things I will make allusion at a later stage.

This dependence of the distance between the striæ upon the pressure of the gas may be well illustrated by using a tube fitted at one end with a chamber containing potash. The potash has the property of absorbing gases of almost every kind, of giving them out when it is heated, and of re-absorbing them when it is allowed to cool again. This process may now be seen in actual operation.

The number and disposition of the striæ will naturally depend also on the length of the tube. The effective length may be altered without altering any other conditions of the experiment, by having one terminal attached to the wire leading into the tube by a flexible spiral wire; so that the terminal itself may be shifted. At first sight it might have been supposed that any change due to an alteration in the length would have depended very much upon whether the shifting terminal is the positive or the negative. But whichever be the case, the striæ are seen to drop one after another into the positive terminal; the solitary stria and the adjacent dark space remain unaltered, and no change is apparent beyond a reduction in the number of the striæ.

This is, however, not the only way in which the disposition of the striæ may be made to vary. In some gases at suitable pressures an increase in the strength of the current used, or in the quantity of electricity discharged through the tube, reduces the number of the striæ, and to some extent shortens the column by drawing or driving the striæ one by one into the positive terminal. In such a case it also increases their mutual distances in the same manner as if they were threaded on an elastic string. In other gases the reverse is the case. Thus, in this sulphide of hydrogen tube, the striæ in the column are numerous and crowded while the machine is in rapid motion. As the speed is diminished the striæ recede from one another, until only a few lingering specimens are left, separated by the broad dark and mysterious spaces which you now see.

The long continuance of the discharges from the induction coil afford an opportunity of examining the various phases of striæ during their existence. The details of the instrumental arrangements, as well as other particulars of the observations, have been elsewhere described; but the main features observed may be apprehended by the illustrations subjoined.

Fig. 7 represents the appearance of (in the mirror) a carbonic-acid tube with the slit attached. This tube, viewed by the eye, shows flake-like fluttering striæ, with a slight tendency to flocculency near the head of the column. The commencement of the discharge is at the right hand, and the negative terminal at the top. The drawing fairly represents the appearance of the upper part or head of the column of striæ during one complete coil-discharge. When the battery-surface exposed is small, the whole consists of, first, three or four columns of striæ of decreasing length, and afterwards of an almost unbroken field of striæ. Each of the initial columns is perfectly stratified; and the same disposition of striæ prevails throughout the entire discharge. The striæ which fill the main part of the field present a proper motion, that is a motion along the tube during their period of existence, usually steady and towards the positive. In this case it is nearly uniform, but slightly diminishing towards

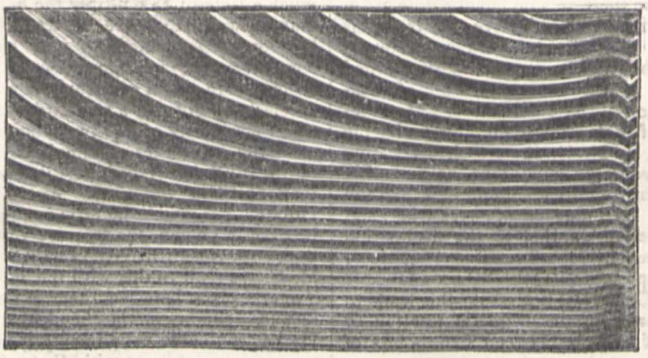


Fig. 8.

the end. These striæ are for the most part unbroken, but are occasionally interrupted at apparently irregular intervals. When the battery-surface is increased, the elementary striæ are more broken, and near the head of the column the interruptions occur as in the figure.

Fig. 8 represents the discharge in a hydrogen-tube of conical form, the diameter of which varied from capillary size to half an inch, the capillary end being at the bottom. The positive terminal is at the top. The principal interest of this tube consists in showing the influence of diameter upon the velocity of proper motion. The wider the tube the freer, it seems, the striæ are to move.

The same fact may be observed by comparing tubes differing in diameter, but in other respects the same; but the conical tube brings out the fact in the most striking manner.

Fig. 9 represents a chloroform-tube, in which a piece of

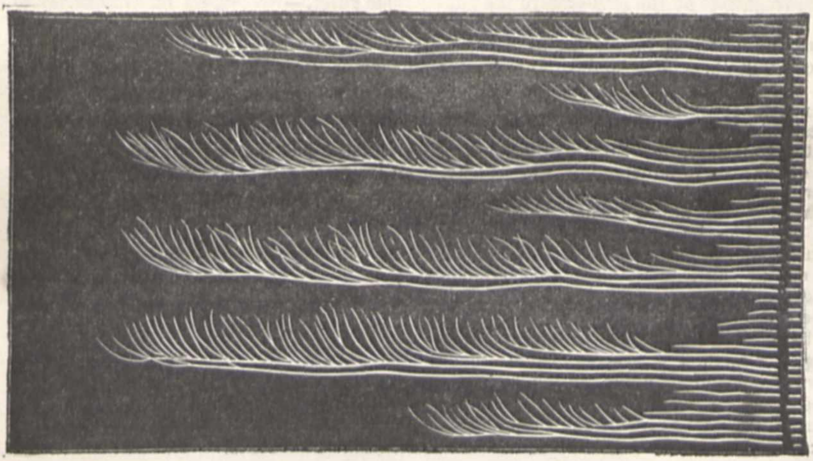


Fig. 9.

cotton-wool had been inserted with a view of ascertaining whether any motion would be communicated to it by the current. This proved to be the case; but I do not attempt here to describe the phenomenon. To the unassisted eye the discharge was extremely brilliant; it passed in a column not quite straight, but in a writhing, snake-like curve, with flaky striæ at intervals through its length. When viewed in the mirror the striæ were seen to spread themselves out with slight, but irregular, proper motion. With an increased battery-surface, or with a greater number of cells, but more notably with the latter, not only were the striæ lengthened, but from several of the long elementary striæ shorter ones were thrown out nearly at right angles to the former. These were of short duration, and had great proper motion. The general appearance of these compound striæ was that of branches of fir trees, the twigs of which represented the permanent striæ, and the leaves the secondary.

(To be continued.)

SOCIETIES AND ACADEMIES

Paris

Academy of Sciences, Sept. 19.—M. Wurtz in the chair.—The president gave a welcome to the foreign members of the International Congress of Electricity who were present, including Clausius, Clifton, Du Bois Reymond, Everett, Förster, Helmholtz, Kirchhoff, Melsens, Spottiswoode, Siemens (William and Werner), Smith, Stas, Thomson, Warren De La Rue, and Wartmann.—The following papers were read:—On the relative resistances that should be given, in dynamo-electric machines, to the active bobbins, the inductor electro-magnets, and the interior circuit, by Sir William Thomson.—On experiments made in 1826 on electric currents by lightning far from the place of observation, and on recent studies of M. René Thury on sounds of telephones during thunderstorms, by M. Colladon. M. Thury stretched a copper wire horizontally between two houses at the height of the roofs, and connected it with the water pipes, and with two telephones. The telephones gave a characteristic sound each time and at the same instant as a flash of lightning was seen, near or far (and even when no thunder was heard). It was like the sound of a Swedish match rubbed on the box. M. Colladon, in 1826, observed deflections in a galvanometer in Paris during a thunderstorm at a distance, while there was no cloud within 30° of the zenith, and M. Peclet describes like inductive effects in his "Traité de Physique" (1832). M. Colladon thinks the sounds will be best heard in the telephone when the air is surcharged with humidity. The telephone affords an easy method of measuring the velocity of transmission of those influences.—Measurement of rotation of the plane of polarisation of light under the magnetic influence of the earth, by M. H. Becquerel. Repeating his experiments under more favourable conditions, he finds that the yellow rays D, traversing horizontally a column of 1 metre of sulphide of carbon at 0°, under the influence of terrestrial magnetism at Paris, and in a direction parallel to the declination needle, undergoes a simple magnetic rotation of 0'·8697 from right to left for an observer supposed to lie with his head towards the magnetic north. In the C.G.S. system of units this leads to the number $1{\cdot}31 \times 10^{-5}$ as expressing the magnetic rotation of yellow rays through sulphide of carbon between two points of unit distance in a magnetic field equal to unity. (Mr. Gordon's figures, got by different methods, give $1{\cdot}24 \times 10^{-5}$ for sodium light.)—On the passage of projectiles through resistant media, on the flow of solids and the resistance of air to the motion of projectiles, by M. Melsens. He arranged experiments with a view to catching the air carried in front of a projectile. Lead balls (about 0·017m. in diameter) were shot into a hollow cone in a block of iron, the apex being of steel, and having an opening, smaller than the ball, into a gun-barrel communicating with a bell-jar in a reservoir. The gun, the reservoir, and the bell-jar were filled with water, which was prevented escaping through the cone by a light obstacle of paper or thin brass. Detached fragments of the lead entered the gun-barrel, the bulk of the ball stopping the hole of the cone, and appearing pointed, or with an oblong drop. The effects of the penetrating air are indicated in the cracks and rupture of the gun-barrel, the bell-jar, and the bent tube between them. M. Melsens considers the resistance of the air implies factors of which artillery has not taken sufficient account. This resistance is variable throughout the trajectory, in virtue of the mass of the projectile, the form of the mass of adherent air, the velocity, the thrust of the powder-gases, up to a certain distance from the gun, and, lastly, from the very brief moment when the projectile is equally pressed in all directions by air.—On new sulphurised salts produced with sesquisulphide of phosphorus, by M. Lemoine.—On tungstoboric acid and its salts, by M. Klein.—Determination of phosphoric acid by titrated liquors, by M. Perrot.—On some of the scientific researches contained in the manuscripts of Leonardo da Vinci, by M. Ravaisson. He calls attention to a passage recommending, as a method of hearing distant sounds at sea or on land, inserting one end of a tube in the water or in the earth, and putting one's ear to the other. M. Ravaisson is preparing the manuscript B, one of twelve in the Bibliothèque de l'Institut, for publication (to follow MS. A, published in December last).

September 26.—M. Wurtz in the chair.—The following papers were read:—Researches on the gymnotus in Venezuela, by the late Dr. Sachs, by M. du Bois Reymond. At the instance of Prof. du Bois Reymond, five years ago, Dr. Sachs went out with modern electrophysiological apparatus, to study the gymnotus in the marshy waters of the Llanos of Calabozo. Returning to Berlin in 1877, he set himself to composing a work on his observations in general, and was about to write specially on the gymnotus, when he lost his life by falling down a crevasse in the Alps of the Tyrol. The monograph now presented gives the results of his studies of gymnotus, with further valuable observations by Prof. Fritsch, who has worked out the anatomy of the animal, numerous specimens of which Dr. Sachs had brought home. M. Fritsch has been able to demonstrate in an almost certain manner the development of the electric organs through metamorphosis of striated muscles.—Results obtained in treatment of phylloxerised vines by the use of sulphide of carbon and sulpho-carbonate of potassium, by M. Henneguy. The vines treated with sulphide of carbon retain their greenness longer than those treated with sulpho-carbonate of potassium, but their branches are shorter and bear fewer grapes.—Observations relative to accidents to vines treated in 1881 with sulphide of carbon, by M. Pastre. These accidents have been mostly due to excess of humidity in a compact clayey soil. The sulphide either remains liquid, or evaporates in too little space; and in both cases (the former especially) it destroys the roots. A less frequent cause is too low temperature. Among rules M. Pastre lays down are these: To treat only well-dried ground, and vines not too much affected; to multiply the holes and diminish the doses; to manure well; to leave off treatment when the temperature is too low.—On trilinear forms, by M. le Paige.—Photometric comparison of luminous sources of different colours, by M. Crova. He uses a spectrophotometer. With two sources (say an electric light and a standard Carcel lamp), so placed that the mean luminosity of the two contiguous spcetra is the same, the ratio the intensities of simple radiations of one light to those of the other (corresponding) is represented by a fraction greater than unity in violet, and less in red, and there is one simple radiation for which the ratio is equal to unity. If this radiation be exactly known, the measure of the ratio of its intensities in the two spectra will give *exactly* the ratio of the total intensities. M. Crova realises this with the aid of two Nicol prisms having a quartz plate between them. The apparatus gives very exact results.—Studies on the chemical action of light, by M. Lemoine. He has compared experimentally, from various points of view, the influence of light with that of heat in chemical reactions; considering, more especially, isomeric transformations, and the influence of dissolution, temperature, organic matters, and colour. *Inter alia*, chloride of silver, so sensitive to light, is unaltered by it when dissolved in ammonia. The rate of chemical transformations often varies extremely with the temperature, for light as well as for heat. Presence of organic matters often accelerates a reaction in light and allows of its commencing at a lower temperature. For various substances which heat alone would decompose at low temperatures, the red end of the spectrum seems much less efficacious than the violet end; but in time both lights seem to produce the same effect.—Researches on tropine, by M. Ladenburg.—On a ureometer, by M. de Thierry. This apparatus, for determining the urea in urine of men and animals, is based on the process of decomposition of urine by hypobromite of soda. It is in two parts, one comprising a tube, with ampulla and stop-cock, adapted to a reservoir which communicates through a lateral tube of caoutchouc with the second part. This includes a test-tube, a graduated bell-jar, and a thermometer.—M. Larroque described an instrument for observation of meteors; it is a mirror having the form of a double pyramid.

CONTENTS