THURSDAY, APRIL 8, 1886

KINSHIP AND MARRIAGE IN EARLY ARABIA

Kinship and Marriage in Early Arabia. By W. Robertson Smith. (Cambridge: University Press, 1885.)

IT is almost, if not quite, an act of presumption to attempt to review Prof. Robertson Smith's book. The subject (the development of the family in early Arabia) is exceedingly obscure. The evidence is mainly drawn from books whose very names I never heard of before. In matters of Greek and Roman antiquities the evidence is handy, and may be estimated by one who only knows the usual classical tongues. In matters of early India, we have, at least, the German translations of the Veda and Mure's Sanskrit texts to help us, and Prof. Max Müller's English works, and all that Bergaigne, and Whitney, and Barth have written. But Prof. Robertson Smith's Arabian writers are wholly inaccessible to the ordinary anthropologist. He cannot presume to criticise the sources and testimonies, and I make no such pretension. One has to take the author's statements as he gives them, with the confidence inspired by his great renown as an Orientalist, and by the assent which, it is understood, other famous Eastern scholars give to his method and conclusions.

The thesis maintained by Prof. Robertson Smith is that in Arabia, as elsewhere, the Patriarchal family, where it existed, grew slowly out of a system, commonly called the *Matriarchate*, in which women were the acknowledged permanent element in the household. Such families are familiar to readers of Mr. McLennan's books, and Prof. Robertson Smith, on the whole, is chiefly occupied here in extending the sphere within which Mr. McLennan's opinions hold good. A period of promiscuity, or at least of brief informal unions, was succeeded by an age of polyandry, and consequent doubtfulness about male parentage in each case. This condition was gradually modified, for example, by brothers sharing the same wife, till the patriarchal family emerged from the confusion. Stocks of kindred were not so much gentes, like those of Rome, but totem kindreds, with relationship and the totem and family name descending through the woman, and, of course, with the exogamous prohibition against marriage between a man and woman of the same totem.

These, roughly, are the conditions whence, in early Arabia, Prof. Robertson Smith thinks that marriages and families with the husband and father for recognised centre were evolved. In many savage lands it is certain, in some civilised lands it is probable, that affairs have taken this course. But there is a very strong disposition to resist this conclusion among scholars who had it put before them rather late in life, when new ideas are distasteful. The existence of an older generation of doubters is most profitable to science. They exercise a constitutional check, and demand that proofs shall be very clear and unmistakable before they give up their old opinions. I do not expect Prof. Robertson Smith to make converts among the devotees of an original primæval patriarchal family. On the other hand, in my own case, he is "preaching to a proselyte." I am convinced that the order of development in which he believes has been very common if not universal. I think his theory colligates a great number of curious facts, and explains them at one stroke; whereas, if his theory is *not* accepted, I fail to see any one hypothesis, on the other side, that meets all the cases. These old survivals of customs will have to receive each its separate solution, or to be left unexplained as mere sports and curiosities. But, if Prof. Robertson Smith is right, they all fall into their proper strata, venerable fossils left by the tide of social progress, examples of laws known to have worked elsewhere to similar results. This appears to be an argument in favour of Prof. Robertson Smith's hypothesis.

When the Prophet started on his career, the unit of Arab society was the local group, feigned by genealogists to be a patriarchal tribe with a common ancestor. But the common ancestor's name often shows him to have been a fiction. "Many tribal names are plainly collectives." Some are plural animal names—Panthers, Dogs, Lizards—exactly such as we find in America, Africa, Australia, and India. Now, in these countries, the groups bearing such names are demonstrably *not* patriarchal, and demonstrably did grow up through exogamy and female kinship. If the similarly-named Arab tribes grew up differently, grew up on patriarchal lines and male kinship, the presence of beast names, like totem names, is a very curious coincidence. On the other view, Leopard, Wolf, Lizard was the name of the original or ideal ancestor. Now animal names as Christian names (so to speak) for individuals are common among savages. The personal name of a Red Indian whose totem and family name is "Crane," may be Wolf or Lizard. But as far as I know the *personal* name—the Christian name as it were—is always accompanied by an epithet, "Spotted Dog," "Sitting Bull," and the like, while the family or totem name is the beast, or plant, or another name *sans phrase*. For this reason I am disinclined to share Mr. C. J. Lyall's doubts (*Academy*, March 6, 1886). I think when an individual man has a personal name derived from a beast, it is a name with a qualification, as a rule. To a kindred calling themselves "Spotted Dogs," I would allow their claim to descend from a gentleman named "Spotted Dog," but a tribe called "Dogs" have a very totemistic air. However, so far, there is no certain demonstration. Arab tribes have many other names, divine or local, which cannot be derived from an actual ancestor. For these and similar reasons, Prof. Robertson Smith rejects the patriarchal origin of the several tribes, as conventionally given by genealogists. That explanation naturally occurred to men living in a state of male kindred, and the patriarchal family, but that explanation explains nothing. It does not, *e.g.*, explain tribes which refer their origin to a female eponym, an eponymous heroine. Nor does it explain why the Arab technical term for clan means "belly," just as, among aboriginal tribes of India, the native name for clan means "motherhood."

If we now examine marriage law, we find that by the prevalent type a woman goes to her husband's kin, and *her* children are reckoned of *his* blood, and take the side of *his* clan. But there are proofs that the opposite, the anti-patriarchal system, once existed. The man went to the woman's people (either permanently or on visits), and *his* children were reckoned to *her* blood, and took the side of *her* clan. Even now, among the Bedouins, a woman, it seems, rarely leaves her tribe, but strangers readily marry and settle in the tribe of their brides.

In the fourteenth century, a wife of the women of Zebîa would never follow a stranger husband, and she kept the children. The women of the Jâhîlya had the right to dismiss their husband, *the tent was theirs*. Ammianus mentions the gift of the wife to the bridegroom, a spear and a tent, he dwelt in *her* tent, and followed her people to the washing of spears. All this means *beena* marriage, as it is called in Ceylon. In marriages by capture, necessarily, the opposite rule prevailed. A woman went with the husband to his people, he is her lord, or *ba'al*, and thus *ba'al* marriage is the reverse of *beena* marriage. Purchase of wives naturally produced marriages of a *ba'al* type. As the two latter forms of marriage prevailed, women lost that independence in the wedded condition which they had enjoyed under *beena* marriage, thanks to the kindred of their own blood who surrounded them. Prof. Robertson Smith goes on to show the existence of various shapes of polyandry in early Arabia; there were "small sub-groups having property and wives in common as in Tibetan polyandry." In short, at the Prophet's time, the Arabs had already the orthodox family system with a paterfamilias, but previously there had been a system with a materfamilias, the house and children were hers, succession was through mothers, and the husband came to the wife, not the wife to the husband. The end of the book (Chapters VII. and VIII.) deals with traces and survivals of totemism. A list of tribal names derived from animals is given: the evidence that the animals were totems, worshipful, and not to be slain or eaten, is, naturally, scanty. In fact, though the analogies strongly point to the existence of totemism at a remote period in Arabia, I do not think the evidence will have much effect on the minds of the people who dismiss totems with the remark that they should be spelled *otes* or *otems*. A note (2, p. 221, see p. 304) is more to the point and more convincing. This note is of great religious interest and importance.

The tendency of the book, on the whole, is to show that among the Semitic races, as among Red, Black, and Yellow men, the matriarchal preceded the patriarchal family, and the totem kindred preceded the *gens*. That is precisely what one believes, but it is not in this generation that the doctrine will be universally accepted. In the case of Arabia proof is peculiarly difficult, as the reforms of the Prophet did so much to veil the remains of earlier religion and custom. It would be superfluous to praise a book so learned and masterly as Prof. Robertson Smith's; it is enough to say that no student of early history can afford to be without "Kinship in Early Arabia."

ANDREW LANG

FIELD'S CHROMATOGRAPHY

Field's Chromatography; a Treatise on Colours and Pigments, for the Use of Artists. Modernised by J. Scott Taylor, B.A. (London: Winsor and Newton, 1885.)

The Artists' Manual of Pigments. By H. C. Standage. (London: Crosby Lockwood and Co., 1886.)

THE new edition of "Field's Chromatography" differs in two important particulars from the previous issues of this well-known treatise. Firstly, one-third of the volume is devoted to a discussion of such parts of the modern theory of chromatics as bear upon the practice of the painter; secondly, a large number of useless or disused pigments and of substances suggested for use as pigments have been excluded from the pages before us. In accuracy and compactness this hand-book has undoubtedly been much improved, but it affords the student very little information upon two of the most important aspects in which artists should study their paints—those, namely, of purity and permanence. For instance, we are informed on p. 72 that "the artist will be told all that is known, outside manufacturing circles, of the constitution of his pigments." How is this promise redeemed? We turn to the description of white lead (pp. 97-101);—not a word can we find as to the presence in it of intentional adulterants or of such a frequent and injurious impurity as lead subacetate. We search in the same way and with the same result for some of the most rudimentary scraps of information as to the chemical characters and tests for the purity of vermilion, cadmium yellow, and artificial ultramarine. Then too we find statements as to individual pigments which are positively incorrect. It is not strictly true that the Naples yellow now sold is an imitation of the original pigment. One London house sells the original pigment—an antimoniate of lead, another supplies an equally good paint in which some oxide of zinc is associated with the antimoniate; neither preparation is an "imitation," made, say, with cadmium yellow and zinc white, and falsely called "Naples yellow." The question of permanence is not adequately discussed in this volume. We want numerical values representing the degrees of change suffered by those pigments with which the artist cannot dispense but which are known to alter under exposure. For example, it is misleading to call brown madder "very permanent" (p. 155): let any one try the effect of an exposure to a single summer's sunshine of a wash of this paint on a sheet of pure white paper. The same criticism applies to the statement (on p. 115) that the madder lakes are "not liable to change by the action of light." Certainly they cannot be termed fugitive in the same sense as the cochineal lakes, but they are by no means permanent. The editor of "Field's Chromatography" should have given more attention to gradations in the amount and nature of the colour-changes suffered by comparable pigments. In the tables of pigments in the appendix (pp. 171-185) no distinction is made between pigments used as oil-colours and those employed in water-colour drawings, although it is notorious that the medium has a marked effect upon the degree of stability shown by many pigments. And we altogether object to the accuracy of Table IV. (p. 176). Several of the pigments named in that list are entirely unaffected "by admixture with ochres and other ferruginous substances" instead of being "decomposed" by them as there stated.

The second work on our list has very slight claims on our attention. Mr. Standage's "Manual of Pigments" is stated on its title-page to show the composition of pigments, their degrees of permanency, their adulterations, and their mutual action; it also offers "the most reliable tests of purity." But when we examine into the chemical details given under the heads of the individual pigments we find that this compilation teems with the most ludicrous blunders. We proceed to cite a few of these, which need neither note nor comment in order to be fully appreciated by our scientific readers. On p. 1 we are informed that baryta white (barium sulphate) "consists of 137 equivalents (!) of barium, 32 equivalents of sulphur, and 64 equivalents of oxygen." On p. 3 we are furnished with an elegant test for the detection of free sulphuric acid in baryta white; we are directed to "add a few fragments of loaf-sugar to a largely diluted *solution* of the pigment, and evaporate to dryness. A black charred residue indicates free sulphuric acid." We are told (p. 7) that calcium imparts a *green* coloration to the blow-pipe flame. In testing verdigris for sulphate of copper we are informed (p. 21) that "sulphuretted hydrogen will throw down the *sulphur* present in it." Cœruleum (oxides of tin and cobalt) is stated to be made (p. 26) of "carbonate of soda 15 parts, powdered flint 20, and copper 3." Thénard's cobalt blue is "a salt of calcium calcined with alumina or oxide of tin" (p. 27). Indian yellow (p. 39) is "uriophosphate of lime" identical with "a magnesium salt of a curious acid called euxanthic." In order to see whether cadmium red (p. 47) contains any lead, "mix with white lead (!), boil in water, and add SH_2 to the solution." Red lead is said (p. 55) to undergo a "rapid oxidation" when mixed with sulphuretted hydrogen. Vermilion "must not be used with iodine" (p. 58). When chromate of lead is mixed with sulphide of cadmium, sulphide of lead is formed, and chromium, oxygen, and metallic cadmium are set free (p. 74). The iron in yellow ochre will if mixed with Naples yellow (antimoniate of lead) abstract oxygen from the latter and become deeper in tone (p. 76). Enough of Mr. Standage's chemistry: one line as to the value of his statements as to the theory of chromatics. On p. 81 he is good enough to inform us that from his own knowledge of colour-science he remains "steadfast to the old original theory of red, yellow, and blue being the three primaries."

We should not have devoted so much space to this curious little book if the present issue had been a first edition. But the majority of the extraordinary statements cited above were published by Mr. Standage in a work called the "Artists' Table of Pigments," of which the "Artists' Manual of Pigments" is to be regarded as a revision and enlargement.

OUR BOOK SHELF

American Journal of Mathematics, vol. viii. Nos. 1 and 2. (Baltimore, 1885, 1886.)

THIS volume opens with a memoir by Capt. MacMahon, R.A., on seminvariants, in which the author continues the discussion of the asyzygetic seminvariants commenced by nim in vol. vi., No. 2 (see also vol. vii. No. 1). Mr. J. Hammond contributes "Syzygy Tables for the Binary Quintic." One table replaces in part the enumeration given by Prof. Cayley in his tenth memoir on Quantics (*Phil. Trans.*, part 2, 1878) and that given by Prof. Sylvester (*Amer. Journ*, vol. iv. p. 58). The same writer has two papers in No. 2—one "On Perpetuants, with Applications to the Theory of Finite Quantics," this is a subject familiar to the readers of the *Journal* through Prof. Sylvester's brilliant papers, and is handled in the author's usual accurate and clear manner; the second paper is on "The Cubi-quadric System," and is likewise a following out of previous papers in the *Journal* the size of whose paper is admirably suited for such lengthy and wide tables. P. Seelhoff has two papers on the theory of numbers, "Prüfung grösserer Zahlen auf ihre Eigenschaft als Primzahlen" and "Nova methodus numeros compositos a primis dignoscendi illorumque factores dignoscendi." The first is a continuation of a paper in vol. iii. No. 3, and puts in the forefront a remark of Mr. Glaisher's: "The process of determining without a table the factors of a number is excessively laborious. Thus to determine, for example, whether the number 8559091 is or is not a prime, would require a long day's work." Upon this the writer remarks "Sehen wir zu!" There are ten pages of tables. The memoir by Dr. Emory McClintock entitled "Analysis of Quintic Equations," is a very interesting and apparently thorough discussion of the subject, with full historic references. Dr. T. Craig contributes a paper "On Linear Differential Equations whose Fundamental Integrals are the successive derivatives of the same function." This paper runs on into No. 2. The same writer closes the number with a memoir "On a Linear Differential Equation of the Second Order." Messrs. E. H. Moore and C. N. Little, in their "Note on Space Divisions," follow on the lines of Pilgrim's "Ueber die Anzahl der Theile, in welche ein Gebiet k^{ter} Stufe durch n Gebiete $(k-1)^{ter}$ Stufe getheilt werden Kann," and discuss the division of flat space of k dimensions by flat spaces of $k-1$ dimensions. In a "Note on a Roulette" Dr. A. V. Lane discusses that generated by the rolling of an ellipse on a right line, one extremity of the major axis being the generating point. Mr. H. B. Fine contributes a paper "On the Singularities of Curves of Double Curvature," and Mr. J. C. Fields has a notelet, "Proof of the Theorem—the equation $f(z) = 0$ has a root where $f(z)$ is any holomorphic function of z."

Burma, as it was, as it is, and as it will be. By James George Scott ("Shway Yoe"). (London: George Redway, 1886.)

MR. SCOTT'S position as a competent and instructive writer on Burma was assured by his volume on "The Burman; his Life and Notions," published a few years ago. In this work he showed an intimate knowledge of the habits and modes of thought of the Burmese which could only have been acquired by a mastery of the language and a familiarity with the inner life of the people such as few Europeans can obtain of any Oriental nation. The present work is, no doubt, published in view of recent political events which have naturally attracted public attention especially to Upper Burma. In it the reader will find the whole subject treated in a general way, the first section being devoted to history, the second to geography, the third to "the people," under which head we find information respecting the method of administration, the religion, superstitions, and social habits of the Burmese. It is inevitable that the book should have a somewhat encyclopædic air, but Mr. Scott's entertaining style should gild the pill for the "general reader." Moreover, there are no really popular books in which the comprehensive information here given can be obtained in English. The average reader can hardly be expected to master the large works of Fytche, Yule, Craufurd, and others, merely in order to get some accurate information about one small portion of the British Empire. In this respect the book is of a kind more familiar to French than to English readers; but it is much more than a mere catchpenny publication to meet a superficial and temporary demand. Readers of this journal, for example, may find much in it of special interest to them. The sketch of Burmese cosmogony and mythology is very interesting. The story of the forbidden fruit is familiar in Burma, the place of the apple being taken by the seeds of a species of creeper, and the fall being gradual instead of immediate.

Another point of much importance at the present moment is dealt with at comparative length. We refer to the hill-tribes in the mountainous region to the north of Burma, and especially between Bahmo and Momien. These call themselves by many different names, Chyens, Kyaws, Paloungs, Khamis, Mros, &c., but a closer examination of dialects, and especially of traditions and customs, proves, says Mr. Scott, that they are merely waifs and strays from the four main stocks, Burmese, Peguan, Karenns, and Shans. The Salones of the Mergui archipelago, some of the Arakan hill-tribes, and the notorious Kachyens in the north, are apparently exceptions, but all the others belong to one or other of these four families. The Kachyens just mentioned are so called by the Burmese; they call themselves Singpho, or Singpaw, which means simply "men." Ethnologically they are a branch of the Singphos proper, who inhabit the northern Assam hills, and are better known to us by their local names of Gáros and Nagas. Such at least is Mr. Scott's account of them; but it is quite clear that the last word has yet to be said by ethnologists about these and other tribes adjoining our new territory. The last pages of the volume are devoted to an account of the habits, manners, superstitions, &c., of these hill-tribes. The writer would probably be the last to expect a very high position for this volume as one of original research or information; but he may fairly claim to have performed a task of much usefulness and interest in a thorough and workmanlike manner. He has placed within easy reach of his countrymen sound and accurate information about a region for the peace, order, and good government of which they have now assumed the responsibility; and Mr. Scott's own previous writings are mainly responsible for having deprived part at least of the present book of the merit of originality likewise.

Marvels of Animal Life. By Charles Frederick Holder. (London: Sampson Low, Marston, and Co., 1886.)

THE author, during a long residence among coral reefs somewhere on "our southern border"—we have failed to find exactly where—studied very diligently the various forms of marine life abounding in such places, and he seems to have been attracted more especially to the study of the fishes. From the interesting records of these observations to be found in this little volume there can be no doubt that Mr. C. F. Holder has been a close and intelligent student of nature, and he has grouped the observations of others with his own in a manner to make the record fairly interesting reading to a specialist. To the wider field of young students some of the escapes from whales and swordfish will prove even exciting reading, while, so far as we can judge, none of the chapters convey erroneous or exaggerated views of the marvels of animal life. The illustrations, of which there are thirty-one, in the form of plates, are often rather sensational, and the majority of them would hardly be claimed as after nature. The work is sure to be popular, from the very novelty of the subjects about which it treats.

LETTERS TO THE EDITOR

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

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

Integer Numbers of the First Centenary, satisfying the Equation $A^2 = B^2 + C^2$

I HAVE sometimes wished to refer to the principal integer numbers which satisfy the equations $A^2 = B^2 + C^2$, and I have computed all in which the leading numbers rise to and slightly pass the value 100. Perhaps they may interest some of the readers of NATURE.

No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
A	5	13	17	25	29	37	41	53	61	65	65	73	85	85	89	97	113	145
B	4	12	15	24	21	35	40	45	60	56	63	55	77	84	80	72	112	144
C	3	5	8	7	20	12	9	28	11	33	16	48	36	13	39	65	15	17

In mechanical applications of these numbers, it is usually desirable to select those in which the proportion $B : C$ differs least from 1. I place, below, the numbers B and C arranged in the order of value of the fraction $\frac{B}{C}$.

No. in order of value of $\frac{B}{C}$	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
B	21	72	55	4	45	56	15	80	77	12	35	24	63	40	60	84	112	144
C	20	65	48	3	28	33	8	39	36	5	12	7	16	9	11	13	15	17
$\frac{B}{C}$	1·05	1·11	1·14	1·33	1·61	1·70	1·87	2·06	2·14	2·40	2·92	3·43	3·94	4·44	5·45	6·49	7·47	8·49
Original order	5	16	12	1	8	10	3	15	13	2	6	4	11	7	9	14	17	18

White House, Greenwich, March 31 G. B. AIRY

The Sunrise Shadow of Adam's Peak, Ceylon

SOME of the phenomena of the shadow of Adam's Peak in the early morning have been remarked by almost every traveller who has visited this island. The mountain rises to a height of 7352 feet as an isolated cone projecting more than 1000 feet above the main ridge to which it belongs. The appearance which has excited so much comment is that just after sunrise the shadow of the Peak seems to rise up in front of the spectator, and then suddenly either to disappear or fall down to the earth.

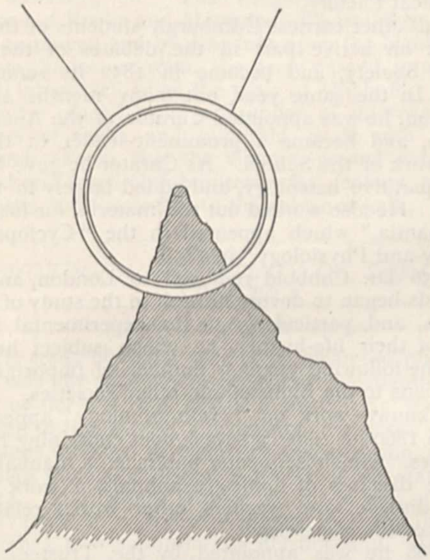
Various suggestions have been made as to the source of this curious shadow; among others one, which was published in the *Phil. Mag.*, August 1876, that attributed the rise of the shadow to a kind of mirage effect, on the supposition that the air over the low country was much hotter than on the Peak top.

I determined to attempt the discovery of the true nature of this appearance, and was fortunate to see it under circumstances which left no doubt as to the real origin. Through the courtesy and hospitality of Mr. T. N. Christie, of St. Andrew's Plantation, I was able to pass the night on the summit, and to carry up a few necessary instruments.

The morning broke in a very unpromising manner. Heavy clouds lay all about, lightning flickered over a dark bank to the right of the rising sun, and at frequent intervals masses of light vapour blew up from the valley and enveloped the summit in their mist. Suddenly, at 6.30 a.m., the sun peeped through a chink in the eastern sky, and we saw a shadow of the Peak projected on the land; then a little mist drove in front of the shadow, and we saw a circular rainbow of perhaps 8° or 10° diameter surrounding the shadow of the summit, and as we waved our arms we saw the shadow of our limbs moving in the mist. Two dark lines seemed to radiate from the centre of the bow, almost in a prolongation of the slopes of the Peak, as in the figure.

Twice this shadow appeared and vanished as cloud obscured the sun, but the third time we saw what has apparently struck so many observers. The shadow seemed to rise up and stand in front of us in the air, with rainbow and spectral arms, and then to fall down suddenly to the earth as the bow disappeared. The cause of the whole was obvious. As a mass of vapour drove across the shadow, the condensed particles caught the shadow, and in this case were also large enough to form a bow. As the vapour blew past, the shadow fell to its natural level—the surface of the earth.

An hour later, when the sun was well up, we again saw the shadow of the Peak and ourselves, this time encircled by a



Shadow, circular rainbow, and dark radiating lines of Adam's Peak.

double bow. Then the shadow was so far down that there was no illusion of standing up in front of us.

I believe that the formation of fog-bow and spectral figures on Adam's Peak is not so common as the simple rising up of the shadow, but one is only a development of the other. In fine weather, when the condensed vapour is thin and the component globules small, there is only enough matter in the air to reflect the Peak shadow in front of the spectator, and no figure is seen unless the arms are waved. In worse weather the globules of mist are large enough to form one or two bows, according to the intensity of the light. We were fortunate to see the lifted shadow accompanied by fog phenomena, which left no doubt as to the cause of the whole appearance.

Any idea of mirage was entirely disproved by my thermometric observations, which cannot be detailed here for want of space. RALPH ABERCROMBY

Colombo, February 25

"Bishop's Ring"

THE critique on Dr. Riggenbach's pamphlet on the Krakatão dust-glows alludes to the peculiar ring since seen surrounding the sun, and known as "Bishop's Ring," as though it had ceased to be visible last year. But the peculiar pink-tinged area surrounding the sun has been constantly seen since then, though perhaps without so definite a succession of tints as to deserve the title of "halo." On almost any day when the sun is hidden by a dense cloud so that the direct light is greatly subdued, there will appear, surrounding the cloud, an area at first intensely white, and then passing into a definite pink tinge. I saw this phenomenon very markedly this afternoon at 5.10 p.m., when walking across the fields from Swinggate, a hamlet between here and Dover, towards the Cornhill Coastguard Station. I have always observed it better when there is a strong southwest wind blowing. Does this mean that the great mass of the dust-particles is still in equatorial regions? Though the phenomenon to which I allude is undoubtedly best seen when the sky has that gray tinge which accompanies a saturated or super-saturated condition, I can hardly think it due to moisture. I did not observe it till after the Krakatão eruption, and I have observed it constantly since that outbreak. Perhaps condensation of moisture in the upper aërial regions may result in the formation of minute particles of water to which the dust-particles become attached, and thus both water and dust may be concerned in the production of the pink-tinged area. EDWARD F. TAYLOR

St. Margaret's-at-Cliffe, Dover, March 29

"Ferocity of Rats"

IN reference to the correspondence that appeared in last week's issue (p. 513) upon the above subject, permit me to state I have found by practical experience that the ferocity and voracity of rats is very great. They devour one another at all times and under all circumstances, whether living in a wild state or under the influence of domestication. I kept six rats at one time in confinement, and although well fed, the largest specimen consumed all the rest. Again, shortly after the late Inventions Exhibition closed last year, the following incident came under my notice, which fully confirms me in the belief I have expressed. As I was passing through the building I heard wild and piteous cries issuing from a spot close to where I stood. I immediately proceeded thence, and beheld six large rats feasting upon three of their congeners not much smaller than themselves, who were endeavouring to free themselves from the sharp teeth of their assailants. All of these rodents appeared thin and wild, and were no doubt rendered bold and desperate by privation, for my presence had no effect upon their carnivorous attacks. I frequently hear rats scampering beneath the floor of my office, accompanied by loud and protracted squeals; and, after what I saw, I am induced to believe that a deadly raid is on such occasions being made upon one or more of them.

W. AUGUST CARTER

The Claylands, South Norwood, April 5

Weather in South Australia.—Stevenson's Thermometer-Screen

LATELY the conditions of weather on the Adelaide Plains have been so very interesting to the English meteorologist that a few figures will doubtless be acceptable to readers of NATURE. On February 18 the shade-maximum temperature at this observatory was 105·5 during a barometric depression. This was followed by a minimum of 48°·7 accompanying a barometric crest on the morning of the 21st, a range of 56·8 within three days. Again, at 3 p.m. on the 18th the dry bulb read 105°·5, and wet bulb 69°·1, giving the extraordinary difference of 36°·4. These figures actually give 9 as the percentage of relative humidity, according to Guyot. The instruments are exposed in an enlarged Stevenson screen, which answers admirably in this climate; and what can be a better test? I may add that I also have a small "Stevenson," of the pattern usually employed in England, with duplicate instruments. The differences between the two usually amount to merely a few tenths of a degree. The Hon. Ralph Abercromby, who visited my observatory a short while ago—since my return from Queensland—was much pleased with the result of my comparison. I reserve a table for the Royal Meteorological Society, but I may mention that I claim to have proved that Mr. Stevenson's screen is in every way suitable for the hot and dry climate of this continent. I am strongly of opinion that this screen, in its enlarged form, should henceforth be universally employed to secure *uniformity* of exposure—a desideratum of the very highest importance. I have strongly recommended its adoption throughout Queensland. I have found no trace of undue heating of the internal louvres, even under temperatures over 100°. CLEMENT L. WRAGGE

Torrens Observatory, near Adelaide, South Australia, March 1

"Radicle" or "Radical"

MAY I utter a word of protest against a common, but (as I venture to think) erroneous way of spelling the above word when used in its ordinary chemical sense of a root (Latin, *radicula*), basis, or common ingredient of a series of chemical compounds?

Surely the word is a substantive, and, like similar derivatives, should be spelt "radicle," and not as the adjective "radical." I hope, however, that those who spell it in the latter way will be able to adduce a partic*al* of reasoning in favour of their practice.

I am quite aware of the existence of a "leading artic*al*" called a "Radical" in politics; but in this case there is reference to one who desires a "radical" change in existing institutions. If, however, we are to consider him as "a common ingredient in a series of Caucuses," then I should maintain that here also the spelling should be amended. H. G. MADAN

Eton College, April 5

An Earthquake Invention

REFERRING to Prof. Milne's letter in NATURE of March 11 (p. 438), I have to say:—(1) That what I, as representing my father, have to complain of is that in a British Association Committee's Report describing experiments made with an aseismatic arrangement, and which appeared in the *Transactions* of the British Association of 1884, the writer thereof, who appears to have been Prof. Milne alone, did not acknowledge that Mr. David Stevenson had invented, described, and constructed precisely such apparatus in 1868, facts which Prof. Milne cannot deny, and yet took the honour to himself; and, when this was pointed out, he then set up a claim for Mr. Mallet which Mr. Mallet assuredly never made, and would have been the first to repudiate.

(2) Prof. Milne in that Report praised the aseismatic joint as a most useful invention, introducing a new and valuable principle of construction for earthquake-affected countries, and though he may now think otherwise, yet the account given in the Tsugisaki light-keeper's letter, quoted by him, of the effects of a shock at that lighthouse, in place of showing the uselessness of the apparatus, in my opinion proves the reverse, as the shock is reported to have been very severe; and had there been no aseismatic joint under the illuminating apparatus, it would have been so seriously damaged as to have been rendered useless, in place of which the light was only extinguished for five minutes.

Mr. Stevenson, in his original paper, with characteristic caution, carefully calls it an apparatus to *mitigate the effect of earthquake shocks*. Mr. Kinjero Fugicura, Engineer in Chief to the Lighthouse Department of Japan, writing January 11, 1886, says he is unable at present to give any definite opinion as to the merits of the aseismatic arrangements, because, since he put them in operation when he became Engineer in Chief, the occurrence of earthquakes has been very rare indeed; and further, he is of opinion that really to get at the bottom of the matter, two experimental tables would have to be placed at the same locality side by side, one with the aseismatic arrangements, and the other fixed, so that the behaviour of the two tables might be directly compared. To which I might add that the whole lighthouse (or any building of equal size), like that constructed and sent to Japan by my father, but which was unfortunately lost at sea, should be rebuilt and tried against ordinary houses unprovided with my father's invention.

(3) Prof. Milne asks what I claim as coming under Mr. Stevenson's invention. I claim of course everything which employs the same principle, and most distinctly the house carried on shot or "*cast-iron sand*," as Prof. Milne calls it, and which he lately erected in Japan, as well as the building described by him in the B. A. Report, p. 248, for 1884, as "resting on four cast-iron balls," and the action of which has been so perfect as to have actually "destroyed" all the "sudden motion or shock," and recorded by him as a notable earthquake.

I will not further trespass on your space, but refer your readers to the former correspondence on this subject in NATURE.

D. A. STEVENSON

84, George Street, Edinburgh, March 22

DR. T. SPENCER COBBOLD, F.R.S., F.L.S.

DR. COBBOLD was the son of the Rev. Richard Cobbold of Wortham in Suffolk. He was born in 1828, and educated at Charterhouse. He matriculated at the University of Edinburgh in November 1847, after having, in accordance with the mode of preparation for the profession of medicine then regarded as most advantageous, served a three years' apprenticeship with Mr. Crosse of Norwich, one of the most eminent and distinguished surgeons of his time. He thus came up to the University provided with a large amount of practical information, and even as a first year student possessed great dexterity in dissection and in the making of museum preparations, and was a skilful draughtsman. After working diligently for a year under Prof. Goodsir, he was appointed by that great anatomist as his prosector, and under his influence was led to abandon practical medicine for the more attractive study of morphology; his first original research being an anatomical essay on the Canal of Petit, which he offered as his graduation thesis, and for which a gold medal was awarded him by the Medical Faculty.

Like all other earnest Edinburgh students of that time he took an active part in the debates of the Royal Medical Society, and became in 1852 its senior President. In the same year, not many months after his graduation, he was appointed Curator of the Anatomical Museum, and became a prominent leader in the biological work of the School. As Curator he gave lectures on comparative osteology, and added largely to the collections. He also worked out the material for his article "Ruminantia," which appeared in the "Cyclopædia of Anatomy and Physiology" in 1856.

In 1856 Dr. Cobbold removed to London, and soon afterwards began to devote himself to the study of animal parasites, and particularly to the experimental investigation of their life-history, on which subject he made during the following years a number of important communications to the Linnean and other Societies. In 1864 his well-known work on "Helminthology" appeared, to which in 1869 he added a supplement containing his later researches. He subsequently published a manual of the parasitic diseases of domestic animals, a work on the grouse disease, and various other works relating to diseases of the same class.

In 1868 he was appointed by the Trustees of the British Museum to the Swiney Professorship of Geology, to which subject he had been led, under the influence of Prof. Edward Forbes, to devote much attention during his residence in Edinburgh. The greater number of these lectures were given at the Royal School of Mines, and were largely attended.

Dr. Cobbold's reputation as a comparative pathologist will rest on his treatise on the Entozoa. His most important contributions to morphology are his article on Ruminantia, his experimental researches on *Tænia mediocanellata* and other Cestodes, on Trichina, and on *Distoma hæmatobium*, and his recent paper on the parasites of elephants. His last communication to the Linnean Society was read on March 4.

THE GEOLOGISTS' ASSOCIATION AT THE SCIENCE SCHOOLS

ON Saturday, March 20, a party of over a hundred members of the Geologists' Association visited the Science Schools at South Kensington, by permission of the Science and Art Department, and were conducted over the building by Prof. J. W. Judd, F.R.S. The visitors met in the entrance-hall at 2.30, and then seated themselves in the large Chemical Lecture Theatre, where Prof. Judd gave a sketch of the history and development of the Schools and of the methods of study therein followed. At the conclusion of this address the party walked slowly through the various laboratories and lecture-rooms—metallurgical, physical, and chemical—gradually ascending to the upper stories of the lofty building, where are situated the biological and geological rooms. In one of them a large collection of apparatus employed in various parts of the course was laid out.

Although not termed a museum, the teaching collections of minerals, rocks, fossils, &c., at the Science Schools are sufficiently full and complete for the most advanced student. Some time was spent in these rooms; as many of the members of the Association are engaged in teaching science they examined the arrangements with much interest. The elementary collections, which every student is required to know thoroughly, are arranged in table-cases always open to inspection; the more advanced collections are in drawers beneath. Over the table-cases and drawers which contain the fossils there are coloured vertical sections and diagrams of the geological formations and their subdivisions, showing the variations in their development in different districts.

In the Biological and Geological Lecture-Room an address was delivered by Mr. G. A. Cole, Prof. Judd's chief assistant, on "The Preparation of Microscopic Sections of Rocks and Minerals," illustrated by the apparatus employed and by drawings upon the blackboard.

From the lecture-room the party passed into the biological laboratory, upon the table of which, for this occasion, were placed a large number of microscopes, with sections of rocks and minerals, each with its name attached. From this the visitors passed into the advanced and research laboratories for geology, and thence down the main staircase to the entrance-hall.

PHOTOGRAPHIC STUDY OF STELLAR SPECTRA

Henry Draper Memorial

THE study of stellar spectra by means of photography was one of the most important investigations undertaken by the late Prof. Henry Draper. He was actively engaged in this research during the last years of his life. His plans included an extensive investigation, one object of which was to catalogue and classify the stars by their spectra. Mrs. Henry Draper has made provision, at the Observatory of Harvard College, for continuing these researches, as a memorial to her husband. The results already obtained, with the aid of an appropriation from the Bache Fund, permit the form of the new investigation to be definitely stated. The part of the sky to be surveyed is that extending from the North Pole to the parallel of 30° south declination. Each photograph will be exposed for about one hour, and will include a region 10° square. The telescope employed has an aperture of 20 centimetres (8 inches), and a focal length of 117 centimetres (44 inches). The object-glass is covered by a prism, and the resulting spectrum of each star in the region photographed has a length of about 1 centimetre; which enables the character of the spectra of stars from the fifth to the eighth magnitude to be determined. A modification of the apparatus is employed for the brighter stars.

Meanwhile, experiments are in progress with the 15-inch equatorial, with the object of representing the spectra of some typical stars upon a large scale. The spectra so far obtained are about 6 centimetres in length, and exhibit much well-defined detail. Additional experiments will be tried with a spectroscope provided with a slit, as well as with the simple prism hitherto employed, in order to secure the best possible definition. The present results encourage the expectation that the movements of stars in the line of sight may be better detert mined by the photographic method than by direc observations.

To keep the astronomical public informed of the progress made in this work, specimens of the photographs obtained will be gratuitously distributed from time to time. The first of these distributions will probably be made in a few weeks. Owing to the expense of providing a large number of copies, it is desirable to limit the distribution, as far as possible, to those who are interested in this class of work. It is also desired, however, to send the specimens to all who will find them of value from the scientific point of view. A blank form of request is attached to the present circular, and may be filled out and sent to the Harvard College Observatory by any one desirous of receiving the specimens; but requests to the same effect in any form which may be convenient will also be cheerfully complied with so far as may prove practicable.

EDWARD C. PICKERING,
Director of Harvard College Observatory
Cambridge, U.S., March 20

SOLAR HALO WITH PARHELIA

ON Thursday, April 1, a solar halo with parhelia was seen here, in regard to which, with the consent of the Astronomer-Royal, I beg herewith to offer a few particulars. The best display occurred between 1h. 30m. and 2h. p.m., and at one time exhibited the following appearance. There was the large halo commonly seen, in addition to which a luminous ring passing through the sun encircled the sky, everywhere of the same altitude above the horizon, forming a small circle of the sphere taking the zenith as pole. On this, the parhelic circle, and outside of the halo by about 5°, a mock sun was seen both on the eastern and western sides; another was seen in about a north-north-west direction, and a fourth nearly east, both also situated on the circle.

Calling the real sun S, and the several mock suns, counting westward, S_1, S_2, S_3, S_4, differences of azimuth were independently estimated as follows:—

	S to S_2		S_2 to S_3		S_3 to S
	°		°		°
By myself, numerical estimation ...	115	...	130	...	115
By Mr. Nash, by estimation ...	120	...	120	...	120
By Mr. Lewis, measured from a sketch	123	...	115	...	122
Mean	119	...	122	...	119

apparently indicating that the true difference of azimuth was in each case 120°.

Mr. Turner states that S_4 was on the meridian at 1h. 55m., at which time the calculated azimuth of S from south was 36°, which is therefore the difference of azimuth between S_4 and S. I estimated this difference to be 31°, Mr. Nash 35°, and Mr. Lewis 35°. Mean = 34°. This azimuthal measure corresponds to about 27° as measured on a great circle at about the position of the sun. Deducting 5°, the estimated amount by which S_1 or S_4 was outside the halo, we have 22° for an approximate value of the radius of the halo, about the usual magnitude.

The evidence that the altitude of the circle on which the suns were seen was everywhere the same is as follows:—At 2h. the altitude of the sun, by direct calculation, was 37°. At the same time Mr. Turner, by measurement with the transit-circle, found the altitude of the circle at the point at which it crossed the north meridian to be 37°, it being well seen; its altitude on the south meridian appeared to be 40°, but the circle at this moment was not distinctly visible at this point. At 2h. 15m. Mr. Turner found, with the altazimuth, the altitude of both S_2 and S_3 to be 35°, which, allowing for change of altitude, gives 36½° for the corresponding altitude at 2h.

There were great variations in brilliancy of the different parts during the interval first mentioned, and some of the appearances were visible at a much later hour. The suns S_1 and S_4 at times exhibited prismatic colours in a marked manner.

Two mock suns, such as at times accompany the ordinary halo, were seen also on April 2, and a simple halo also on April 3. WILLIAM ELLIS

Royal Observatory, Greenwich, April 5

NOTES

WE learn that, at the request of the Royal Society, the Treasury has agreed to insert a sum in the estimates, and the Admiralty has agreed to furnish transport and assistance, in aid of an expedition to observe the total eclipse of the sun, visible in the island of Grenada (West Indies) on August 29 next. The Expedition, which will consist of seven observers, will leave England on July 29 in the Royal Mail s.s. *Nile*. According to present arrangements a ship-of-war will meet them at Barbados, and take them on to their various stations. It is a noteworthy sign of the interest taken in such national work by our great public companies that the Directors of the Royal Mail Company have enabled the Eclipse Committee of the Royal Society to increase the number of observers beyond that at first contemplated by a concession in their terms which amounts to an important endowment of the expedition.

MR. H. FOWLER stated in Parliament the other day that the final report of the expeditions to observe the transit of Venus in 1882, subsidised by the British Government to the extent of 14,680*l*., would be presented in June.

WE have already announced the death, on March 20, at Leyton, Essex, of Mr. Charles George Talmage, F.R.A.S., in the forty-sixth year of his age. Mr. Talmage, who was well known as a skilful astronomical observer, had the entire direction of Mr. J. Gurney Barclay's observatory at Leyton for more than twenty years. During this period he turned his attention chiefly to observations of double stars, and the results of his work are given in four volumes of the "Leyton Astronomical Observations." Previous to his appointment to this post he had served his apprenticeship to astronomy at the Royal Observatory, Greenwich, in the years 1856-60, had worked under Mr. Hind at Mr. Bishop's observatory, first at Regent's Park, and then at Twickenham, and had spent four years at Nice in order the better to prosecute the work on which he was then engaged, the revision of Admiral Smyth's Bedford Catalogue. He was sent to Gibraltar in 1870 to observe the total solar eclipse of that year, and was placed in charge of the Transit of Venus Expedition to Barbadoes in 1882. His death will be much regretted in the astronomical world and by his numerous friends.

MR. EDWARD SOLLY, F.R.S., F.S.A., died on Friday at Camden House, Sutton, Surrey, in his sixty-seventh year. Educated at Berlin, he was appointed chemist to the Royal Asiatic Society in 1838, Lecturer on Chemistry at the Royal Institution in 1841, honorary member of the Royal Agricultural Society in 1842, Fellow of the Royal Society in 1843, Professor of Chemistry in the East India Company's Military College at Addiscombe in 1845, and honorary Professor of Chemistry to the Horticultural Society in 1846. Besides several works in which the importance of chemistry to agriculture was maintained, he wrote "Rural Chemistry" (1843) and "Syllabus of Chemistry" (1849).

MR. RICHARD EDMONDS, the seismologist and antiquary, died recently at Plymouth in his 85th year. He closely studied the extraordinary agitations of the sea and earthquake shocks, and published the results of his investigations in the *Edinburgh New Philosophical Journal*, the British Association *Reports*, and the *Transactions* of the Royal Society of Cornwall. In 1862 Mr. Edmonds published a collection of his papers, under the title of "The Land's End District; its Antiquities, Natural History, Natural Phenomena, and Scenery."

PROF. OLIVER LODGE will give the first of two lectures at the Royal Institution on Saturday next (April 10) on Fuel and Smoke considered with reference to the scientific principles underlying the use of the one and the avoidance of the other. The following arrangements are announced for the Royal Institution lectures after Easter:—Prof. Gamgee, six lectures on the Function of Circulation; Prof. Dewar, three lectures; Prof. A. Macalister, three lectures on Habit as a Factor in Human Morphology; Prof. Ernst Pauer, three lectures on How to Form a Judgment on Musical Works; and Prof. G. G. Stokes, Pres.R.S., three lectures. The first Friday evening discourse will be given by Mr. Frederick Siemens on Dissociation; and succeeding discourses will probably be given by Prof. J. M. Thomson, Sir John Lubbock, Bart., M.P., Prof. O. Lodge, Dr. W. H. Gaskell, and Prof. Dewar.

THE seventh International Oriental Congress will be held at Vienna on September 27 next and following days.

As the work of unpacking the cases which arrive daily at South Kensington from the British colonies all over the world proceeds, the extraordinary variety and interest of the exhibits become more apparent. In addition to objects of specially scientific interest already referred to, we may mention the ethnological groups in the south or Imperial Court of the Indian section. These are intended to illustrate the physiognomy, dress, and customs of the various races inhabiting the Indian Empire. The collection of woods from the Andaman and Nicobar Islands, shown at the Forestry Exhibition at Edinburgh, has been greatly enlarged, especially by specimens of timber of extraordinary size from the Andamans, and will be shown in the Indian section. One of these, the *Diospyros Kurzii*, a marble wood, resembles a combination of oak and ebony. There will be two timber trophies from the Indian Forest Department; one will be a triple arch 46 feet broad by 15 feet high, containing over 300 kinds of wood, while the second will be formed wholly of bamboo, of which thirty species will be shown. The most original arrangement of woods, however, is that adopted in the Victorian Court. Each specimen is in the shape of an octavo volume, on the back being printed, as a title and place of publication, the scientific name of the wood and the locality whence it came. The whole collection is inclosed in a handsome book-case, and so resembles a small library. Prof. McCoy and Baron von Müller have prepared a large natural history collection, and one of rare plants from Victoria in albums. The entomological collection is said to be remarkably complete, upwards of a thousand distinct specimens of insects being included. The Melbourne Botanical Gardens send a collection of fibres and carpological specimens. In a natural history case in the Canadian section, prepared by Col. Stockwell, will be a general representation of the fauna and flora of Anticosti. New Guinea has been taken under the wing of Queensland, and collections from that island will be explained by Mr. Hugh Romilly, who will be appointed Assistant Commissioner for Queensland specially on this account. The trophies in the various sections will also be of great interest and beauty; Ceylon will have a natural history trophy, India a jungle trophy, Queensland two of natural history—one being animals, the other birds—and so for other courts. It may be hoped that one result of this Exhibition and of the meeting of colonists from all quarters of the globe simultaneously in London will be the establishment of a permanent colonial museum in London. The Exhibition will supply abundant materials with which to make a beginning.

IN commemoration of the fiftieth year of the foundation of the Museum of Native Antiquities at Kiel, the directress, Fraülein Mestorf, has published a hand-book on the prehistoric antiquities of Schleswig-Holstein, containing 62 plates with 765 pictures of typical prehistoric objects, the originals of which are for the most part in the Kiel Museum. The first 17 plates contain 149 objects of the Stone Age, vessels, flint, horn, and bone implements, and pottery, some of which is decorated ; the second section is composed of 18 plates containing 227 objects from the Bronze Age, swords, knives, saws, urns, &c. ; lastly, there are 27 plates with 399 objects belonging to the Iron Age, which began in Schleswig-Holstein in the first or second century immediately preceding our era. The last representatives of this series are some silver *denarii* of Charlemagne's time. On the whole the collection appears to be a remarkably complete one for a single province to produce and preserve.

THE third volume of the *Transactions* of the Washington Anthropological Society (November 1883—May 1885) contains a suggestive paper by the President, J. W. Powell, on the growth of barbarism and civilisation from the savage state. This paper, which formed the subject of the annual address delivered on February 3, 1885, deals with the successive stages of savagery, barbarism, and civilisation from a somewhat novel standpoint. It is argued that the evolution of culture, that is, the gradual development of mankind from savagery to civilisation, is essentially the evolution of the humanities—the five great classes of activities denominated arts, institutions, languages, opinions, and intellections. Hence if the course of culture is to be divided into stages, the several stages should be represented in every one of the classes of activities. If there are three stages of culture, there should be three stages of arts, of institutions, and so on. Here the author deals more especially with the essential characteristics of the first two stages, defining the epoch of transition, and explaining how the lower phases of the various activities are developed into the higher. The evolution has everywhere proceeded on the same lines, because the human race is fundamentally one in the strictly genetic sense. The tendency to depart from the original type would doubtless have resulted in the establishment of specific differences, as in the case of other organisms, had it not been checked by various causes arresting free biotic evolution, and bringing about a return to homogeneity. For although much diversity exists it is restricted to narrow limits, the essential characteristics being everywhere the same. Again, after a certain stage is reached, human evolution differs radically from that of all other organisms. It proceeds, not by survival of the fittest, or adaptation of the species to the environment, but on the contrary by adaptation of the environment to the species. There is no aquatic variety of man, no aërial, tropical, boreal, herbivorous, or carnivorous varieties ; but man has everywhere adapted the environment to himself, that is, created an artificial environment by his arts, and in general by the development of his inventive and other intellectual faculties. Man has inherited the body, instincts, and passions of the brute ; the nature thus inherited has survived in his constitution, and is exhibited along all the course of his history. But man has risen in culture not by reason of his brutal nature ; he has been evolved because he has been largely emancipated from the laws of the brute creation. His development has been through the development of the humanities, that is, of those qualities which distinguish him from the brute. It has been a mental and moral far more than an animal evolution. Hence the curious result that, while the mind of man differs immeasurably from that of the next highest in the scale of animal evolution, his body is on the contrary in some respects actually inferior, physically weaker, less able of itself alone to struggle with the adverse conditions of the environment.

THE thirteenth meeting of Scandinavian Naturalists will take place at Christiania between July 7 and 12.

ON the 11th of last month, at about 6.15 p.m., a meteorite fell on the ice off Aastvedt, in the province of Bergen, Norway, with the effect of making a hole about 18 inches in diameter, though the ice was 8 inches in thickness. It was accompanied by an audible hissing.

THE great success of the oyster cultivation carried on by the Norge Company in the Christiania fjörd has induced the Swedish Government to invite the manager of this establishment to inspect the coast of the province of Bohus, on the opposite side of the fjörd, with a view to the arranging of similar establishments there should the conditions be favourable. A gunboat has been placed at the disposal of the inspector by the Government. The subject is engaging much attention in Sweden, where very few oyster-banks exist.

ON the night of March 30, between 8 and 9 o'clock p.m., there was a very fair display of auroric light in the co. Donegal. Mr G. H. Kinahan writes :—" At the time the sky to the northward was clear and bright, but after 9 p.m. it became overcast, with dark snow-clouds. The light was peculiar for Ireland, not being of the usual type, but bright light silver-coloured, of the type seen in the autumn in Canada, although far less elaborate. The light extended from the N.W. to the N.E. To the N.E. was a wide column of white light, rather stationary, but at times extending across the zenith in a broad arch to the N.W. horizon. Between this column and the N.N.W. point, being more numerous and prevalent between the N.N.E. and N. points, were pencils and horns of light, even shooting up and down, with clouds of very bright light rising at intervals, and as they ro e sent up pencils of light from the upper edges. In the space between the N.E. and N.N.W. points, the pencils of light rose, some perpendicularly, and some obliquely, in a north-easterly direction. Towards the end of the display dull light-reddish clouds rose at intervals, at one time there being a faint marginal edge to the N.E. white column." During the last winter auroræ appear to have been remarkably scarce, for although on the look-out for them all Mr. Kinahan saw were very faint and scarcely perceptible to any one but those who had studied them.

THE American Government have forwarded a consignment of landlocked salmon ova to the National Fish Culture Association, which arrived this week in excellent condition. A large number of this species were reared by the Association last year, and placed in nurseries pending their introduction to the Thames, where it is felt they will thrive well in certain places. The Thames Angling Preservation Society are particularly anxious to naturalise this species in the river, it being an excellent fish from a sporting point of view, and, moreover, it does not migrate to the sea.

THE German Fisheries Union intend to try the acclimatisation of the sterlet in the Vistula and the Oder. About 2000 living sterlets are to be caught in the Save, under the personal superintendence of Prof. Spiridion Brusina, the Director of the Zoological Museum of Agram. They are to be sent to Thorn and to Oderberg respectively for transfer into the two rivers named above. Hitherto sterlets could only be obtained from Russia.

MESSRS. MACMILLAN AND CO. will publish in a few weeks an elementary treatise on Statics, by John Greaves, M.A., Fellow of Christ's College, Cambridge. Although adapted for those beginners whose mathematical reading does not go beyond geometrical conics and trigonometry, the book contains propositions of a more general character, especially in connection with the principle of work, than any other book that does not assume a much wider range of knowledge on the part of the reader. In order to meet the wants of students who can get little assistance in their work, a large number of illustrative examples have been carefully worked out. The mode of treatment chiefly differs from that usually adopted in that the principle of transmissibility of force is discarded; while the conditions of equilibrium of all bodies, including liquids and flexible strings, are deduced from those of a single particle by means of D'Alembert's principle. The Newtonian definition of force is, of course, the one employed.

THE additions to the Zoological Society's Gardens during the past week include a White-fronted Capuchin Monkey (*Cebus albifrons*) from South America, presented by Mr. Matthews; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Miss Agnes Shouman; a Common Kingfisher (*Alcedo ispida*), British, presented by Mr. Cuthbert Johnson; two Cambayan Turtle Doves (*Turtur senegalensis*) from Egypt, presented by M. J. M. Cornély, C.M.Z.S.; a Chinese Mynah (*Acridotheres cristatellus*) from China, presented by Mr. T. Douglas Murray, F.Z.S.; a Huanaco (*Lama huanacos*) from Bolivia, two Llamas (*Lama peruana*) from Peru, a Dingo (*Canis dingo*), a Roseate Cockatoo (*Cacatua roseicapilla*) from Australia, two Sonnerat's Jungle Fowl (*Gallus sonnerati*) from Southern India, seventeen Tuatera Lizards (*Sphenodon punctatus*) from New Zealand, deposited; two White-eared Scops Owls (*Scops leucotis*) from West Africa, a Red and Black Lizard (*Ctenosaura erythromelas*), purchased; two Geoffroy's Doves (*Peristera geoffroii*) from Brazil, two Blood-breasted Pigeons (*Phlogœnas cruentata*) from the Philippine Islands, received in exchange; a Black Lemur (*Lemur macaco*), an Axis Deer (*Cervus axis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

AN ASTRONOMICAL DIRECTORY.—M. Lancaster, of the Brussels Observatory, has compiled and published a most useful list of observatories, with their geographical co-ordinates and the astronomers attached to them, of astronomical societies and institutions, and of reviews and journals specially devoted to astronomy. The pamphlet also contains a select list of the names and addresses of those astronomers who are not attached to any observatory, and of amateurs, as well as a further list of makers of astronomical instruments. As is practically inevitable in a work of this nature, there are faults both of omission and of commission noticeable in it. The most conspicuous of the former perhaps occurs in the account of the English *Nautical Almanac* office, where the staff is represented as consisting of the superintendent and *one* assistant. There are, we believe, as many as eleven assistants attached to this office. A good many mistakes have also been made in the addresses of individual astronomers. We hope that in a second edition M. Lancaster will be enabled to remove these blemishes from what must be considered, on the whole, as a very valuable publication, and one which ought to be in the library of every astronomer who is engaged in the active work of his profession.

ROUSDON OBSERVATORY, DEVON.—Mr. Cuthbert Peek has recently published a short *résumé* of his astronomical work during the years 1882-85, including a description of his private observatory near Lyme Regis. This observatory, of which a photograph is given, is solidly built, and seems to be very thoroughly equipped for its size. It contains a transit instrument, by Troughton and Simms, of 2 inches aperture; an equatorial by Merz, mounting by Cooke, of 6·4 inches aperture; solar and sidereal chronometers; position-circle micrometer by Hilger, &c. Beneath the equatorial room is a room used as a laboratory and for photography. Of the observations, the most important is a monograph on the nebula surrounding η Argûs. Mr. Peek had joined the Expedition under the command of Capt. W. G. Morris, R.E., which was sent out to Queensland to observe the transit of Venus in 1882, and, whilst at Jimbour, the place selected as the observing-station, made the observations here recorded. The other observations are of comets 1883 *b* (Pons-Brooks), 1884 II. (Barnard), 1884 *c* (Wolf), Encke's comet, the lunar eclipse of 1884 October 4, occultations of Aldebaran, Saturn, Nova Andromedæ, and the meteor-shower of November 27 last. As the observatory was in course of erection during the years 1884 and 1885, and therefore no systematic work could be undertaken, this record must be considered as very satisfactory.

THE GREAT MELBOURNE TELESCOPE.—The first part of observations of the southern nebulæ made with the great Cassegrain reflector at Melbourne has just been published. Other parts, containing the results of observations for the revision of the southern nebulæ observed by Sir John Herschel at the Cape of Good Hope in the years 1834 to 1838, the work to which the telescope has been chiefly devoted since its erection in 1869, are to follow at short intervals. The present part contains a description of the instrument itself and of the methods employed in using it, together with observations of some of the smaller nebulæ, and it is illustrated by two good photographs representing the great telescope and its surroundings, and by three lithographic plates of the nebulæ observed. The report as to the performance of the great telescope is to the effect that on the average of ordinary fine nights it is somewhat disappointing to one accustomed to observe with smaller apertures, but on *really good nights* it is quite different. So large an aperture, that is to say, requires specially good atmospheric conditions for its full powers to be displayed. The number of nights fit for using the telescope is given as about 40 per cent., but of best nights only 17 per cent. Moonlight nights are reckoned as bad nights, as, though used for lunar photography, they are unsuitable for the special work to which the instrument is devoted—the observation of nebulæ. The observations of the nebulæ given afford several remarkable instances of apparent changes having taken place in a few years. Nebulæ Nos. 187 and 567 ("Gen. Cat.") seem to differ from Herschel's description, and the group of four nebulæ—Nos. 962, 963, 966, and 968—appear to have altered in their relative positions in a very striking manner in the interval between Mr. Turner's observation in 1876·8 and Mr. Baracchi's in 1884·8. It seems very difficult to explain the differences between the descriptions of this group by Herschel, Turner, and Baracchi.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 *APRIL* 11-17

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

At Greenwich on April 11

Sun rises, 5h. 15m.; souths, 12h. 1m. 1·7s.; sets, 18h. 47m.; decl. on meridian, 8° 24′ N.: Sidereal Time at Sunset, 8h. 6m.

Moon (at First Quarter) rises, 10h. 15m.; souths, 18h. 6m.; sets, 1h. 52m.*; decl. on meridian, 17° 41′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	4 56	11 43	18 30	8 31 N.
Venus	3 48	9 14	14 40	7 26 S.
Mars	14 9	21 15	4 21*	11 56 N.
Jupiter	16 23	22 37	4 51*	2 2 N.
Saturn	8 41	16 53	1 5*	22 51 N.

* Indicates that the setting is that of the following morning.

Variable-Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
Algol	3 0·8	40 31 N.	Apr. 12,	23 38	*m*
			,, 15,	20 27	*m*
U Monocerotis	7 25·4	9 32 S.	,, 12,		*m*
U Canis Minoris	7 35·2	8 39 N.	,, 12,		*m*
V Cancri	8 15·2	17 39 N.	,, 12,		*M*
R Hydræ	13 23·5	22 42 S.	,, 14,		*m*
δ Libræ	14 54·9	8 4 S.	,, 11,	4 18	*m*
			,, 15,	20 0	*m*
R Coronæ	15 43·9	28 30 N.	,, 17,		*m*
S Scorpii	16 10·9	22 37 S.	,, 15,		*M*
U Ophiuchi	17 10·8	1 20 N.	,, 14,	3 52	*m*
			and at intervals of	20 8	
X Sagittarii	17 40·4	27 47 S.	Apr. 14,	2 20	*m*
			,, 17,	0 0	*M*
W Sagittarii	17 57·8	29 35 S.	,, 13,	21 30	*M*
β Lyræ	18 45·9	33 14 N.	,, 13,	19 10	m_2
			,, 17,	0 0	*M*
R Lyræ	18 51·9	43 48 N.	,, 12,		*M*
S Delphini	20 37·8	16 41 N.	,, 13,		*m*
δ Cephei	22 24·9	57 50 N.	,, 14,	21 40	*M*

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

Occultations of Stars by the Moon (visible at Greenwich)

April	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image
			h. m.	h. m.	° °
13	ξ Leonis	6	20 0	near approach	342 —
14	48 Leonis	6	22 57	23 40	40 329
15	τ Leonis	5	21 21	21 55	359 310
16	13 Virginis	6	18 14	19 4	69 180
16	Uranus	–	21 58	22 44	6 297

April h.
16 ... 12 ... Jupiter in conjunction with and 0° 29′ north of the Moon.

Meteor Showers

Amongst the radiants represented at this season are the following:—Near ψ Ursæ Majoris, R.A. 162°, Decl. 48° N.; from Coma Berenices, R.A. 190°, Decl. 21° N.; from Libra, R.A. 225°, Decl. 5° S.; from Corona, R.A. 240°, Decl. 25° N.; from Hercules, R.A. 265°, Decl. 23° N.; maximum April 13.

GEOGRAPHICAL NOTES

THE sixth German "Geographentag," which will be held at Dresden on the three last days of this month, together with a Geographical Exhibition, will, first of all, bring up the reports of the two travellers, Messrs. Reichard and Lieut. von François, concerning their experiences and observations in Equatorial Africa. Dr. Ed. Naumann will speak on his topographical and geological survey of Japan, and Director A. Matzat, of Weilburg, on drawing in geographical instruction. Further addresses which will be delivered are by Dr. G. Leipold (Dresden), on the raising of the sea-level near the coasts of continents; by Dr. Hahn (Königsberg), on the development and division of coasts from a geographico-commercial point of view; by Dr. P. Lehmann (Berlin), on the significance of Kant for geographical science; by Dr. Egli (Zürich), on the development of the nomenclature of towns, &c.; by Dr. Petri (Berne), on the exploration of Siberia; by Dr. O. Schneider (Dresden), on the closer limitation of geographical terms; and by Dr. S. Ruge (Dresden), on the Central Commission for German topography.

A LETTER was recently read before the Russian Geographical Society on March 17 from M. G. N. Potanin, the leader of another Expedition to Central Asia. At the end of October last the explorer was on his way from Sukhan-Hiln to Lon-djou. He had met great difficulties on this journey; the Expedition having been compelled to march on foot and their luggage to be carried by porters. The direction of the return journey will depend on the success of the proposed passage across the Desert of Gobi. However, this return is secured.

WE have received a communication from M. Grigoriev, Secretary of the Imperial Russian Geographical Society, in which he informs us that Dr. Bunge has left Nasàtchyé, his head-quarters, on the Yana River, in command of the Expedition to explore the New Siberian Islands during the summer, and that he is expected back at the end of October or early in November. These islands, which by many Arctic explorers are held to be the right base for an attack on the Pole, are very little known, not having been visited since 1823.

THE Norwegian Storthing has granted a sum of 4500*l.* towards the further geographical survey of Norway.

MR. C. WINNECKE, of South Australia, has prepared a plan showing the contour of the country along the overland telegraph line from Port Augusta to the Queensland boundary, a distance of 1626 miles.

THE SAHARUNPUR BOTANICAL GARDENS

MR. J. F. DUTHIE'S Report on the progress and condition of the Government Botanical Gardens at Saharunpur and Mussoorie for the year ending March 31, 1885, has reached us. It is a bulky Report of some fifty-one pages and a very interesting Report of fifteen pages, on "an examination of the indigenous grasses and other fodder-yielding plants growing on the Hissar Birland," under date September 5, 1885, accompanies it. In the Report on the Gardens, amongst other interesting and important matters Mr. Duthie refers to samples of wheat and barley grown in the Saharunpur Garden, which had attracted some amount of attention in this country. He says:—"Amongst some contributions for the Economic Museum of the Royal Gardens, Kew, which I took to England last year were two samples of grain—one of a variety of wheat called 'Gujaria,' and grown at Saharunpur from selected seed, the original having been received some years since from the Government Farm at Cawnpore; the other a remarkable variety of loose-grained barley, of a dark chocolate colour, from a small sample exhibited at a previous agricultural show at Saharunpur." These samples were considered by the authorities at Kew to be of sufficient interest for their being specially reported on, and they were accordingly sent to Messrs. McDougall Bros., of Millwall Docks, who reported to the effect that the samples had been shown to most of the principal people on the Corn Market, who took much interest in them. The wheat was valued at about 30*s.* per 496 lbs., it being classed with the Kubanca (Russian) wheat, its bright and clean appearance causing much remark. On grinding and pasting it was found to contain much gluten, but to be somewhat sticky. The reporter thinks, however, that it would pay better to grow the white seed, such as is now shipped from Bombay, and realises 39*s.* per 496 lbs. Regarding the barley, the specimen, it is said, was looked upon with much interest, and many opinions expressed upon its being quite new, and the value varied from 23*s.* to 30*s.* per 400 lbs. On damping, the grains were found to sprout well, and so would do for malt, but the colour comes off, and so would not do (it is thought) for pale ales, but it might do well for stout; for feeding purposes it would be useful, although it would take time to remove prejudice against its colour. In some comments on this Report Mr. Duthie says:—"The wheat is a very hard free-growing sort, and always gives a good yield, both in grain and chaff. Last season the yield was 18 maunds and 13 seers chaff per acre. This variety possesses the good quality of being able to stand well up when grown in highly-manured soil; for, as is well known, most varieties of Indian wheat run up into straw and fall over before coming to maturity when the soil is too highly manured. This variety is thus well-adapted for those who attempt to cultivate wheat according to the European method. The chocolate-coloured barley produced 15 maunds grain and 12½ maunds straw per acre. The yield of grain was thus heavier than the yield of straw. The objection as to colour, alluded to in the Report, is fatal to its value, and will prevent its ever being grown except as a curiosity. We possess a white-grained variety of huskless barley, and a good large sample of this has lately been sent to Kew for special report. The huskless barleys appear to be quite unknown in England, and as everything except colour was favourably commented on in the case of the variety sent, I am in hopes that the report on the white variety will be altogether favourable, and perhaps become the means of bringing the barley to the notice of the English market." Mr. Duthie records the introduction of many useful and ornamental plants to the Gardens; and to the Herbarium, he says, large and valued contributions continue to be received, amongst them a very interesting set of specimens from Mr. C. B. Clarke, chiefly belonging to families which have been specially worked up by him in his several monographs contributed to the "Flora of British India" and De Candolle's "Prodromus," also a large collection made by Mr. J. S. Gamble during a tour in the Madras Presidency. Besides which duplicates had been received from Dr. King, of the Calcutta Botanic Garden, and Dr. Trimen of the Peradeniya Botanic Garden, Ceylon. In addition to these contributions, specimens had been placed in the Herbarium collected during Mr. Duthie's expedition to North-Eastern Kumaun. This collection, it is stated, "consists of over 1000 species and varieties, including about 25 new to science, one (*Cystopteris montana*) new to India, and upwards of 128 not previously recorded for Kumaun. The north-eastern portion of Kumaun, including the districts of Dárma and Byáno, had not hitherto been explored botanically, and this, of course, accounts for the large number of new records. Amongst these latter are several which had previously been known only from Nepal and Sikkim. Further investigation will, no doubt, confirm my own conclusions as to the greater similarity of the vegetation along the entire length of the Himalayas as you approach the inner and drier ranges." Mr. Duthie's "Appendix VI.," being "Notes on a Botanical Expedition to North-Eastern Kumaun in 1884," will be read with interest by the botanist interested in Indian plants.

THE SUN AND STARS[1]

V.

Metallic Prominences

VERY impressive indeed are the phenomena when we pass to that other class representing prominences no longer of the quiet sort. These are at times observed shooting up almost instantaneously—the exact rate of motion I will state by and by—to enormous heights; and not only are they seen to shoot up into the atmosphere with very great velocity and with every indication of the most violent disturbance, but the alteration in the lines of hydrogen in the spectrum indicates most violent lateral motions. These phenomena unfortunately have been called eruptions, and, as it very often happens, when we get a word like that coined it means more than it is intended to mean by the author of it; and more or less on the strength of this word "eruption," we have theories trying to explain these prominences on the idea that they are ejected, possibly from a volcano—a real solar volcano—at some distance below the photosphere. I think we have no right to call them eruptions at all. In the first place they are not like any volcanic eruption that man has ever seen.

When we get the chromosphere agitated preparatorily to one of these tremendous outbursts—one of these metallic prominences, as they are called—the lines which we see are different from those in the table which I have given. The Italian observers, to whom we are indebted chiefly for our knowledge on this part of the subject, have recorded three lines, which they call the "elementary metallic prominence spectrum." These are—

4943 No Fraunhofer lines corresponding.
5031 ,, ,,
5315·9 = 1474

Although these energetic prominences are eventually very often full of lines of various vapours these three lines always precede them when the action commences. There is one point about this matter to which I must call attention, and that is that of these three lines one—the 1474 line—is not the line with the same name to which I have already drawn your attention, and about which we know absolutely nothing, but it is a line of iron almost coincident with it, which the temperature of the spark brings out, though it is invisible in the arc. The other two are lines which do not even appear amongst the Fraunhofer lines at all, and about which, therefore, we know nothing. We have means, both by actual observation in the case of the uprise of the prominences into the solar air and in the change of the wave-lengths of the lines in the case of any lateral motion, of determining how fast these violent prominences rise and are driven by solar winds. Well, these metallic prominences have been seen to mount upwards at the rate of 250 miles a second, that is very nearly 1,000,000 miles an hour; so that, if these gases continued their flight they would reach the top of the solar atmosphere, if the solar atmosphere were 1,000,000 miles deep from the top down to the photosphere, in about an hour's time. There are indications that these prominences, instead of rising vertically, as we may imagine them to do, are at times shot out sideways—almost tangentially. In that case, of course, the spectroscope enables us to determine the velocity. 100 miles a second, either towards or from the eye, is by no means an uncommon velocity, and there are also indications that, in the neighbourhood of the photosphere where these enormous prominences take their rise, vividly incandescent hydrogen at a considerable pressure is rushing up from the interior part of the sun.

FIG. 15.—Metallic prominence, Young. Rate of ascent 400,000 miles an hour.

In the case of some of these violent prominences the spectrum at the base appears to be full of lines, but we know enough about the subject now to know that many, if indeed not most, of those lines are not Fraunhofer lines at all, not lines with which we are familiar, but new ones. In fact, the same thing happens in the prominences as happens in the spots. To show that this is so I again refer to some very important work done by Prof. Young in the United States some years ago. He went to a station in the Rocky Mountains, at a height of 8000 feet, to observe these prominences. Of course the higher we go the purer the air, and the better we can see. As the result of one month's work he brought back a very valuable catalogue of lines which he had seen in such prominences as I have attempted to describe.

Let us consider one particular substance. It is always well in these matters to be as definite as possible, and if the prominences contained that particular substance, say, for instance, barium, in the same conditions in which we find it on this earth, we should imagine that the spectrum of barium in the prominence would be very much like the spectrum of barium in the electric spark. To see whether that was so or not, what my assistants and myself did was this. We prepared a map showing the lines of barium over a long reach of the spectrum, and we drew the lines so that the longest represented the strongest according to our highest authority in these matters, Prof. Thalèn. Alongside of these we made another map showing the particular lines which had been seen by Prof. Young, and we assumed that the line which was strongest at the sun would be the line which he would most probably see most frequently, and therefore we made the line which he saw the greatest number of times the longest line. That being premised, you will see there is no relation whatever between these two spectra. In the first place a great number of the lines of barium seen in the laboratory are left out of account altogether in the prominence spectrum, and when the other lines are considered we find that the intensities in the sun are quite different; and that, I may say, is a very fair indication of what as a matter of fact we have observed with regard to a number of these substances. Calcium, iron, nickel, cobalt, and several other metals which we have tested in the same way, give us exactly the same result.

But there is more important work to do than that. Since Prof. Young made those admirable observations in America, the Italian observers, Profs. Tacchini and Riccò, have been observing metallic prominences every day. It has been our duty at Kensington to map every line which these industrious Italian gentlemen have observed ever since 1871, and in these maps, as in those of spot-spectra, we have the lines of the various elements seen in the sun, in the arc, and in the spark. Now, of all those lines, we only get a very small number in the prominences. In the case of iron, for instance, in the F—*b* region, we may say there are only two lines; one iron line was left out by mistake by Prof. Thalèn in his map of the solar spectrum, and the Italian observations of the sun suggested to us at Kensington that Thalèn, at Upsala, had made an omission in the spectrum of iron. This we found to be the case. All the other lines are clean swept out of the record. We get none of them in the spectrum of prominences.

At a certain date, I believe about the end of December 1873, the lines in question suddenly ceased to appear in the spectrum of prominences. The Italian observers, who had observed them constantly day by day for three years, suddenly found them gone, but other new lines were seen. I shall show by and by that there was a very good reason why that should have happened. But the important point now is that it really did happen.

[1] A Course of Lectures to Working Men delivered by J. Norman Lockyer, F.R.S., at the Museum of Practical Geology. Revised from shorthand notes. Continued from p. 502.

The Relation between Spots and Prominences

We are now in a position to discuss the relation between the spots and the prominences. We are already familiar with the lines affected in spots. We have now seen the lines affected in prominences. Are they the same? To investigate this question maps have been prepared in exactly the same way as those to which reference has already been made. We have at the top the lines affected in spots, and at the bottom the lines affected in prominences. In hardly any case are the lines of any one vapour widened in the spots the same as the lines brightened in the prominences.

There is another very interesting fact which is also seen alongside of this; if we regard the lines seen widened in the spots, or that other set of lines seen bright in the prominences, we find, when we come to study the positions of those lines in the spectrum with the positions of the lines of elementary bodies, that in the case of very many of them there are coincidences between the lines of different chemical elements with the dispersion that was employed.

We have learnt since then that the coincidence is not entirely absolute, but whether that be so or not, we have the very extraordinary fact that, while of all the iron lines taken at random the chances of the coincidence of any one line are very small, of iron lines widened in spots, or of iron lines brightened in prominences, the chances of coincidence are something like ten to one.

In that way you see we make a considerable difference between the lines of iron which are affected in the lower reaches of the solar atmosphere, whether we are dealing with the phenomena of spots or of prominences, and the lines of iron which are dropped out.

These discussions to which I have referred have led us to make the following statements with regard to prominences, on all fours with the statements already made regarding spots:—

General Statements

(1) The chromospheric and prominence spectrum of any one substance, except in the case of hydrogen, is unlike the ordinary spectrum of the substance. For instance, we get two lines of iron out of 460. Thus we see that the spectrum of a substance in the prominences is very unlike its spectrum out of a prominence, that is, in our laboratories or in a sunspot.

(2) There are inversions of lines of the same elements in the prominences as there are inversions in the spots, that is to say, in certain prominences we see certain lines of a substance without others; in certain other prominences we see the other lines without the first ones.

(3) Very few lines are strongly affected at once, as a rule, and a very small proportion altogether; smaller than in the case of spots.

(4) The prominences are not so subject as spots to sudden changes so far as lines of the same element are concerned.

(5) There is a change in the lines affected according to the sunspot period. This is a point about which I shall have to say something by and by.

(6) The lines of a substance seen in the prominences are those which in our laboratories are observed to be considerably brightened when we change the arc spectrum for the spark spectrum.

(7) None of the lines ordinarily visible in prominences are seen at the temperature of the oxy-hydrogen flame. Some of the oxy-hydrogen flame-lines are seen in the spots, but, as said before, none of these lines have ever been seen in the prominences.

(8) A relatively large number of lines ordinarily seen are of unknown origin.

(9) Many of the lines seen are not ordinarily seen amongst the Fraunhofer lines. Some are bright lines.

(10) As in the spots we found that the H and K lines of calcium in the ultra-violet were always bright in the spot-spectrum, the other lines of calcium being darkened and widened; so also it would appear that the lines H and K of calcium are always bright in the prominences in which the other lines are generally unaffected.

(11) Many of the lines are common to two or more elements with the dispersion which has been employed.

A Case in Point

In the region of the spectrum which has been most studied with regard to spots and prominences, are three lines of iron adjacent in the solar spectrum, so close together, that if you see one you are bound to see the other two. A study of these three lines affords a very definite and interesting case, indicating that it is not at all necessary to go over the whole spectrum to see these results. We have those three lines in the solar spectrum of wave-lengths 4882, 4898, and 4923·1. They are seen among the Fraunhofer lines with the intensity shown in the accompanying diagram (Fig. 16). If we photograph the spectrum of the arc very quickly we miss the right-hand member altogether, and get the two left-hand lines alone. If we observe the spectrum of the iron spark with a quantity coil (and a jar) the left-hand member almost disappears. If we use no jar the right-hand member almost disappears. If we use an intensity coil with a jar not only does the left-hand member nearly disappear, but the right-hand member is enormously developed. If we take out the jar we bring about very much the same condition as we have among the Fraunhofer lines. Now, what happens at the sun? The two lines on the left of the diagram have alone been seen widened in spots. The right-hand member has never been

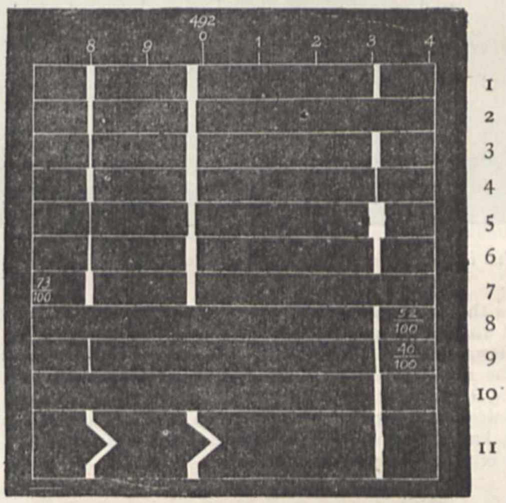


Fig. 16.—Diagram showing the behaviour of three iron lines under different conditions, solar and terrestrial. 1, solar spectrum; 2, arc; 3, quantity coil with jar; 4, quantity coil without jar; 5, intensity coil with jar; 6, intensity coil without jar; 7, spots observed at Kensington; 8, prominences observed by Tacchini; 9, prominences observed by Young; 10, reversed in penumbra of spot observed on August 5, 1872, by Young; 11, motion indicated by change of refrangibility.

seen widened in spots. Contrariwise the right-hand member has been seen in 52 per cent. of the prominences which have been observed by Prof. Tacchini, but the left-hand members have never been seen in any prominence whatever. The last result is this, that in spots the left-hand members have indicated that the spot has been descending at the rate of 50 miles a second, while the right-hand member has shown that the spot is not descending at all—that the vapour is just as quiet as could possibly be expected.

Those are some of the hard facts gathered by the observation of three lines quite close together. During the eclipse of 1882 my chief work was to see what happened to those three lines. What did happen was this: the line seen in prominences was observed 7 minutes before totality began, as a very short bright line close to the photosphere of the sun, whilst the other two lines did not come out until the moment before totality began, and were then very thin and feeble lines at the best, indicating that the absorbing molecules which produce them exist in all probability at a considerable elevation in the sun's atmosphere.

The Corona

We now pass to the inner and outer corona. We are still of course engaged with the question of materials, and may take these two together.

The spectrum of the inner corona indicates that it is chiefly composed of hydrogen. All the hydrogen lines are seen in it, and up to a certain height in it we get the H and K lines of calcium, showing that either calcium, or something that exists in calcium which we cannot get at in our temperature, is there.

When we go further afield into the outer corona we leave behind us most of the hydrogen lines, but one, the green line F, remains for a considerable height side by side with the 1474 line, indicating, as far as we can see where everything is so doubtful, that so far as the gaseous constituents of the outer corona are concerned they consist most probably of hydrogen in a cool form, and this unknown stuff which gives us the line 1474.

With regard to the other materials of the outer corona we know that it contains particles which reflect the ordinary sunlight to us, because in 1871 Dr. Janssen and in 1878 Prof. Barker and others saw the dark Fraunhofer lines in the spectrum of the corona. We must imagine, therefore, that some part of the spectrum of the corona depends for its existence on solid particles which not only give us such a spectrum as the limelight does, but which further have the faculty of reflecting to us the light of the underlying photosphere.

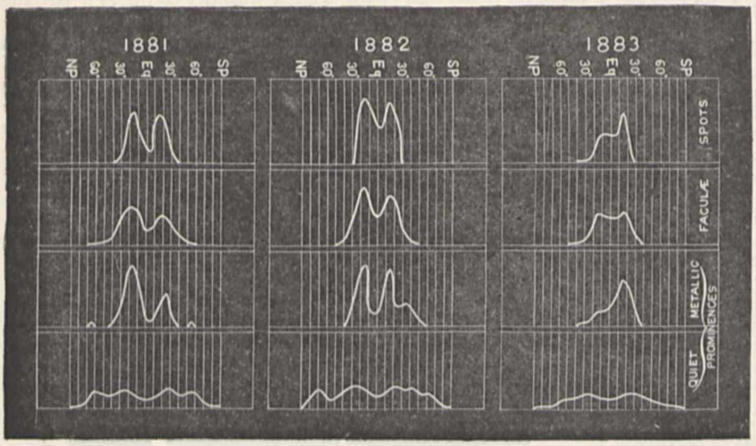


FIG. 17.—Diagram summarising the results of the Italian observations for the years 1881-83.

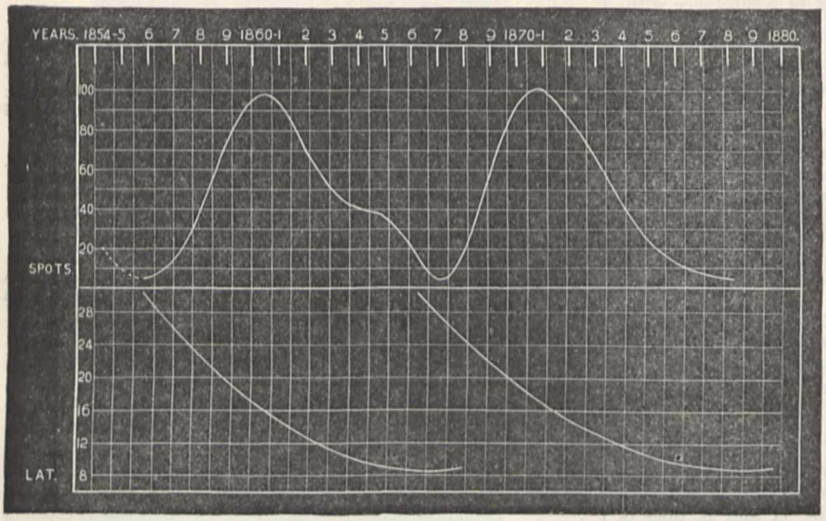


FIG. 18.—Spörer's sunspot curves. The upper one indicates the amount of spotted area in each year; the lower one the mean latitudes of the spots.

It was also put beyond all question in the eclipse of 1882 in Egypt that this corona has another spectrum of its own. I was fortunate enough to see that eclipse under very good conditions, and the spectrum which had been supposed up to that time to be a continuous spectrum only was an integration of a considerable number of spectra. There were bright bands and dark bands from one end of the spectrum to the other, showing that, with these additions, it was no longer continuous in the same way that the spectrum of the limelight is continuous, but that it was probably excessively complex in its origin.

General Connection of the Foregoing Phenomena

We next come to an excessively important point—the connection of the various phenomena which we have now passed under review with each other.

The Italian observers have not only very carefully observed the prominences from day to day, but they have observed spots and the other phenomena which require continuous investigation. The accompanying diagram puts together in a very convenient form much information which we want at the present moment. The information extends over three years, so that we have not merely to depend on the result of one year's observation. The curious-looking hieroglyphics, which are called curves, have a very simple explanation. In the middle of each of these series E stands for the equator, and right and left of that we have vertical lines giving every 10° of latitude from the equator to the poles south or north for each year. The height of the curves from the base-line represents the number either of spots, faculæ, metallic or quiet protuberances seen each year. The spots in the year 1881 had their maximum in latitude 20° N. and 12° S. There were no spots either north or south of latitude 40°, and there were very few spots indeed near the equator of the sun. In 1882 the conditions are a little changed. There are some spots near the equator, and the maximum of spots now is 18° N., and there are more spots this year than there were last, because the curve is higher. Going on to 1883 the maximum of spots has changed from the north of the equator to the south, and in latitude 15° S. we have a reduced maximum, whereas in the northern hemisphere we get very nearly the same quantity in latitudes 10° and 20°. The other curves may now be compared with these, and the point of enormous importance is this, that the maxima faculæ and the metallic prominences agree absolutely in position with those of the spots.

When and where the spots are at the maximum the faculæ and the metallic prominences are at the maximum. If the maximum changes from north to south, as it does, in the spots, it changes from north to south in the metallic prominences, and from north to south in the faculæ; so that were we dependent on these diagrams alone, representing three years' work, we should be driven to the conclusion that there is absolutely the most tremendous and important connection between spots, the metallic prominences, and the faculæ; and not only that, we reach finally the fact of the wonderful localisation of these phenomena upon the sun. The spots are never seen north or south of 40°. They are invariably seen in smaller quantity at the equator; similarly the faculæ do not go very much further than 40° north or south, and their minimum is also at the equator. The metallic prominences also never go very much beyond the spot region, and they also have a minimum at the equator.

But when we pass to the protuberances of the quiet sort that is not so. They extend from one pole of the sun to the other, so that whatever it may lead us to, we are bound to consider that there is the most intimate connection between spots, metallic prominences, and faculæ, and that there is a great difference between the metallic prominences and the quiet ones. That is a result to have arrived at of the very first order of importance.

I have next in connection with that diagram to give another which we owe to the labours of a German observer, Prof. Spörer. Not only have we to accept the fact that these important solar phenomena are limited to certain zones, but we have to study that fact in connection with another, that though all of them vary very violently, they all have what is called a cycle, and the cycle affects the particular zone of the sun on which they appear. Here a sunspot curve, as it is called, writes out for us in a graphic form the quantity of spotted area on the sun from year to year. It begins at 1867, and ends at 1878. This curve means that when the curve is at its highest, we get the greatest number of spots, or the greatest amount of spotted area on the sun's surface. At one place we get a very sudden increase of the spotted area. The curve is almost like a chalk cliff, it goes straight up, but it does not come so straight down. The curve from the minimum of spots on the sun to the maximum is very much steeper than that from the maximum to the next minimum. The sunspot period on an average is one of about eleven years, and it may be said, though I do not want the term to be misunderstood, to represent the seasons on the sun, because when we get that curve low, we see the sun for days together without any spots on it at all. When we get to the highest part, of course there is the greatest number of spots on it.

In connection with that period then, which, as it is good for spots, must also be good for faculæ and for metallic protuberances, after the results obtained by the Italian observers, it is most interesting to see in further detail whether there is any difference in the part of the sun thus affected. The two lower curves show us that when there is the smallest number of spots on the sun—when there is a sunspot minimum—the spots that appear are seen in a high latitude, and that latitude goes on decreasing and decreasing regularly and gradually until we get, at the next minimum, a real over-lapping of two perfectly distinct spotted areas. When we have the maximum period of sunspots, the latitude of the sunspot zone is between 8° and 10°, but it gets much lower than that when the period is closing, and even before one period has closed another one has begun in a higher latitude, so that the swirl in the solar atmosphere seems to begin in a high latitude—say 30° or 35°, or thereabouts—and very soon gets into full swing in latitude between 10° and 12°, and then it very gradually dies away until spots and metallic prominences and faculæ cling pretty near to the equator, and then we get a new wave of activity, beginning again in a high latitude, as is indicated by the beginning of the second curve.

Drawings made by Mr. Carrington a good many years ago show this result in another form, which emphasises the enormous difference in the amount of spotted area, as it is called, at the maximum and minimum time. Another diagram gives the results of the last eleven years' work at Greenwich, where they have been computing the positions of the spots obtained on their photographs and on the photographs which the Solar Physics Committee receives from India. This gives the history of the sunspot period in rather a different way; we begin in the year 1873, and end in the year 1884, and the curves represent the amount of faculæ, of penumbræ, and umbræ. Here again we get both faculæ, penumbræ, and umbræ increasing towards the maximum period, and it is seen that when we come to discuss photographs instead of depending on eye-observations, as the Italians did, we still find that the faculæ and the spots vary together. Another diagram shows another important matter. We are now discussing at Kensington the results obtained from the photographs from several points of view. One point of view is this. It seemed hard, after all the trouble taken to observe latitudes, that all spots north and south of the equator should be lumped together in a mere statement of spotted areas. The two upper curves in the diagram represent the spots north and the spots south; and an important thing which comes out of this is that the curve representing the greatest amount of spotted area north and that representing the greatest amount of spot area north and south do not go together. We do not get the greatest amount of spots north and south of the equator at the same time. A peak in the south curve is in two or three cases associated with a valley in the north curve.

J. NORMAN LOCKYER

(*To be continued.*)

THE CORRELATION OF THE DIFFERENT BRANCHES OF ELEMENTARY MATHEMATICS[1]

AMONG the permanent acquisitions to mathematical science secured within the last half century, within the limits of those branches with which our Association concerns itself, two (I conceive) stand out as pre-eminent in their far-reaching and all-pervading consequences.

These are the firm establishment as distinct entities of two concepts, which have been fixed for all the future of science in the terms *Energy* and *Vector*, and the development of the groups of ideas and principles which cluster around each.

The term *Energy* indeed, and the great principle of the *Conservation*, or (as I prefer with H. Spencer to call it) *Persistence*, of Energy, the establishment of which will live in the history of science as the great achievement of the central part of the nineteenth century, have a scope far beyond the purely mathematical treatment of dynamics and the allied branches of physical sciences. They, the concept and the principle, have already profoundly modified the views of the physicist as to the natural laws with which he is concerned, and are destined to form the starting-point and firm foundation for all his conquests in the future. But no less is it true that the conception of energy, while it has naturally arisen out of the higher mathematical treatment of dynamics, has necessitated a very material recasting of that treatment in its most elementary, as well as in its more advanced, stages, if it is to bear any fruitful relation to physical science in general. This recasting of elementary dynamics, if not yet fully and satisfactorily effected in most of the text-books which still remain in use, in which the notion of energy is brought in rather as the "purple patch" than inwoven into the whole texture of the robe in which the subject is clothed, is yet, thanks pre-eminently to the teaching of Maxwell, Thomson and Tait, and Clifford, in a fair way for being accomplished.

The influence of the conception of energy is, however, as regards mathematics, rather an influence from without than one from within its peculiar domain.

That which is strictly mathematical in the treatment of any science is not its subject-matter, but the *form* in which that subject-matter must from its nature be expressed. Mathematics, as such, is in fact *a formal* (may I not say *the* formal?) science, concerning itself with the particular matter only so far as that matter necessitates a particular form for its expression. Hence the recurrence of the same formulæ and mathematically the same propositions in different branches of science, so that, to take elementary instances, a proposition in geometry may be read off as a proposition in statics by substituting forces for lines, or the formula which determines the speed of the centre of mass of two masses having different speeds is also that which determines the temperature resulting from the mixture of two masses of different temperatures.

To this *formal*, or essentially mathematical, part of the exact sciences belongs the conception of a *Vector*, or rather the group of conceptions which cluster around that term. The term itself was introduced by Hamilton in connection with his grand theory of quaternions about forty years since, but the idea had been already firmly grasped and developed so as to afford a complete explanation of the imaginary ($\sqrt{-1}$) of ordinary algebra within the twenty years preceding that epoch. In fact in the year 1845 I myself enjoyed the privilege, as a young student, of attending lectures of De Morgan on this subject, which he afterwards developed in his treatise on "Double Algebra," published in 1849.[2] I think, however, that we may conveniently date from the introduction of the term "*Vector*," which is now the accepted term for any magnitude which besides numerical quantity or intensity has a definite direction in space, the definitive acquisition of this concept with all its consequences to the settled territory of mathematical science. The calculus of quaternions indeed, or that part of it which was truly original and due to the genius of Hamilton alone, involving the conceptions of the products and quotients of vectors in three-dimensional space, is doubtless beyond the range of what now can be, or within the near future is likely to be, regarded as elementary mathematics; but the notions of vector addition and subtraction

[1] A paper read before the Association for the Improvement of Geometrical Teaching by the President, R. B. Hayward, F.R.S. (see NATURE for January 21, p. 277). We print the address in the hope that a discussion of some of its principles may ensue.

[2] Sir W. R. Hamilton's Lectures on Quaternions were published in 1853.

and their consequences in geometry and mechanics ought assuredly to be considered as within that range, as ought also, for a complete view of ordinary algebra, vector products and quotients in one plane.

If we inquire in what manner we should expect the idea of a Vector and its attendant ideas to affect our elementary teaching, I think the answer would be that it would naturally lead to a different grouping, or arrangement in order, of the various branches taught. It would lead us to group them not according to their subject-matter—arithmetic and algebra, the sciences of number, particular and general; geometry, the science of space; trigonometry, in one aspect treating of space and number in combination, in another as a development of algebra; statics, dealing with forces in equilibrium; dynamics, with forces producing motion; and so on—but according to their *form*, as dependent on the nature of the magnitudes dealt with. One-dimensional magnitudes, that is, magnitudes defined by one element only, whether such as are completely defined by one element, or more complex magnitudes regarded for the moment in respect of one of their elements only, would naturally form the first stage, with subdivisions according as the treatment is purely *quantitative* or *metric*, or *scalar*, that is, metric with the addition of the notion of sign or sense. Then would follow two-dimensional magnitudes, or magnitudes defined by two elements, treated with respect to both elements in subdivisions *metric* and *scalar* as in the first stage, and also finally as complete *Vectors*.

If we further inquire how far these notions have in fact affected our elementary text-books, I think we shall find that the extent to which they have done so is very small. A comparison of the text books of the present day (I speak of them in the gross, not forgetting that there are some important exceptions) with those that were current at the time when my own mathematical studies began, an interval of some forty years, produces the impression of likeness rather than that of contrast. Changes, which are welcome improvements, have doubtless been made in matters of detail, and in various ways the paths have been smoothed for the student; but the general treatment is essentially the same, and shows very little sign of independent thought, informed by more extended views, having been exercised with regard to the old traditional modes of presenting the subject as a whole.

The algebra, for instance, of our ordinary text-books is (if I may venture to give it a nickname which every brother Johnian at any rate will understand) *heptadiabolic*,[1] or that whose highest outcome, in the mind of the pupil who has studied it, is the solution (so called) of a hard equation or equation problem—little more in fact than a series of rules of operation, which skilfully used (and how many fail to attain even this amount of skill) will solve a few puzzles at the end, but very barren of any intellectual result in the way of mental training:—an algebra in which the interpretation of negative results and the use of the negative sign as a sign of affection has been ignored, or so lightly dwelt on, that the notion of the signs + and − as appropriately expressing opposite senses along a line, has to be elaborately explained as almost a new idea in commencing trigonometry; and further, an algebra which, as Prof. Chrystal has observed in his address to the British Association, is useless as an instrument for application to co-ordinate geometry, so that the student has at this stage practically to study the subject again, and only then obtains something of a true notion of what algebra really is.

With the foregoing general considerations as a guide, I will now examine in some detail the correlation or affiliation of the several branches of elementary mathematics to which they seem to lead.

Mathematics naturally begins by treating magnitudes with reference to the single element of quantity. The answers to the simple questions, How many? How much? How much greater? How many times greater? lead up to the arithmetic of abstract and concrete number, and the doctrines of ratio and proportion, and the development of these with the use of the signs +, −, &c., as signs of the elementary operations, and letters to denote numbers or ratios, naturally leads to generalised arithmetic or arithmetical algebra. At this stage $a - b$, where b is greater than a, is an impossible quantity, and a negative quantity has by itself no meaning. In this earliest stage the magnitudes dealt with are either pure numbers or concrete one-dimensional magnitudes, value, time, length, weight, &c., whose measurements are assumed as known. There are few magnitudes which are metric or quantitative *only*, but all magnitudes have quantitative relations which may be regarded apart from their other relations, and so may be the matter or subject of arithmetic, if they are such that their quantity can be estimated definitely or measured. Purely metric magnitudes are such as can be conceived to be reduced in quantity down to zero or annihilated, but of which the negative is inconceivable, so that at zero the process must stop. Such are many magnitudes that are measured by integral numbers—as population, numbers of an army or a flock, a pile of shot, &c., or continuous magnitudes, such as mass, energy, quantity of heat or light, the moisture of the atmosphere, the saltness of water, &c. But there is a far larger class of magnitudes, of which it is true that not only the opposite or negative can be conceived, but that they cannot be fully treated without regard to such opposite. For these, reduction to zero, or annihilation, is only a stage in passing from the magnitude to its opposite, *e.g.* time after and time before a given epoch, lengths forward and backward along a line, receipts and payments, gain and loss, and so forth. The consideration of such magnitudes at once leads to the scalar subdivision of the one-dimensional stage. In this, magnitudes which are themselves purely scalar, or the scalar elements of more complex magnitudes, are alone considered. But to the quantitative element is now superadded the notion of sign or sense, appropriately denoted by the signs + and −, which, without ceasing to be signs of operation, are now regarded also as signs of affection. The introduction of this notion leads at once to scalar algebra, in which $a - b$, where b is greater than a, is no longer an impossible quantity, and a negative result has a definite meaning, so long as the magnitudes dealt with are not purely metric. The step from arithmetical to scalar algebra, though very simple and almost insensibly made, should, I think, be much more distinctly emphasised in our teaching and our text-books than is usually the case. Exercises in metric and scalar readings of the same simple expressions should be frequent, and negative results, whenever they occur, examined and shown to be impossible only if the magnitude in the question is purely metric, but interpretable if it is scalar. Thus the idea would be gradually evolved that the impossibles or imaginaries of algebra are so in a purely relative sense and with regard to the particular subject-matter treated of, and it would become readily conceivable that the remaining impossible quantity $a + b\sqrt{-1}$, to which form scalar algebra, working on the basis of its laws of combination, would show that all expressions may be reduced, may be completely interpretable when ultra-scalar magnitudes form the subject of investigation.

Passing now to the consideration of special magnitudes and how far their discussion can be carried in the one-dimensional stage, I think we shall arrive at some important practical results.

The scalar element of space is length measured forwards or backwards along a line, and the resulting geometry is the simple geometry of points on the same line. Starting from the definition that $-AB$ is BA, the fundamental proposition is that $AB + BC = AC$, whatever be the positions of A, B, C on the line, and this with a few simple consequences completes all that is necessary to be considered in linear geometry.

Combine with this the notion of time, and the science of linear or scalar kinematics emerges This includes the measurement of the motion of a point along a given line by the scalar magnitudes, *speed*[1] and *acceleration*, and the discussion of different kinds of linear motion, uniform and uniformly accelerated, and so the laws of falling bodies. When the notion of a variable rate became firmly grasped, the investigation might be extended to some simple cases of variable acceleration without any large demand on algebraical skill, and so the fundamental notions of the fluxional or differential calculus and some idea of its scope and aim be attained.

Introduce now the notions of force and mass and the axioms of force or motion as contained in Newton's laws, and the science of linear or scalar dynamics results. If we drop for an

[1] The allusion is to a paper which used to be set at the annual May Examinations at St. John's College, Cambridge, consisting of seven very hard equations and equation problems, familiarly known as the "seven devils." As a test of a certain kind of skill in algebraical operation and of ingenuity and clearheadedness it was not without considerable value, but it tended to produce false notions of algebra in its relations to mathematics generally.

[1] The term *speed* has been happily appropriated for the scalar element of velocity. A corresponding term is wanted for the scalar element of acceleration; no better word than *quickening* suggests itself to me.

instant the notion of time, or rather of *change in time*, we have linear statics, which consists of little more than the single proposition—the "tug-of war" proposition—that the resultant of any number of forces along the same line is their scalar sum. Linear kinetics, however, covers a wide field—the relations of force, mass, and acceleration, their measures and their applications to simple cases of linear motion; the time integral of force, momentum; the space integral, work; energy, kinetic and potential; the relations of force applied to resistance overcome in simple machines working steadily; impulsive actions in collisions and explosions; and other simple developments—would here be studied in their simplest forms apart from any greater mathematical difficulties than arithmetic and very rudimentary algebra, and yet involving almost every truly dynamical principle needed for the highest problems in dynamics. Here, with perhaps a few applications to other branches of physics, the range of the one-dimensional stage ends.

Proceeding next to two-dimensional magnitudes, we commence of course with elementary plane geometry, in which the propositions, which are not purely descriptive, deal with the magnitudes considered in purely metric relations.

The introduction of the notion of sense for lines and angles, denoted by the signs + and −, leads in one direction to elementary trigonometry, and in another to co-ordinate geometry.

Kinematics is now extended to motion in two dimensions, and this should lead at once to the notion of velocity, acceleration, &c., as vector magnitudes, and with this the general notion of a vector and vector addition. In dynamics force emerges as a vector, and the composition of forces regarded as the addition of vectors lays the foundation of statics, or the relations of forces independent of the element of time, to be developed on the one side with the aid of pure geometry and graphical methods, on the other by the application of trigonometry. This is naturally succeeded by uniplanar kinetics, developed more or less fully till it extends to regions beyond the range of elementary mathematics. Algebra will have been carried on *pari passu* to meet the increasing requirements of the special subjects, but will still remain scalar with its impossible or uninterpreted symbols.

The next step is to complete the algebra of vectors in one plane. The notion of a vector and vector addition will already have been grasped and will need only some further application and development, but the extension of the notion of multiplication to vectors in one plane at once leads to the already familiar algebra, but with wider meaning and without impossible quantities or uninterpretable symbols. The immediate result is a complete trigonometry, of which De Moivre's theorem, now completely intelligible and not a mere formula, forms the basis, and the higher developments of ordinary elementary algebra. It will then appear that ordinary algebra receives its full explanation in vectors limited to one plane, and it will naturally be anticipated that the algebra of vectors in any directions in three-dimensional space will be different from the ordinary algebra, an expectation which will be amply justified by the study of the algebra or calculus of quaternions, the grand discovery of Sir W. R. Hamilton, but to pass on to this would be to pass beyond the limits of what is, in the sense of our Association, elementary mathematics.

If the correlation of the elementary branches of mathematics, which I have now sketched out, is accepted as based on true principles, I cannot doubt but that it will lead to important practical consequences, the development of which I may safely leave in the hands of those who so accept it. There are, however, a few immediate deductions from it, which occur to me as naturally calling for expression before I close this paper.

In the first place I would observe that while I believe the several stages in the foregoing scheme to be natural and such as every teacher would do well to have in his own mind in arranging the course of instruction for his pupils, I do not at all regard it as marking out the exact order to be followed by each individual student. There is room here, still in subordination to the general scheme, for wide variation according to the different requirements of different students. It would in almost all cases, I think, be very unwise that any one of the stages should be completed before the next was commenced. For instance, though the theory of ratio is purely one-dimensional and metric, no one, I suppose, would think of dealing with it otherwise than in the incomplete form sufficient for arithmetic before commencing the study of the simple two-dimensional geometry of Euclid or our own text-book. And again, how far scalar or linear kinematics and dynamics should be studied (or whether at all) before proceeding further in the two-dimensional stage to trigonometry, &c., is a question which may fairly be answered in different ways according to the different objects aimed at in the study of mathematics by different classes of students.

It appears to me too to follow from our scheme that, whatever may be true for the select few who aim at becoming mathematicians, for the great mass of those with whom the chief object is, or ought to be, intellectual training, algebra should be studied at first, not as a subject for its own sake, but as an instrument for use in other subjects. I hold that, unless pursued into its higher developments, algebra *per se* is not a valuable instrument of mental training. Can it be said that such algebra as is required (say) at the Previous Examination at Cambridge, a large part of which has had no application for the student in any other subject, is of any value at all proportional to the time it has taken him to acquire it? I think, then, that algebra should be studied piecemeal: first just that small quantity which is necessary for one-dimensional magnitudes treated as scalars; then, when the need was felt from the occurrence of problems requiring more knowledge of algebra, adding more, and so on continually, keeping up the study of algebra concurrently with, and only slightly in advance of, the requirements of the subjects to which it is applied.

Again, our scheme suggests, I think, a definite answer to the question:—What minimum of mathematics is it reasonable to expect every educated man, not professing to be a mathematician, to have acquired?

I think there are few who are satisfied with the answer practically given to this question by our Universities in their first examinations for matriculation or degrees. At Cambridge, the question with reference to the "Little Go" Examination is even now under consideration. I would submit that the subjects included within our one-dimensional scalar stage together with elementary geometry, and statics, treated geometrically, or by graphical methods only, from the two-dimensional, would constitute a far more satisfactory minimum than the present. This would exclude a good deal of the algebra now expected and the trigonometry, but would add linear kinematics and kinetics. The student, who had gone through such a course, would not probably be able to effect any but the simpler algebraical reductions or solve any but the simplest kinds of equations; but he would have gained some notion of what an algebraical formula means as the expression of a law, and be able to deduce from it numerical consequences and to follow out the simpler general results obtainable from it, and he would have acquired a clearer conception and higher appreciation than is common with people otherwise well educated of the part which mathematics plays in its application to the physical sciences, and with it that sound dynamical basis which is the essential condition of a fruitful study of physics. I feel sure, too, that the consciousness of the student that he was dealing with actual living laws and not with the dry bones of algebraical processes or trigonometrical formulæ leading to no results, and that his mathematical studies were meant to be, and were, more than a mere mental gymnastic, would add life and interest to those studies which would react on the whole of his mental training.

I may note, further, that our scheme seems to give the best answer to the question which has frequently been mooted of late, in our Association as well as elsewhere, whether statics should precede kinetics, or whether it should be treated as a particular case of the more general science. Linear kinematics and kinetics, being one-dimensional and scalar, may well precede the study of statics, which deals with vectors, though not of necessity in the case of one who has attained sufficient knowledge of elementary geometry not to be stopped by mere geometrical difficulties; but vector or uniplanar kinetics, on account of its much greater complexity and its consequent larger demands on mathematical attainments, would in general naturally follow a somewhat detailed study of statics.

I will take this opportunity of making one other remark, which, if it does not directly arise out of the present discussion, is closely akin to it, and that is on the importance of our teaching of the several branches of mathematics being *proleptic*, or looking forward in one stage to what will be required in a higher stage. In definitions for instance, of two that are equally good for the immediate purpose, that one is to be preferred which will be intelligible and useful when the term defined comes to be extended to higher matter.

Thus I conceive that multiplication should be defined from the outset in such a manner as would make it applicable to a fractional as well as to an integral multiplier. If I explain that to multiply 6 by 5 is to repeat 6 five times and find the aggregate result, my explanation fails when I am asked to multiply 6 by $\frac{3}{4}$; but if I use De Morgan's definition that "multiplication consists in doing with the multiplicand what is done with the unit to form the multiplier," or an explanation of multiplication cast in this form, I have given an explanation equally simple with the former and applicable also to a fractional multiplier.

Again, in the very beginning of arithmetic, which is counting, I maintain that much would be gained if from the first the child were taught to count, not one, two, &c., but *nought*, *nothing*, or *zero*, one, two, three, &c.; and then if, later on, ordinal reckoning were made to accord with this, though here unfortunately language and usage fails to supply the word wanted, for which, for want of a better, I must coin the form *zeroth* (*noughtth* or *nothingth* being out of the question), thus: *zeroth*, first, second, &c. Then the transition to counting below zero by negative numbers would follow at once as by a natural development, when the need for it arose. Thus when it came to the notation of numbers, the place of a digit would properly be reckoned from the units as the *zeroth* place (not the *first*), and would be extended naturally by negative ordinal reckoning downwards, when decimal fractions are introduced.

This leads me to another illustration, which I am also anxious to introduce as a suggestion on its own merits. Prof. Chrystal has complained that to many students even when beginning co-ordinate geometry the idea of the *order* of a term or an expression is unfamiliar. Now it has occurred to me that this is just the word wanted, to replace the five-syllable word "characteristic," which has been used (or perhaps has *not* been used just because it is pentasyllabic) to express the distance of any digit of a number in order from the unit's digit. Let us speak of the unit's digit as of the order 0; the tens, hundreds, &c., digits of the orders 1, 2, &c.; and the tenths, hundredths, &c., of the orders -1, -2, &c.; and add to this that a number is said to be of the same *order* as that of its highest significant digit, and we have a language not only of the utmost use and importance in decimal arithmetic, but also at once applicable by the most natural extension to an algebraical expression arranged according to the powers of some letter or letters, while it would enable us conveniently to express in language numbers which transcend our ordinary numerical vocabulary, so that, for instance, 53×10^{12} might be read as 53 of the 12th order, and 53×10^{-12} as 53 of the $-$12th order, and so on.

In conclusion I will only add that, if in this paper I have in any parts expressed myself somewhat dogmatically, I have done so in the hope of challenging discussion, and only claim the acceptance of the views which I have tried to express *distinctly*, if *briefly*, in the event of discussion resulting in a verdict in their favour.

ON THE METHOD OF STATING RESULTS OF WATER ANALYSES

THE Chemical Society of Washington is desirous of bringing before chemists and others interested, the report of Committee herewith inclosed; and as NATURE has a wide circulation in this country, I am authorised to send a copy of the abstract to your journal, hoping you may find space for it.

A. C. PEALE, M.D.,

Sec. Chem. Soc. Washington
(Office of U.S. Geol. Survey)

Washington, D.C., February 25

The Chemical Society of Washington, at the meeting of November 12, 1885, appointed a Committee to consider the present state of water analysis, and to present a method of stating analyses, adapted for general use, in order that those hereafter published may be readily compared with each other and with future work. This Committee reported February 11, 1886, and was authorised to prepare an abstract for publication, in order to call the attention of chemists to the subject. The Society earnestly recommends the adoption of the scheme which is herewith briefly presented. The full text of the report will be published in the next *Bulletin* of the Society.

(*Abstract*)

Water analyses are usually made to answer one of three questions, viz:—

(1) Is the water useful medicinally?
(2) Is it injurious to health? and
(3) Is it suitable for manufacturing purposes?

Many books relating to water were published during the eighteenth century, but accurate chemical analysis was not attempted until about 1820. As the earlier analyses were isolated, rare, and made for special purposes, the form of the statement was of little importance if it were only intelligible. At the present time, however, water-analyses are very numerous. An examination of about a thousand shows some forty-two methods of stating quantitative results, there being sometimes three different ratios in the report of one analysis. Such discrepancies render comparisons difficult and laborious. The various methods of statement may be classified under the following general forms:—

(1) Grains per imperial gallon of 10 lbs. or 70,000 grains.
(2) Grains per U.S. or wine gallon of 58,372+ grains.
(3) Decimally, as parts per 100, 1000, 100,000, or 1,000,000.
(4) As so many grammes or milligrammes per litre.

The last two would be identical if all waters had the same density; but as the densities of sea water, mineral waters, &c., are much above that of pure water, it is plain that the third and fourth modes are not comparable. The Committee therefore unanimously recommends—

(1) That water-analyses be uniformly reported according to the decimal system, in parts per million or milligrames per kilogramme, with the temperature stated, and that Clark's scale of degrees of hardness and all other systems be abandoned.

(2) That all analyses be stated in terms of the radicals found.

(3) That the constituent radicals be arranged in the order of the usual electro-chemical series, the positive radicals first.

(4) That the combination deemed most probable by the chemist should be stated in symbols, as well as by name.

The abandonment of Clark's *scale* has been recommended by Wanklyn and Chapman; and the recommendation made by the Committee does not involve the disuse of his method, but merely the bringing it into accord with the decimal system—the changing from grains per gallon to milligrammes per kilogramme.

The last conclusion (4) was deemed desirable from the frequent confusion in the statement of the iron salts and of the carbon oxides.

The Committee is unanimously of the opinion that analyses in the form recommended will prove quite as acceptable to Boards of Health and to the public in general, for whom such analyses are often made, as if presented in the mixed and irregular forms commonly adopted.

The Committee also feels sure that the people in general are better able to form a definite idea of the character of a water from a report stated in parts per 100, parts per 1,000,000, &c., than from one expressed as grains per gallon, the latter being a ratio wholly unfamiliar to any but those in the medical or pharmaceutical professions.

(Signed) A. C. PEALE, M.D.
WM. H. SEAMAN, M.D.
CHAS. H. WHITE, M.D.

ON SOME POINTS IN THE PHYLOGENY OF THE TUNICATA

IN his monograph on the genus *Doliolum*, forming one of the recent parts of the series illustrating the Fauna and Flora of the Bay of Naples,[1] Dr. B. Uljanin gives a sketch of the phylogeny of the Tunicata, some parts of which cannot, I think, be accepted without considerable modification. Uljanin has evidently regarded the subject from the *Doliolum* point of view, and, in fact, he only introduces the other groups of Tunicata for the purpose of discussing their relationships to *Doliolum*. Consequently it is not to be wondered at that he should assign rather too central a position to that genus, and give it too much importance relatively to the other groups. What is of more importance is that his scheme shows a course of evolution which seems not altogether in accordance with

[1] "Fauna und Flora des Golfes von Neapel." X. Monographie: Doliolum, von Dr. Basilius Uljanin. (Leipzig, 1884.)

what is known of the anatomy and embryology of the various forms.

In the first place the diagram given on page 123 shows the lines of development of certain groups passing through other existing groups, an arrangement which should be avoided in phylogenetic tables. It always suggests that the groups passed through are the direct ancestors of the group at the free end of the line, and it is highly improbable that any existing forms are precisely the same as the ancestors from which a group was derived. To take an example, Uljanin represents the line of evolution of *Doliolum denticulatum* passing through first *Anchinia rubra*, and then *D. mülleri*, thus suggesting, I hold, that the two last-named species are extinct forms which were direct ancestors of *D. denticulatum*. Now of course *A. rubra* and *D. mülleri* are not extinct, and although they are undoubtedly closely related to ancestral forms on the line of development terminating in *D. denticulatum*, still it is very unlikely that they are in all respects identical with these ancestral forms. The best way to represent such a case diagrammatically would be to place *A. rubra* and *D. mülleri* on the ends of short side branches springing from the main stem at the points which the ancestral forms they seem to resemble probably occupied. In that way the line of evolution of *D. denticulatum* would be shown as passing not *through*, but *close to*, *A. rubra* and *D. mülleri*.

Uljanin represents the Appendiculariidæ giving rise to the Ascidiæ Simplices, from which three lines then diverge, one leading to *Salpa*, the second to the Doliolidæ through *Anchinia*, and the third to the Ascidiæ Compositæ. From this last group (presumably only the typical Compound Ascidians) three lines start upwards, leading,—the first to *Pyrosoma* through *Distaplia* (?), the second to *Botryllus*, and the third to the "Social" Ascidians through *Pseudodidemnum* and *Trididemnum*.

The starting-point in this scheme of evolution is undoubtedly correct. The various existing groups of Tunicata are all descended from common ancestfal forms closely resembling the Appendiculariidæ. But the origin of the Salpidæ and the Doliolidæ from groups of the Simple Ascidians is very questionable. The passage from *Appendicularia mossi*[1] through *Anchinia rubra* to *Doliolum*, and through the ancestral Doliolidæ to *Salpa*, seems so simple and natural that it makes it very unlikely that the Thaliacea were ever fixed Simple Ascidians which have undergone great modification and have become free-swimming pelagic organisms again. The argument made use of by Uljanin that the Thaliacea, &c., have not such a typical method of development as the Simple Ascidians, and are therefore a younger group, is not necessarily of great value, since the process of development may have undergone modification.

Then, again, it seems more probable that the Simple and the Compound Ascidians were derived from a common ancestor resembling the simpler forms of the two groups (*e.g. Ciona* and *Diazona*) than that the Compound were derived from the Simple. Many of the Simple Ascidians show far more differentiation and far more specialisation of certain important organs (*e.g.* the branchial sac in the Molgulidæ) than is found in any of the Compound Ascidians.

I must protest against Uljanin's statement that the "Social" Ascidians are a group derived from the Compound forms and having no close connection with the Simple Ascidians. This view is opposed to all we know as to the very close relationship[2] between the Clavelinidæ and the Ascidiidæ. There can, I think, be no doubt, after the examination of such a series of forms as *Diazona*, *Clavelina*, *Ecteinascidia*, and *Ciona*, that the "Social" Ascidians (Clavelinidæ) are intermediate between the least modified forms of the Simple Ascidians (*e.g. Ciona*) and the least modified forms of the Compound Ascidians (*e.g. Diazona*), and ought therefore to be regarded as being closely allied to the ancestral forms from which both Simple and Compound Ascidians were derived.

I agree with Dr. Uljanin in considering *Pyrosoma* a modified Compound Ascidian, but I differ from him inasmuch as I regard it as being derived from the family Didemnidæ, and not from *Distaplia*. The remarkable new genus *Cœlocormus*, found during the *Challenger* Expedition,[3] is a valuable connecting-link between *Pyrosoma* and the primitive Didemnidæ, which in their turn were derived from the primitive Distomidæ, thus carrying the origin of *Pyrosoma* back to the typical Compound Ascidians.

Distaplia, which figures in Uljanin's scheme as the stepping-stone to *Pyrosoma*, is not really such an extraordinary form as has been supposed. It is an ordinary Compound Ascidian belonging to the family Distomidæ. The Didemnidæ (*e.g. Trididemnum*) and the Diplosomidæ (*e.g. Pseudodidemnum*) are not at all closely related to the "Social" Ascidians. They are highly modified and in some respects degenerate Compound Ascidians which have probably originated from the primitive Distomidæ.

Dr. Uljanin is, I think, right in regarding the Botryllidæ as an abnormal group of Compound Ascidians worthy of being placed in a branch by themselves. They show certain resemblances to some of the Simple Ascidians, and it is just a question whether they should not be regarded as a remarkably modified offshoot from the primitive Cynthiidæ quite distinct from the other Compound Ascidians. I am inclined to regard the Compound Ascidians as polyphyletic. There is some evidence in favour of their having arisen as three distinct groups from the ancestral Social and Simple Ascidians, and in that case one of these groups would be the Botryllidæ. This question will be discussed more in detail in a paper I am now preparing on the Phylogeny of the Tunicata.

On some points, then, I am quite in accord with Dr. Uljanin, while we differ on others. With the modifications suggested above I would accept his views. Probably the most valuable part of his scheme is that dealing with the evolution of the Doliolidæ, and the relations between the different forms of *Doliolum* and *Anchinia*.

W. A. HERDMAN

[1] I have ventured to call by this name a species described as new, but not named, by Dr. Moss (*Trans. Linn. Soc. Lond.*, vol. xxvii. p. 229, 1871).

[2] See Herdman, "Report upon *Challenger* Tunicata," part i., and Sluiter, "Ueber einige einfachen Ascidien," &c., *Natuurkundig Tijdschrift v. Nederlandsch-Indie*, Band xlv. p. 160, 1885.

[3] See "Report upon *Challenger* Tunicata," part ii.

SCIENTIFIC SERIALS

The Quarterly Journal of Microscopical Science for February 1886 contains:—On the development of the mole (*Talpa europæa*); the ovarian ovum and segmentation of the ovum, by Walter Heape, M.A. (plate 11). Of the two membranes the outer (zona radiata) was thick, the inner (vitelline) thin; between them there was a space; radial canals exist in the outer membrane; no micropyle was observed. Two kinds of yolk are noticed—homogeneous vesicular and minute highly refractive bodies. During maturation the vitellus divided into a medullary and cortical portion, and withdrew from the vitelline membrane, excepting where connected by pseudopodia-like processes, and at the spot where the polar bodies are formed. A single spermatozoon appears to effect impregnation. Segmentation occurs while the ovum traverses the Fallopian tube.—On the development of the Cape species of Peripatus, by Adam Sedgwick, M.A., part 2 (plates 12-14). This part is chiefly devoted to a consideration of the segmentation of the ovum and the formation of the layers. The important and in several cases novel facts brought to notice do not readily admit of being abstracted. The embryo at the gastrula stage and in all the earlier stages of development is a syncytium: no part of the nucleus or centre of force of the unsegmented ovum enters the clear endoderm masses. The gastrula gut arises from an enlargement and confluence of the vacuoles in the centre of the mass.—Studies on earthworms, by W. B. Benham, B.Sc. (plates 15, 16, 16 *bis*). In this series of papers the authors describe a number of earthworms from various parts of the world, placed at his disposal by Prof. Lankester; these include new genera and species. In this paper, after an historical *résumé*, a notice of the hitherto known genera and species is given, and *Microchæta rappi*, Bedd., is described and figured.—The official refutation of Dr. Robert Koch's theory of cholera and commas.

The Journal of the Royal Microscopical Society for February 1886 contains:—Fresh-water algæ (including chlorophyllaceous Protophyta) of the English Lake District, with descriptions of twelve new species, by A. W. Bennett, F.L.S. (plates 1 and 2). A record of a six weeks' collecting in the district between Windermere and Langdale, and no doubt only an indication of what a more protracted study would do for the Lake flora.—Explanatory notes on a series of slides presented to the Society, illustrating the action of a diamond in ruling lines upon glass, by Prof. W. A. Rogers.—On the preparation of sections of pumice-stone and other vesicular rocks, by Dr. H. J. Johnston-Lavis.—On the cultivation of Bacteria, by Dr. E. M. Crookshank (plates 3-5).—On the appearance which some micro-organisms present under different conditions—as exemplified in the microbe of chicken-cholera, by G. F. Dowdeswell, M.A.

(plate 6).—On "central" light in resolution, by J. W. Stephenson, F.L.S.—With the usual summary of current researches and the proceedings of the Society.

The Journal of Physiology, vol. vii., No. 1, January 1886, contains but one memoir, but that an important one by Dr. W. H. Gaskell, on the structure, distribution, and function of the nerves which innervate the visceral and vascular systems (plates 1–4). If the various nerves of different function which are described as innervating the viscera have a real and separate existence, then, as in the case of the motor nerves of ordinary skeletal muscles, a similar correlation must exist between their function and their morphological arrangement. In a series of papers the author proposes to deal with this question for all the different groups of nerves, classifying them according to function, and including afferent as well as efferent nerves. In the present memoir he confines himself to the efferent nerves of the vascular and visceral muscles, treating of the structure and distribution of these nerves; of the nature of the action of the motor and inhibitory nerves of the same, and he further treats of the morphology of the superior cervical ganglion; on the central origin of the ramus visceralis; on the relation of the posterior root ganglia to the visceral nerves; and on the roots of the cranial nerves.

The American Journal of Science, February.—The story of Biela's comet, a lecture delivered at the Sheffield Scientific School of Yale College on March 9, 1874, by A. Newton. This paper is here reproduced in consequence of the renewed interest created in Biela's comet by the meteoric display of November 27, 1885.—Relation between direct and counter-electromotive forces represented by an hyperbola, by H. S. Carhart. In discussing the relations between the electromotive force (E.M.F.) of the generator, the counter E.M.F. resulting from the electromagnetic reactions taking place in the motor, and the rate at which energy is absorbed by the latter in the electrical transmission of power, it is implicitly assumed that E is constant. Here it is shown that, with an assumed amount of work spent upon the motor per second and a given resistance R, E has a minimum value equal to twice E_i; this corresponds with Jacobi's law of maximum rate of working or greatest electrical activity and constant E.M.F.—Tendril movements in *Cucurbita maxima* and *C. Pepo* (continued), by D. P. Penhallow. From 436 distinct observations upon the motion of the tendrils and terminal bud under all conditions of temperature, sun and humidity, a normal rate of movement under all conditions to which the plant is ordinarily subjected, has been determined at 0·351 m. per minute. In the terminal bud the greatest movement occurred about noon under conditions of great humidity, the least at night, also during great humidity. In all the results so far obtained we have still further proof of the influence of meteorological conditions on the growth of the plant.—A theorem of maximum dissipativity, by George F. Becker. The proposition here demonstrated is that in all moving systems there is a constant tendency to motions of shorter period, and that, if there is a sufficient difference between the periods compared, this tendency is always a maximum. Hence all natural phenomena occur in such a way as to convert the greatest possible quantity of the energy of sensible motion into heat, or the greatest possible quantity of heat into light, &c., in a given time, provided that the interval of time considered exceeds a certain fraction of the period of the most rapidly moving particles of the system.—A new law of thermo-chemistry, by George F. Becker. Considering chemical energy as a form of motion, and accepting Berthelot's thermo-chemical law of maximum expenditure, the author seeks to ascertain whether any definite results may be reached as to the rate of evolution of heat. The principle arrived at is set forth in the previous paper, the chemical interpretation of which is thus summed up: the sum of the chemical and physical transformations in any chemically active system will be such as to convert higher forms of energy into heat, light, &c., at the greatest possible rate, provided that the interval of time for which the comparison is made is a multiple of a certain fraction of the period of the most rapidly moving particles of the system. This is practically equivalent to the statement that the transformation will be such as to evolve heat, light, &c., at the highest possible rate.—Recent explorations in the Wappinger Valley limestone of Dutchess County, New York, by William B. Dwight. This paper, the fifth contribution on the subject, deals with the discovery of fossiliferous Potsdam strata in the Poughkeepsie district, New York.—Wind-action in Maine, by George H. Stone. Drifting sands, partly of marine, partly of fresh-water deposition, are common in Maine. But here two less common phases of wind-action are considered,—till-burrowing, such as is frequently observed in Colorado, and sand-carving, as seen in the grooves, scratches, and striated polished surfaces of the boulders scattered over several square miles, and already described in Hitchcock's Report on the Geology of Maine (1861).—The westward extension of rocks of Lower Helderberg age in New York, by S. G. Williams. It is shown that the Lower Helderberg period, including all above the Water-lime group, is represented at least as far west as Cayuga Lake by limestones not less than 65 feet thick, containing an unmistakable Lower Helderberg fauna.—Meteoric iron from Jenny's Creek, Wayne County, West Virginia, by George F. Kunz. This specimen, picked up in 1883, is octahedral, belonging to the "grobe Lamellen" of Brezina's new classification, and yielding on analysis: iron, 91·56; phosphorus, 0·13; nickel and cobalt, 8·31;—specific gravity, 7·344.

The American Naturalist for February 1886 contains:—On the post-mortem imbibition of poisons, by Dr. George B. Miller. Treats of a subject of a highly interesting character from its medico-legal aspect.—Notes of an ascent of the volcano of Popocatapetl, by A. S. Packard (woodcuts). The ascent was made from Amecameca (a town forty miles by rail from Mexico, and 8223 feet above the sea) at 1 p.m.; a rancho where the party stopped for the night was reached at 5.40, twelve hours after the ascent proper began; it was for two hours on horseback, and then on foot for three hours and a half. While it was hard work, there were no dangers or difficulties. No notes of the vegetation are given.—Notes on the Œcodomas or leaf-cutting ants of Trinidad, by C. Brest (woodcuts).—The Flood-Rock explosion, by W. H. Ballou.

March 1886:—On the migrations of Siouan tribes, by Rev. J. Owen Dorsey.—The torture of the fish-hawk, by J. Lancaster.—A study of garden lettuce, by Dr. E. L. Sturtevant.—Aquatic respiration in soft-shelled turtles, by Simon H. and Susanne Phelps Gage.—This is a very valuable contribution to the physiology of respiration in vertebrates. By comparing the free gases found in water with those in the same water after a turtle had been immersed in it without access to air, it was found that a turtle, weighing two pounds, in ten hours removed from the water 71 milligrammes of free oxygen and added to it 318 milligrammes of carbon dioxide.—On a new sub-species of the common Eastern Chipmunk (*Sciurus striatus*), by Dr. C. H. Munair.—Fish remains and tracks in the Triassic rocks at Weehawken, N.J., by O. T. Mason.

Journal of the Russian Chemical and Physical Society, vol. xviii. fasc. i.—On the influence of contact on the course of chemical transformations, by Prof. D. G. Mendeléeff.—On the specific gravity of aqueous and alcoholic solutions of mercuric chloride, by J. Schreder.—Thermic data for the group of aromatic compounds, by Werner. The thermic effects accompanying the neutralisation and dissolution of di- and tri-oxybenzoic acids and di- and tri-phenols are determined and verified.—On the action of the tri-carbonate of potassium on salts of nickel and cobalt, by F. P. Rosenblatt. This reaction is proposed as a new method of separation of the above metals and of their qualitative determination also.—On the action of sulphuric acid on oleic acid, by M. Sabaneyeff. Important for dyeing industry; the literature on the subject is given.—On azocumol, by Pospekoff; and on one of the xylidines, by E. Wroblewski.—On the heating of the glass of condensators in consequence of the alternative electrisation, by M. J. Borhman. The author comes to the conclusion that the heating of the glass in consequence of the rapid successive charges and discharges is very nearly proportional to the square of difference of potentials of the charges.—On the demonstration of the second Kirchhoff's theorem concerning the ramification of electric currents, by J. Borhman.—On the geometrical demonstration of the conditions of minimum declination of a ray in the prism, by V. Lermontoff.

Bulletins de la Société d'Anthropologie de Paris, tome viii., fasc. 3.—Sequel to M. Verrier's paper on the various modes of delivery practised among the women of civilised and savage nations.—Report of M. Hovelacque's address at the third meeting of the Transformist Conference, on the evolution of language. This treatise cannot be commended on the score of originality or profoundness of knowledge, or even as contributing in any way to the advance of philology.—Hypothetical suggestions as to the origin of right-handedness or left-handedness, by M. Dareste. The author believes that we must seek in embryonic relations for the preponderance of the right hand over the left, in which he sees a possible result of the position generally maintained by the fœtus in regard to the vitellus, in which one side of the body enjoys greater freedom for development than the opposite one. Dr. Dareste wishes to verify, by the observation of others, his hypothesis that left-handedness is present in those who suffer from inversion of the viscera (heterotaxy), which would seem to be unquestionably due to malposition in the fœtal state.—M. Sebillot has presented to the Society a comprehensive formula of questions relating to the appearance, character, and various other phenomena of the sea, together with the popular legends and superstitions connected with it by different races. These he wishes to see incorporated with the Society's authorised directions for travellers.—Note on May celebrations in the Gironde, by M. Daleau.—Discussion on the assumed Quaternary jaw found at Châlons-sur-Marne, and forming part of M. Nicaise's collection. M. Topinard, who gave the result of his own measurements, considers that the differences between this jaw and the one found at Naulette prove the co-existence, in primæval ages, of different human types. The Naulette jaw he regards as unique of its kind, differing as it does from the thousand and upwards of inferior maxillæ which he had examined with special reference to this question. — On the difficulties of distinguishing between genuine prehistoric trepanning and recently effected injuries of the crania, either through accident in the process of exhumation, or for purposes of deception, by M. Manouvrier.—On the best means of measuring the cranial capacity, by M. de Jouvenrel.—On Broca's method of determining cranial cubage, as exemplified by means of a bronze test-cranium, by M. Topinard.—On an archæological exploration on the Island of Téviec, near Quiberon, by M. Gaillard. The similarity of the dolmens, shells, and bones with those on the neighbouring mainland, and the numbers and character of the silex and bone fragments found on the island, lead the writer to believe that a separation from the continent has been effected since prehistoric ages.—On the Dutch dwarf known as Princess Pauline, by M. Mortillet.—On curious methods of conducting barter in parts of Asia and Africa, by M. Hovelacque. In tracing the history of the development of the process of bartering silently and from a distance, which still prevails between tribes or castes who refuse to meet or be seen by each other, the author draws attention to notices by Herodotus which prove the existence of the same customs among the people of Libya.—On the existence of wars in primæval times, by Dr. Hoffman, of Washington.—On the finds of a cave near Ojcow, by M. Zaborowski. Numerous fragments of the bones of the mammoth, rhinoceros, hyæna, and cave-bear were found intermixed with those of the ox, horse, hare, &c., together with flint knives, bone implements, &c.—On the brain of an insane woman, by M. Rey.—On a case of microcephalism, by M. Letourneau.—On a gibbon-fœtus and its placenta, by M. Deniker.—On ideas and memory, by M. Fauville. In this elaborate treatise the author considers memory as the result of special manifestations of the impressionability of the sensient cellules of the brain, while ideas are defined as the consequences of sensations.—On the common origin of Malays and Dravidians, by M. O. Beauregard. In this sequel to his former paper on the subject of the Malayan races the author begins with their language, which may be traced from the Moluccas as far west as Easter Island, many words in use among the inhabitants of the various island-groups that lie between these remote limits being absolutely the same. This paper is an exhaustive compendium of what has been written by other authors, chiefly Englishmen, on the language and legendary literature, the political and social constitution, and the religion and laws of the Malayan and Dravidian races, with special reference to those settled in Ceylon.

SOCIETIES AND ACADEMIES

London

Royal Society, February 11.—"The Electrical Phenomena accompanying the Process of Secretion in the Salivary Glands of the Dog and Cat." By W. Maddock Bayliss, B.Sc., and J. Rose Bradford, B.Sc., Senior Demonstrator of Anatomy in University College, London (from the Physiological Laboratory of University College). Communicated by E. A. Schäfer, F.R.S.

March 11.—"The Influence of Stress and Strain on the Physical Properties of Matter. Part I. Elasticity (continued). The Internal Friction of Metals." By Herbert Tomlinson, B.A. Communicated by Prof. W. Grylls Adams, M.A., F.R.S.

An abstract of a paper on this subject has been already published (*Proc. Roy. Soc.*, vol. xxxviii. p. 42), but the paper itself was withdrawn for the purpose of revision. The fresh experiments which have been for this purpose instituted during the last year, besides confirming the results of the older ones, as far as the latter have been published, have furnished, more or less in addition, the following facts relating to the internal molecular friction of metals:—

The proportionate diminution of amplitude is independent of the amplitude, provided the deformations produced do not exceed a certain limit. This limit varies with the nature of the metal, and is for nickel very low.

The logarithmic decrement of amplitude increases with the length of the vibration-period, but in a less proportion than the latter, and in a diminishing ratio. The amount of increase of the logarithmic decrement, attending on a given increase through a given range of the vibration-period, varies with the nature of the metal, and with those metals which possess comparatively small internal friction becomes almost insensible. It follows as a consequence that the internal friction of metals differs from the viscosity of fluids, for in cases of damping by the latter the logarithmic decrement is *inversely* as the length of the vibration-period.

Permanent molecular strain resulting from loading not carried to a sufficient extent to produce sensible permanent extension, diminishes the internal friction, and increases the torsional elasticity.

Considerable permanent longitudinal extension and permanent torsion produce increase of internal friction and diminution of torsional elasticity. The effect of torsion is much greater than that of extension, and the increase of internal friction is much greater than the decrease of torsional elasticity. As a consequence, wire-drawing, where we have permanent extension and torsion combined, sometimes increases enormously the internal friction; in fact, in the case of six different metals it was found that, by careful annealing, the internal friction was decreased from *one-half to one-thirtieth* of the original amount of friction of the metals in the hard-drawn condition.

The internal friction of a metal wire, whether in the hard-drawn or annealed condition, is temporarily decreased, and the torsional elasticity is temporarily increased by loading not carried beyond a certain limit; beyond this limit both the friction and the elasticity become independent of the load.

The "fatigue of elasticity," discovered by Sir William Thomson in metal wires when vibrating torsionally, is not felt, provided the deformations produced do not exceed a certain limit, depending upon the nature of the metal. The above-mentioned limit is extraordinarily low for nickel, so low, indeed, that it is difficult to avoid "elastic fatigue" with this metal. This last consideration, and others founded on the results of experiments on the effects of stress on the physical properties of nickel, tend to show that the molecules of this metal are comparatively easily rotated about their axes.

The author agrees with Prof. G. Wiedemann, that the loss of energy due to internal friction in a torsionally vibrating wire is mainly due to the to-and-fro rotation of the molecules about their axes; any cause, therefore, which increases the molecular rotatory elasticity diminishes the internal friction, and conversely.

The molecules of a metal tend to creep into such positions as will ensure a maximum molecular rotatory elasticity, and they can be assisted in doing so by agitations effected either by thermal or mechanical agency; hence—

Rest after suspension, aided by oscillations at intervals, diminishes the internal friction of a wire which has been recently suspended, or which after a long suspension has been subjected to considerable molecular agitation by either mechanical or thermal agency.

On the contrary, when a maximum molecular rotatory elasticity has been reached, molecular agitation, if carried beyond a certain limit, diminishes the elasticity; hence the results of "fatigue of elasticity;" and hence—

Mechanical shocks and rapid fluctuations of temperature beyond certain limits may considerably increase the internal friction, and, though to a much less extent, diminish the torsional elasticity.

The logarithmic decrement is independent of both the length and diameter of the wire.

"Effects of Stress and Magnetisation on the Thermo-electric Quality of Iron." By Prof. J. A. Ewing, B.Sc., F.R.S.E., University College, Dundee. Communicated by Sir William Thomson, F.R.S.

This paper comprises a revised version of one submitted to the Royal Society in 1881, under the title "Effects of Stress on the Thermo-electric Quality of Metals, Part I." (published in abstract in *Proc. Roy. Soc.*, No. 214, 1881), along with much new matter. It deals principally with the cyclic changes of thermo-electric quality which an iron wire undergoes when exposed to cyclic variations of stress (described in the abstract of the former paper), and with the relations of these changes of thermo-electric quality to the changes of magnetism which also occur as an effect of stress. Stress was applied by exposing the wire to longitudinal pull by means of loads. The changes both of thermo-electric quality and of magnetism exhibit that tendency to lag behind the changes of stress to which in a previous paper (*Proc. Roy. Soc.*, No. 216, 1881, p. 22) the author gave the name *hysteresis*, and the effects are sufficiently similar in regard to the two qualities to suggest that the changes of thermo-electric quality occur as secondary effects of changes of magnetism. To examine whether this is the case, simultaneous measurements of the magnetic and thermo-electric effects of stress on an iron wire were made, and also independent observations of the thermo-electric effects of magnetisation, without change of stress. A comparison of these made it clear that stress causes change in the thermo-electric quality of iron directly, and not as a secondary effect of magnetisation. If the wire be completely demagnetised to begin with, and kept clear of all magnetisation during the application and removal of stress, the presence of hysteresis is not less marked than before. Experiments are given to show how the thermo-electric effects of stress are modified by the existence of more or less magnetisation in the wire; and, conversely, how the thermo-electric effects of magnetism are modified by the existence of more or less constant stress. The influence of vibration in destroying the effects of hysteresis is investigated, and also the result of exposing the wire to the process of demagnetising by repeated rapid reversals of a continuously diminishing magnetising force, and it is shown that this process acts in the same way as vibration in destroying the effects of hysteresis. Residual effects of hysteresis are studied, as, for example, the difference which presents itself when a wire is magnetised after having been loaded strongly and then unloaded down to a certain constant state of stress, and, on the other hand, when the same state of stress has been produced by simply increasing the load; and it is shown that these residual effects are wiped out by vibration or by demagnetising by reversals. With regard to the effects of stress on thermo-electric quality it is shown that if a somewhat soft wire be more and more strongly magnetised these effects become more and more similar to those which are found when the wire is hard-drawn but not magnetised. A few experiments were made with wires of silver, copper, lead, magnesium, aud German silver, but in none of these was hysteresis of thermo-electric quality with regard to load discovered.

Special attention is directed to a peculiar feature in the curves by means of which the experimental results are exhibited. In curves showing the relation of thermo-electric electromotive force to load, it is shown that any reversal from loading to unloading, and *vice versâ*, causes an inflection in the curve, the first effect of the new process being to continue the kind of change of thermo-electric quality that was going on before. That this is not due to any mechanical disturbance which the loading or unloading produces is shown by the fact that it occurs in an equally marked way after the molecules have been brought to a condition of stable equilibrium by vibrating the wire before beginning to load or unload. It is suggested that the effects of hysteresis, described in the paper, have a possible relation to the properties which Prof. Osborne Reynolds has recently shown to be possessed by granular media.

The experiments described in the paper are closely connected with those which were communicated to the Society in January 1885, under the title "Experimental Researches in Magnetism," and are now being published in the *Philosophical Transactions*. They were conducted in the Physical Laboratory of the University of Tokio, in 1881–83, partly with the help of one of the author's Japanese students, Mr. S. Sakai. The results are given graphically, and are for the most part reduced to absolute measure.

March 18.—"On the Properties of Matter in the Gaseous and Liquid States under Various Conditions of Temperature and Pressure." By the late Thomas Andrews, M.D., LL.D., F.R.S. Communicated by the President.

The following are the general conclusions to which this inquiry has led:—

(1) The law of gaseous mixtures, as enunciated by Dalton, is largely deviated from in the case of mixtures of nitrogen and carbonic acid at high pressures, and is probably only strictly true when applied to mixtures of gases in the so-called perfect state.

(2) The critical point of temperature is lowered by admixture with a permanent gas.

(3) When carbonic acid gas and nitrogen diffuse into each other at high pressures, the volume of the mixture is increased.

(4) In a mixture of liquid carbonic acid and nitrogen at temperatures not greatly below the critical point, the liquid surface loses its curvature, and is effaced by the application of pressure alone, while at lower temperatures the nitrogen is absorbed in the ordinary way, and the curvature of the liquid surface is preserved so long as any portion of the gas is visible.

Linnean Society, April 1.—Sir John Lubbock, Bart., President, in the chair.—Mr. J. G. Baker exhibited *Scolopendrium Devalyi*, a new species of fern discovered by the Abbé Devalyi in the province of Yunnan.—Dr. F. Day showed photographs of the fully-grown skulls of *Salmo salar* and *S. fario*, in proof of the marked cranial differences existent in the very adult stages of the salmon and the trout.—A paper was read, botanical observations made in a journey to the Naga Hills (between Assam and Munipore), by Mr. C. B. Clarke. Writing from Kohima, a station 4750 feet altitude, he says the country above 5000 feet is nearly all jungle, and that the predominant plant-groups, such as the Commelinaceæ, Rubi, Senecio, and ferns, besides others, are nearly all identical with those growing in Sikkim, while, on the contrary, many Khasi plants are conspicuously absent. Various kinds of oaks form forests around Kohima, and the alder is abundant, the latter occasionally having an enormous trunk. The Nagas pollard the alder at 6 feet from the ground, and cut the innumerable sprouts for firewood. Two rare species of Dyospyros were observed. The flora is altogether rich and interesting, though there are few new species. Mr. Clarke gives an account of his ascent of Jakpho, a mountain-peak 9980 feet high, and about 10 miles distant from Kohima. *Lomaria glauca*, a rare fern in Khasia, is here plentiful, rhododendrons are plentiful at 8500, and the ridge at the top is clothed with dwarf bamboo. The levels 5000 to 7000 feet on Jakpho are mostly forests of shrubby Strobilanthes 6 to 12 feet high, just as in Sikkim. There are several laurels, and *Ilex Aquifolium* exists as a tree 30 to 40 feet high. The Convolvulaceæ are prominent up to 5000 feet.—The first part of a lengthened technical communication, "Index Floræ Sinensis," or an enumeration of all the plants known from China proper, Formosa, the Corea, and the Luchu Islands, together with their synonymy and distribution, was spoken to by the authors, Messrs. F. B. Forbes and W. B. Hemsley.—Afterwards a paper was read by Mr. H. N. Ridley, on the fresh-water Hydrocharideæ of Africa. Among many new species described is *Bootia exserta*, obtained by Sir John Kirk on the borders of the Zambesi in 1860.—The Secretary read a communication, on the vegetation of the Arctic regions, by M. Buysman. The author remarks that the flora of Greenland is decidedly Scandinavian in character. Almost all the plants are also found in Lapland, but, notwithstanding the proximity of America, few belong to that continent, while Asiatic Arctic types are rare. Some 378 species of phanerogams and cryptogams compose the Greenland flora. Of these, over 200 are found on the eastern coast, only 7 of them being absent on the western shore, while 170 species are recorded from the west, these being absent on the east. Nova Zemlya and the Island of Waigatz together possess 290 species, and Spitzbergen 117 species. The author enters into particulars regarding the special plants peculiar to the seaboard, and such as are cultivated by the inhabitants both in the open air and under cover. He remarks that the long and continuous summer sunlight, and at times intense heat, have much influence on the vegetation, and counterbalance the dark severe winter season.

Geological Society, February 24.—Prof. J. W. Judd, F.R.S., President, in the chair.—William Barns Kinsey and Henry Maurice Platnauer were elected Fellows, and Prof. Juan Vilanova y Piera, the University, Madrid, a Foreign Correspondent of the Society.—The following communications were read:—On two Rhætic sections in Warwickshire, by Rev. P. B. Brodie, M.A., F.G.S. The sections noticed in this paper were (1) one exposed on a railway at Summer Hill, near Binton, between Stratford and Alcester, and (2) one, thirteen miles further to the south-east, at Snitterfield, three miles north of Stratford-on-Avon, in excavations for a tunnel connected with a supply of water to that town. At the first-named locality, a bed with insect remains overlies the firestone and *Estheria*-bed, and this is succeeded in descending order by a considerable thickness of black and grey shales with the usual Rhætic fossils. The bone-bed is not exposed. At the second locality, in borings and shafts, black Rhætic shales were found in three places resting upon a denuded surface of new Red Marl, and covered by between 40 and 50 feet of drift. *Avicula contorta* and other typical fossils were obtained from the shales. In other shafts the Rhætic beds were wanting, so that apparently those met with were merely small portions remaining of a larger mass which had been denuded away.—On the basement-beds of the Inferior Oolite of Gloucestershire, by E Witchell, F.G.S.—On the Pliocene Beds of St. Erth, by Percy F. Kendall and Robert G. Bell, F.G.S. This paper consisted of a description of the beds exposed at St. Erth, a list of the Molluscan fossils identified, and some preliminary considerations of the evidence afforded by the Mollusca, and may be considered a continuation of that by the late Mr. S. V. Wood, read to the Society in November 1884.

Royal Meteorological Society, March 17.—Mr. W. Ellis, F.R.A.S., President, in the chair.—Mr. W. E. Addison, Mr. A. W. Clayden, M.A., F.G.S., Mr. T. B. Moody, R.N., and Dr. W. Schlich were elected Fellows of the Society.—The President gave an historical sketch of the barometer. After remarking on the accidental nature of the discovery of the instrument in the year 1643 in its best form, in ignorance for some time of its value for purposes of meteorological inquiry, he gave a brief account of many early kinds of barometers, the first endeavour being, in consequence of difficulties experienced with the ordinary mercurial form, to enlarge the scale of variation, attempts which in general introduced other errors and inconveniences. The desire to experiment on elevated positions induced the construction of an early form of portable barometer —one such with cistern completely closed, leaving the air to communicate through the pores of the wood, having been made above 200 years ago. The President further described various points in the arrangement of the Ramsden, Gay Lussac, and other barometers, including also mention of some modern patterns of long-range barometers, standard barometers, and such barometers as are more commonly used. The practice of driving out air from the mercury by heating or boiling appears to have been in use early in the last century. Engraved plates indicating the weather to be expected with different heights of the mercury have been longer used, at least as early as 1688. As regards correction for temperature, De Luc in the last century adopted a temperature corresponding to 54°·5 F. as that to which to make reduction, because corresponding nearly to the average of observations, such reduction being now made to the natural zero, 32° F. Reference was made to the employment of water (as in the well-known Royal Society barometer) and other liquids instead of mercury; also to various kinds of floating and other barometers not at all, or not entirely, mercurial, and to metallic barometers. The President concluded his account with a sketch of the history of recording barometers or barographs, including a notice of the application of photography and electricity to recording purposes.—At the conclusion of the President's address the meeting was adjourned to afford the Fellows and their friends an opportunity of inspecting the valuable and interesting exhibition of barometers which was opened on Tuesday evening.

Anthropological Society, March 23.—Mr. Hyde Clarke, Vice-President, in the chair.—Capt. C. R. Conder, R.E., read a paper on the present condition of the native tribes in Bechuanaland. The new Crown colony of Bechuanaland is a pastoral country, consisting of a great plateau 4000 feet above the sea, with a fine climate, and grazing-lands said to be among the finest in South Africa. The native population consists of about 183,000 souls, belonging to various tribes. The Korannas are a small slightly-built people with a strongly Turanian type of face, but with hair growing in isolated tufts as among the Bantu races; they colour the face and hands with red lead, and black lead is often used for colouring the hair. The Matabele are originally Zulus, who, being unsuccessful in war, were afraid to reappear before Chaka: they settled in the Transvaal, and were driven thence to their present country by the Boers. Their name in Sechuana means "naked," and is due, not to the fact that they are lightly clad, but because they offend Bechuana ideas of decency by not wearing the small fur apron which men and boys always wear among the Bechuana, even when they have no clothes. The author described the Batlaping and Baralay tribes, and discussed some of the peculiarities of the Sechuana language. The customs, superstitions, and native government of the people were dwelt upon, and Capt. Conder concluded by referring to some of the causes of the decay of the native tribes, and urged that the chiefs should be supported in their attempts to keep brandy out of their towns.

EDINBURGH

Royal Society, March 15.—Sheriff Forbes Irvine, Vice-President, in the chair.—Prof. Blyth described an apparatus for determining the absolute strength of an electric current by weighing.—Dr. D. Noel Paton gave an account of an experiment concerning the connection between urea formation and bile secretion.—Dr. G. A. Atkinson read a paper on the volumetric estimation of inorganic nitrates.—Dr. Orme Masson read a paper on sulphines.—Prof. D'Arcy Thompson submitted a paper on the pelvic girdle of birds and reptiles.

PARIS

Academy of Sciences, March 29.—M. Jurien de la Gravière, President, in the chair.—On the flexion of prisms (continued), by M. H. Resal. In this concluding part of his memoir the author deals with the rectangular prism and the elliptical cylinder. In the special case of flexion here considered, the hypothesis advanced by him from the first on the nullity of three pressures is rejected for the elliptical prism but admitted for the rectangular prism, the problem regarding which in connection with flexion may be considered as solved.—Notes on the progress of the Panama Canal, by M. Ferdinand de Lesseps. The eminent engineer reports favourably of the progress made since his first visit six years ago. There has been great improvement in the sanitary conditions, with corresponding diminution of mortality amongst the workmen. During his inspection a rocky eminence 30 metres high, at Gamboa, about the centre of the isthmus, was successfully disintegrated by the explosion of a mine, two parts dynamite and one part powder, which removed 20,000 cubic metres without accident. With the means at present available, he considers that the canal will be completed, as promised, in 1889.—On the variations in the toxic properties of the urine in the healthy subject while awake and asleep, by M. Ch. Bouchard.—Equatorial observations of Fabry's and Barnard's comets, made at the Observatory of Algiers with the 0·50 m. telescope, by M. Ch. Trépied.—On the best instrumental dispositions for determining the elements of refraction by means of M. Lœwy's method, by Mr. David Gill. Some modifications of M. Lœwy's apparatus are proposed, with a view to simplifying its application, and increasing the general accuracy and usefulness of the method.—On the Fuchsian functions and the indefinite ternary quadratic forms, by M. H. Poincaré.—On an extension of Paschal's theorem to surfaces of the third order, by M. A. Petot.—On the determination of the genus of a holomorphous function in certain special cases, by M. de Sparre.—Note on the surface of the sixth order with six straight lines, by M. Giovanni Bordiga.—Note on the screw-pile, by M. Léauté. M. Resal having worked out the theoretical principle of this useful mechanical appliance, the author proposes a case, not considered by him, which presents the twofold practical advantage of diminishing the friction offered to the action of the screw-pile in borings, and preserving greater cohesion to the surrounding soil. In reply to this communication M. Resal expressed himself unable to adopt M. Léauté's standpoint at least until it has been put to some practical test.—On the theory of dynamo-electric machines acting as receivers (two illustrations), by M. Giza Szarvady.—Description of an absolute electrometer with continuous indications, constructed by MM. E. Bichat and R. Blondlot.—Combinations of vanadic acid with the oxygenated acids, by M. A. Ditte. Here the author deals with those oxygenated acids, such as sulphuric, arsenic, iodic, &c., which may be freely isolated under the form of crystals. Those hitherto obtained only as salts are reserved for future consideration.—On the products of decomposition of hypophosphoric acid, by M. A. Joly.—Action of platina at a red heat on the fluorides of phosphorus, by M. H. Moissan.—On the decomposition by compensation of compound bodies optically inactive, by M. E. Bichat.—On a photo-chemical reaction of the oxymetric fluid of M. Schützenberger, by M. Victor Jodin. It is shown by repeated experiments that the oxymetric reagent is of itself sensitive to light and that account should be taken of this property in researches dealing with photo-chemical reactions accompanied by a liberation of oxygen.—On the volatile character of the oxygenated nitriles, by M. Louis Henry.—Note on the salivary glands in the order of Coleopteræ, by M. J. Gazagnaire. A chief result of the author's researches is the verification of the hypothesis that salivary glands are developed throughout the whole order of Coleopteræ.—On the mode of formation of the chromatophores in the Cephalopods, by M. C. Phisalix.—On the toxic properties of the Cytisus, by M. Ch. Cornevin. Of ten species of Cytisus two were found to be harmless (*C. sessiliflorus* and *C. capitatus*), two slightly venomous (*C. nigricans* and *C. supinus*), six extremely venomous (*C. Laburnum*, *C. alpinus*, *C. purpureus*, *C. Weldenii*, *C. biflorus*, and *C. elongatus*).—Note on the Palæozoic formations of the Neffiez-Cabrières district, Hérault, by M. de Rouville.

BERLIN

Physical Society, February 5.—Dr. R. von Helmholtz, in an investigation into the tensions of vapour of solutions of salt, made use of a method whereby the least depressions under which a condensation of vapour occurred, when no heat was admitted from the outside, were determined. With this end in view a glass cylinder was filled to a third of its capacity with the fluid. The space filled with a mixture of air and vapour was on one side connected with a manometer, while a second cock allowed the depression to be effected, a small over-pressure having been generated beforehand. The first formation of cloud was rendered visible in this wise, that a bundle of light was directed through the axis of the glass cylinder, and the observer in a dark section of space under small angle looked towards the axis. Experiments with pure water showed that in saturated air the depression needed first to attain a certain value before the formation of cloud set in. Under the temperature of a sitting-room this depression amounted to about 10 mm. water; at 0° a depression of 12 mm. water was required. In this investigation Herr von Helmholtz confirmed the statements of MM. Coulier and Aitken, that the formation of cloud in saturated air was induced solely by particles of dust. Saturated air completely free of dust might suffer a depression of half an atmosphere without any cloud getting formed in it. The finer and sparser were the dust-particles the slower was cloud in forming itself in the vapour-saturated air. Salt-particles and acids furthered the formation of cloud, and, most powerfully of all, particles of sal-ammoniac. An explanation of this phenomenon the speaker found in the proposition demonstrated by Sir William Thomson, that the tension of vapour was greater over convex than over even surfaces of fluidity. When the air was without dust-particles there were wanting the convex surfaces at which the tension was higher and it was possible for the precipitate to ensue. Dust-particles, on the other hand, presented such surfaces, and all the more the rougher they were. In the atmosphere dust-particles must be present as far up as to the highest layers in which clouds were formed, seeing that without them no cloud-formation was possible. This circumstance yielded support to the explanation given by Prof. Tyndall of the blue colour of the sky, in accordance with which the sky was indebted for its blue colour to the particles floating in the air. The dense and persistent fog-formations in large cities, such as London, were caused by the sulphuric acid with which the air was charged in consequence of the vast consumption of coal, and which thus favoured the formation of clouds. The fact, demonstrated by experiments, that saturated water vapour did not, even under the lowest depression, give rise to the formation of cloud, but required first to attain a perceptible magnitude, rendered necessary a change in the theoretical formulæ for the conditions of cloud-formation. Determinations executed according to this method of the tensions of vapour of various sulphuric acid solutions showed a very good agreement with those executed by Regnault.—Dr. Fröhlich gave a short report on the results of his investigations, lasting for years, into the theory of the dynamo-electrical machines, which he had developed with special reference to the practical requirements of technics, and had quite recently published in a separate work. He communicated and explained the concluding formulæ he had found for the performance of the various systems of machines, in respect of their magnetism, as also of their intensity and polar tensions. He likewise gave the formulæ for the performances of the dynamo machines as transmitters of energy. Be it here specially brought out that, in contrast with MM. Deprez and Silvanus Thompson, he had found that, for the mechanical performance of two machines of similar construction and unequal dimensions, the larger did not gain in mechanical labour to the extent of n^5, n being used to denote the linear enlargement, but only in the proportion of about n^3, in which the mass also increased. The utility-effect, on the other hand, of a machine of similar construction, increased with enlargement in the proportion of n^5.

BOOKS RECEIVED

"British Museum (Natural History) Mineral Department—An Introduction to the Study of Meteorites."—"Astronomical Observations 1882–85 made at Rousdon Observatory," by C. E. Peek.—"Arithmetic for Schools," by the Rev. J. B. Lock (Macmillan).—"Sixteenth Annual Report of the Wellington College Natural Science Society, 1885" (Bishop, Wellington).—"Key to the Text-Book on the Mechanics of Materials, &c.," by M. Merriman (Wiley, New York).—"The Elements of Economics," vol. i., by H. D. MacLeod (Longmans).—"Watt's Organic Chemistry," edited by Prof. W. A. Tilden (Churchill).—"Bulletin of the Philosophical Society of Washington," vol. viii. (Washington).—"The Doctrine of Evolution in its Application to Pathology," by Dr. W. Aitken (MacDougall, Glasgow).—"A Manual of Mechanics," by T. M. Goodeve (Longmans).—"The Code of Nomenclature and Check List of North American Birds" (American Ornithologists' Union, New York).

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