THURSDAY, DECEMBER 13, 1883

PROFESSOR STOKES' WORKS

Mathematical and Physical Papers. By G. G. Stokes. (Cambridge University Press. Vol. I., 1880; Vol. II., 1883.)

THIS is the age of Reprints of the works of great living men, even in an hourly growing subject like Science. The pseudo-scientists have long been accustomed to galvanize into life again, for a few brief moments, their defunct prelections by collecting them in a volume with some catching title. But the real men of science are now building, during their life-time, each his *monumentum ære perennius, regalique situ Pyramidum altius.* Von Helmholtz and Kirchhoff have collected and reissued their scattered masterpieces. Clausius has joined one large series of his works into a connected treatise. At home Sir W. Thomson has given us a grand collection, *Electrostatics and Magnetism*, and the rest of his papers are to appear in a series of volumes, of which one is already before the public. But, heartily as we welcome all these splendid volumes, here is something at least as good as the best of them, and *much more imperatively required.*

There can be but one opinion as to the value of the collection before us, and (sad to say) also as to the absolute *necessity* for it. The Author, by common consent of all entitled to judge, takes front rank among living scientific men as experimenter as well as mathematician. But the greater part of his best work has hitherto been buried in the almost inaccessible volumes of the *Cambridge Philosophical Transactions*, in company with many other papers which deserve a much wider circulation than they have yet obtained. Stokes' well-deserved fame was thus practically secured by means of a mere fraction of his best work. And another inconvenience, which will *now* have some chance of being repaired, has arisen from the same cause. Science demands, at every instant, the solution of certain definite problems each suggested by the last-preceding advances:—and hosts of eager votaries are at work upon them. What is done as it were in a corner is thus sure to be done again:—done, even if not so well done; and this at the expense of unnecessary labour on the part of the second worker, who thus obtains the (temporary) award of the whole credit; while the entire process tends to the retardation of scientific progress.

The present publication will effect a very remarkable amount of transference of credit to the real author, from those who (without the possibility of suspicion of *mala fides*) are at present all but universally regarded as having won it. Two or three years ago, only, the subject for a Prize Essay in a Continental scientific society was *The nature of unpolarized, as distinguished from polarized, light.* But, all that science is even yet in a position to say, on this extremely curious subject, had been said by Stokes *thirty years ago* in the *Cambridge Philosophical Transactions.*

The malady, though grave, is simple, the cure easy. Every Society, whose Memoirs are worthy of appearing in print, ought to consider itself bound to disseminate them as widely as possible. Every University, every public library of any importance, alike in Europe and in America, should be regarded as a centre for such a purpose. The cost of the necessary additional copies should be regarded by a Society as a trifle compared with the priceless advantage of *placing* its own publications where they will be freely accessible to all who care to consult them.

And this altogether independent of the question of *exchange*, which can hardly be expected from a University, but which, in our own experience, is gladly (even eagerly) granted by almost every scientific Society worthy of the name.

Physical and Mathematical researches are the best record of the living intellectual progress of the day, and ought not to be made artificially scarce or dear. It is mere pandering to wealth and vanity which is displayed in advertisements such as "Impression strictly limited to 65 (numbered) copies. After these are printed, the type will be broken up (in presence of witnesses) and the plates destroyed."

Such advertisements are possible only in a world in which Sir Gorgius Midas, and others who have "struck ile," are the willing victims of those who prey on their selfishness, luxury, and ignorance. Education will, it is to be hoped, in time do away with such things.

To give anything like an adequate account of even one of the longer papers in these two volumes would require an entire article. And, when written, the account would in most cases be practically unintelligible to the general reader; while quite unnecessary for the student, who will of course prefer to repair to the fountain-head itself, now at last rendered easy of access.

Prof. Stokes has wisely chosen the chronological order, in arranging the contents of the volumes. Such a course involves, now and then, a little inconvenience to the reader; but this is much more than compensated for by the insight gained into the working of an original mind, which seems all along to have preferred a bold attack upon each more pressing scientific difficulty of the present, to attempts at smoothing the beginner's road into regions already well explored. When, however, Prof. Stokes does write an elementary article, he does it admirably. Witness his *Notes on Hydrodynamics*, especially that entitled *On Waves.*

Before that article appeared, an article as comprehensive as it is lucid, the subject was almost a forbidden one even to the best student, unless he were qualified to attack the formidable works of Laplace and Airy, or the still more formidable memoirs of Cauchy and Poisson. Here he finds at least the main points of this beautiful theory, disencumbered of all unnecessary complications, and put in a form intelligible to all who have acquired any right to meddle with it. It is quite impossible to tell how much real good may be done by even *one* article like this. Would there were more such! There are few, even of the most gifted men, who do not occasionally require extraneous assistance after the earlier stages of their progress:—all are the better for it, even in their maturer years.

The contents of these two volumes consist mainly, almost exclusively, of papers connected with the *Undulatory Theory of Light* or with *Hydrodynamics.* On the

former subject at least, Stokes stands, without a living rival, the great authority. From the *Aberration of Light*, the *Constitution of the Luminiferous Ether*, the full explanation of the singular difficulties presented by *Newton's Rings*, to the grand theoretical and experimental treatise on the *Dynamical Theory of Diffraction*, we have a series of contributions to this branch of optics which, even allowing for improved modern surroundings, will bear comparison with the very best work of Newton, Huyghens, Young, or Fresnel in the same department.

Specially remarkable among the Hydrodynamical papers is that on *Oscillatory Waves*, to which a very important addition has been made in the reprint. The investigation of the "profile" of such a wave is here carried to a degree of approximation never before attempted.

Besides these *classes* of papers we have the very valuable treatise on *Friction of Fluids in Motion, and on the Equilibrium and Motion of Elastic Solids*. This was Stokes' early masterpiece, and it may truly be said to have revolutionized our knowledge on the subjects it treats. To mention only one point, though an exceedingly important one, it was here that for the first time was clearly shown the error of assuming any *necessary* relation between the rigidity and the compressibility of an elastic solid, such as had been arrived at from various points of view by the great Continental mathematicians of the earlier part of the present century.

Of the few purely mathematical papers in the present volumes the most important is the well-known examination of the *Critical Values of the Sums of Periodic Series*, a subject constantly forced on the physicist whenever he has to treat a case of discontinuity.

We need not say that the printing of these volumes is all that could be desired: the name of the Pitt Press is a sufficient guarantee. But the introduction, for the first time, of a *solidus* to save "spacing" and space in the printing of mathematical formulæ, was a bold step on the part of Prof. Stokes:—since amply justified by the testimony of the readers of the first of these volumes, and still more by its almost immediate adoption by thoroughly scientific as well as practical men, such as the Editors of what we still feel inclined to call by the well-known name of *Poggendorff's Annalen*. P. G. TAIT

ROYAL ENGINEER PROFESSIONAL PAPERS

Professional Papers of the Corps of Royal Engineers. Edited by Major R. H. Vetch, R.E. Vol. VIII. 1882, 214 pp., 39 pl. (London: Stanford, 1883.)

SO many essays were contributed to these papers in 1882 that it was found necessary to publish two volumes for that year. This is a healthy sign of the interest taken by the Corps as a whole in their profession. Vol. VII. was devoted entirely to permanent fortification, a purely professional subject; whilst Vol. VIII. contains eleven papers, several of which are of general interest. This volume must have been an expensive one to get up, as it contains thirty-nine plates, some of them pretty large: the size and expense of the volume might have been considerably reduced if the contributors had prepared their plates in a more convenient shape; *e.g.* one plate, a mere genealogical table, and not really a large one (Appendix I.), has eight cross folds and one longitudinal one; this could easily have been much compressed.

Paper 3 is a careful and well got up study of the "Campaigns of Lord Lake against the Marattas," 1804-6 (92 pp., with nine plates), which will be read with interest by all students of military campaigns. A good illustration of the difficulty of ascertaining the truth about events of eighty years back occurs in the verification of the site of the "battle of Delhi" (1803); the supposed site is actually marked by a pillar with inscription; but, after careful collation of contemporary surveys and reports of marches, the author decides *against the site marked by the pillar*.

Paper 8 is an interesting account of the "Triangulation of Northern Afghanistan" carried out during the late war. It is worth notice here that the introduction of the heliograph into army signalling has thrown a difficulty in the way of the use of the heliotrope for survey (in the field), from the liability of confusing the signals; but there seems little doubt that in the future the army heliograph stations could be used for the survey, and be an assistance instead of a hindrance to the survey. The general result of the altitude observations has been to throw doubt on the efficiency of the aneroid, a result much to be regretted. The refraction, which in India is about ·067 of the contained arc, was found to amount to ·08 of the same in the Afghan hills; an unusual result, as refraction commonly decreases with altitude.

An interesting paper (No. 9), on "Organic Compounds in the Sun," by Capt. Abney (read in 1881), gives a popular *résumé* of the subject (up to 1881), ending with the author's spectroscopic researches showing the presence of hydrocarbons in the sun and probably in space itself; this last raises curious questions as to the constitution of the ether; can space be really full of hydrocarbons? This paper has suffered rather by the delay in publication.

Perhaps the most important (military) paper is No. 10, on "Railways for Military Communications in the Field." The author shows that the early attempts at introducing railways on field service all failed to be of much practical use from their unsuitability to the conditions, the first of which is lightness and portability of both rails and rolling-stock, and it is just herein that the English railways fail most, being amongst the heaviest in the world. A light railway largely used in the United States, which has been laid at the rate of four miles a day, is favourably mentioned. After recapitulating the various schemes which have been tried or proposed, the author gives his conclusions as to the conditions for a military railway; among the most important of these are that the gauge should be 2½ feet, the rails 10lbs. per foot, and the line double. It is clearly impossible for any country to keep a *large* stock of railway plant specially for service: now it so happens that this 2½-foot gauge is already in use to some extent in Europe, so that the requisite plant could probably be obtained at short notice in Europe. In India, however, the metre-gauge is so largely in use that field railways in or near India will probably for many years perforce be of metre-gauge. The field railway laid for the use of the British army in South Afgahnistan (1879-80) is not mentioned; this railway was laid for a great

length through a desert in hot weather at the rate of a mile a day.

The other papers in this volume are: No. 1, on "Provisional Fortification," a study of defensive works erected in a moderate time, and capable of extension and improvement, with examples from Adrianople and Tschataldscha. Paper 2, on "Graduated Arcs for Heavy Guns," contains an investigation of the errors in such arcs, and the mode of laying guns correctly, in spite of such errors. Papers 4 and 5 describe some blasting operations in Bermuda. Paper 6 describes bridges laid over the Cabul River during the war in 1879-80. Paper 7 is on "Railway Curves"; and Paper 11 contains "Tables of Ordnance Equipment." ALLAN CUNNINGHAM

OUR BOOK SHELF

Report on the Dyes and Tans of Bengal. By Hugh W. M'Cann. (Calcutta, 1883.)

THIS Report, which is issued under the direction of the Committee of the Bengal Economic Museum, originated in the efforts made by Mr. Thomas Wardle to collect information on the modes of dyeing the silks of India. This information was asked for so far back as 1875, and although the Indian Government were fully conscious of the importance of instituting an exhaustive inquiry upon the subject, it was not until 1880 that an instalment of the General Report was issued, and from this, for reasons which it is here unnecessary to enter into, the dyes of Bengal were omitted. Dr. M'Cann has doubtless done the best he could with the materials at his command, although there is a probability that the Report would have been fuller and more free from errors had it been possible to put together the information, which was mainly collected in 1875-77, at a time when the officers of the local governments and administrations through whom the information was obtained were still resident in their respective districts. As it is, the Report is avowedly incomplete, and in many points already out of date. The classification adopted is, in the main, the same as that already employed by Mr. Liotard in the Report on "Dyes of Indian Growth and Production" above referred to, but with the difference that Dr. M'Cann has preferred to give the methods of dyeing in connection with the accounts of the dye-stuffs themselves, instead of referring them to the fabrics which are dyed by them. The dyes are classed according to the colour they afford when used singly. One disadvantage of this arrangement is that some dye-stuffs which are used both alone and also in the preparation of compound colours are mentioned several times. Many of the dye-stuffs are called simply by their vernacular names, as they have not yet been botanically identified, and in many of the cases in which the scientific name of the specimen has been given there is nothing to show how it has been arrived at. In spite, however, of these imperfections, the Report adds considerably to our knowledge of the tinctorial resources of India, although it must be stated that owing to the delay in its compilation the original object of the inquiry has been in a great measure lost sight of. The primary object of the inquiry was, in fact, to obtain data upon which to base experiments with regard to the possibility of developing and improving methods of dyeing with native Indian dyes. Dr. M'Cann expresses the hope that this project may be revived. He is of opinion that among the vast number of Indian dyes there are many that might be developed into flourishing industries; but he is equally of opinion that this development will never take place through the native dyers themselves, who are content to follow the primitive methods handed down to them by their predecessors. Dr. M'Cann suggests that great results might follow if the Government would send out to India one or two trained chemists or scientific experts in dyeing to conduct experiments with the special object of developing native dyeing industries. The number of properly trained technical chemists already there is too small to hope for anything from them, nor is it likely that improvements will result from the private enterprise of European firms. As it seems nowadays the fashion to commend all such projects to the notice of the City Companies, it may not be out of place to draw the attention of the Worshipful Company of Dyers to the suggestion. T.

Lehrbuch der Vergleichenden Anatomie der Wirbelthiere. Von Prof. Dr. Robert Wiedersheim. Zweiter Theil. (Jena, 1883.)

WE have on a previous occasion (NATURE, vol. xxvi. p. 385) directed attention to the first part of Prof. Wiedersheim's text-book on the "Comparative Anatomy of the Vertebrata," which was published early in 1882. He has now, by the publication of the second part, completed the work, which forms a clearly printed and profusely illustrated volume of 906 pages, with 607 well executed woodcuts. The second part comprises a description of the alimentary, respiratory, circulatory, urinary, and generative organs of the Vertebrata, and the author tells us in his preface that the entire work represents the labour of six years. In his method of treating the anatomy of the viscera, described in this part, he has followed the same lines as in Part I. The description of the modifications of each system of organs observed in the different classes of vertebrates is prefaced by a short chapter on the method of development of that system, and the subsequent description is then based on their developmental history. We can recommend the book as giving an excellent *résumé* of the subject written in a thoroughly scientific spirit.

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.*]

Evolution of the Cetacea

IN the lecture by Prof. Flower "On Whales, Past and Present, and their Probable Origin," which appeared in your columns in June and July last, he contends for the evolution of these animals from the *Ungulata*, and points to the *Zeuglodons* of the older Tertiaries as predecessors of the *Balænoptera*, and as representing an intermediate stage in such evolution; and he insists on the absence of cetacean remains from any Mesozoic formations as strong evidence in support of this view.

I wish therefore to inquire whether Prof. Flower has considered the evidence afforded by *Palæocetus sedgwickii*, so named by Prof. H. G. Seeley from a set of anchylosed cervical vertebræ (one of which he figures), described by him in the *Geological Magazine* for February, 1865, p. 54.

Prof. Seeley states that the specimens were obtained from the boulder (chalky) clay near Ely, and that they were regarded both by the late Prof. Sedgwick and by himself as derived from either the Kimmeridge or the Oxford clay; and he quotes the opinion of Prof. Owen in the British Association reports, in his "British Fossil Mammals," and in his "Palæontology," that they belonged to an animal of the Dolphin group. Prof. Seeley himself regards this animal, for the reasons he assigns, as "not a cetacean of the Dolphin family, but a true whale, its affinity with the Balænoptera being, he says, singularly close"; and he concludes his description with a letter from a veteran student of the Cetacea, the late John Edward Gray, Keeper of the Zoological Department of the British Museum, who, after pointing

out the characters in which the fossils agreed with, and those in which they differed from, *Balæna*, asserted that in those particular respects the animal to which the remains belonged agreed with a genus of whales which he had just described under the name of *Macleayius*, from a specimen in the Australian Museum in Sydney. Perhaps Prof. Flower regards these vertebræ as not those of a cetacean at all; but if he agrees with the authorities just named on that point, the case seems to resolve itself into this, viz. either this whale lived in Mesozoic times, or its remains have come from some Tertiary formation. If the former, and particularly if its age is, as regarded by Prof. Sedgwick and Prof. Seeley, Jurassic, Prof. Flower's hypothesis of the evolution of the Cetacea from the Ungulates is hardly probable, when we consider the known facts as to the development of that group during the Tertiary period, even if we allow for whatever weight *Stereognathus* may afford of an approach to an Ungulate type in Jurassic times. If the latter, and these remains came originally from some older Tertiary formation, it follows that such a formation has, though no traces of it are now to be found, once existed in the area between Ely and the eastern watershed of the Pennine, because the whole of the material of the clay in which the remains were found is made up of the wreck of formations from that area alone.

SEARLES V. WOOD

Martlesham, near Woodbridge, December 6

"Cosmic Dust"

THE report on Baron Nordenskjöld's expedition to Greenland this year, recently given in NATURE, undoubtedly contains important results as to the physical geography of that country. Its statements, of course, will require a more detailed explanation than this preliminary report can give; one statement especially, on account of its significance, induces me to call the reader's attention to a fact which it will be necessary to take into consideration in discussing the question.

The statement is contained in the following words at the end of the article:—"I hope when this (viz. the dust found on the inland ice) has been exhaustively analysed, to be able to furnish fresh proofs in support of the theory that this deposit is, at all events partly, of cosmic origin, and thereby contribute further materials for the theory of the formation of the earth."

The fact to which I have alluded is this: Next to the observations furnished by travelling over the inland ice, it appears to me that an examination of the fresh and pure fragments of it from the very interior of the country, which are pushed out in the shape of icebergs, must give the best key to the solution of the problem. We know that the mass of which these bergs are fragments is formed of snow accumulated during hundreds of years, and it has taken hundreds of years for the ice thus formed in the central regions to travel to the seashore. Consequently the dust which during the lapse of centuries has fallen upon the surface of the glacier must have been mixed up with the snow, and thereby spread over or embedded in the chief mass that constitutes the bergs.

As to my own observations, I have always found the chief mass that constitutes the large bergs to exhibit the appearance of perfectly pure ice, only permeated with thin air-bubbles, and the earthy matters of the bergs distinctly confined to isolated dykes, layers, conglomerates, or even to entire smaller bergs issuing from certain fjords. But I confess that my attention never was directed to a more minute investigation of the chief berg ice, and still less to the problem here mentioned. I do not remember to have seen anything mentioned by my friends Steenstrup, Helland, and Hammer that could throw sufficient light upon this question. I therefore here present it to your readers who are experienced in Arctic researches and may feel inclined to communicate their opinions upon it.

Christiania, Norway, December 5 HENRY RINK

On the Incubation Period of Scientific Links

THE length of the dormant period during which a certain class of scientific discoveries has to remain unrecognised before they are made available is a subject that may form an interesting chapter in the history of science. I will cite one or two examples, in one of which I am personally interested, as illustrating my meaning, particularly as I think they will enable me to point out the cause of this strange anomaly at a time when so much attention is being given to original research, and yet which will leave the results of original research to lie dormant for years after they have been realised. As illustrating the fact that most important laws may remain for many years dormant, I have but to cite the law of Avogadro, which remained unnoticed for fifty years, until the investigations of Dumas proved it to be a most important aid in chemical research. The law of Dulong and Petit on the connection between the specific heat and the atomic weight of the elements had to pass through a dormant period of more than twenty years before it was resuscitated by the experiments of Regnault. More than forty years ago I announced a new law connecting the physiological reactions of inorganic substances with their isomorphous relations. This law, although founded on an extensive series of experiments, and since verified by the investigation of the action of the compounds of more than forty of the elements, has up to the present time remained entirely dormant, not having been noticed, as far as I am aware, by any writer on physiology. A French chemist, M. Rabuteau, has recently very cavalierly consigned it *aux baggages du passé*, apparently under the idea that it is a revival of the hypothesis that connected the action of poisons with the more or less acute angles of their crystals. Now, however, the important part played by these inorganic substances as physiological reagents is beginning to be recognised (see Ringer, *Journal of Physiology*, January and August, 1883; Brunton and Cash, *Proc. Roy. Soc.*, vol. xxxv.).

The question presents itself as to what there is peculiar in these laws which distinguishes them from those which find an immediate recognition by men of science. I think the distinction will be found in the fact that these hibernating laws generally form connecting links between two branches of science which had not, up to the time of the discovery of these laws, been of much mutual assistance. The law of Avogadro, for example, established a new link between chemistry and physics, and for its application the chemist had to be familiar with the manipulations required for the determination of the density of vapours and gases, a subject scarcely alluded to in treatises on chemistry at the beginning of the century. The law of Dulong and Petit forms another link between chemistry and physics, requiring for its verification methods which, at the time of its discovery, were almost exclusively in the hands of physicists. As for the law connecting the physiological action of a substance with its isomorphous relations, when it was first published the distance between chemistry and physiology was greater than that between physics and chemistry at the time of the discovery of Avogadro, and should the subject be already attracting the attention of physiologists, after a latent period of but forty-four years, this fact affords evidence that science is now advancing at a more rapid rate than formerly. The question is an interesting one as to the possibility of something being done to shorten the period during which these linking laws remain unrecognised. Offering, as they generally do, important aids for the advancement of science, it certainly is desirable that some means might be taken to prevent their being shelved amongst *les baggages du passé*, so that at some future period the whole subject has to be gone over *de novo*. In the case of physiological discoveries, it certainly would seem to be the duty of the Antivivisection Society to see that the many experiments which had been performed to verify them were made available, so that a great deal of vivisection might thus be avoided without the progress of science being retarded.

JAMES BLAKE

San Francisco, November 13

Meteor

THIS afternoon, at 5.27 p.m., I observed here a meteor of great brilliancy, a note of which may be worth publishing. The moon, within three days of being full, was shining unclouded, and the western sky was still glowing with the fading tints of another gorgeous cloud-glow, when a bright light caused me to look up. It was due to a bright meteor a few degrees south of and below the moon. Its path was about 20° in length between south-east and south, inclined at an angle, roughly speaking, of 10° to the horizon, its mean altitude being probably 20°. Three minutes later, at 5.30 p.m., I heard a low, distant, rumbling sound, which was not improbably the report of its explosion.

G. M. WHIPPLE

Kew Observatory, Richmond, Surrey, December 11

Physical Society, November 10

UNDER the above heading in NATURE of Nov. 15, p. 71, I notice it is stated that I have found the velocity of sound in air

to be about 320 metres per second. This is manifestly a misprint for 330 metres, but I should like to state that as far as my experiments have gone the value for free air is not determined, although 330·6, Regnault's value, is probably very nearly what my method would make it. D. J. BLAIKLEY

103, Iverson Road, West Hampstead, N.W., December 10

The Ophidian Genus "Simotes"

MY attention has just been drawn to a note by Mr. H. O. Forbes, published under the heading "The Genus Simotes of Snakes," in NATURE, vol. xxviii. p. 539, in which he states that, when describing a new species of *Simotes* discovered by him in Timor-Laut (*P.Z.S.* 1883) and which I observed was the first of the genus known to occur eastward of Java, I overlooked Krefft's *Simotes australis* from Port Curtis, described in *P.Z.S.* 1864. It is a well known fact, pointed out by Dr. Günther in 1865 (*Zool. Rec.* i.) and since admitted by Krefft himself ("The Snakes of Australia"), that *Simotes australis* is not a species of that innocuous genus, but belongs to a widely different family of *poisonous* snakes and to the genus *Brachyurophis*.

London, December 5 G. A. BOULENGER

THE REMARKABLE SUNSETS

WE have received the following further communications on this subject:—

HAVING been rather too persistently of late requested to explain both the why, and whence, and even the future influences, of the recent very red and brilliant sunsets, I gladly take the opportunity of addressing to NATURE the few remarks I have to make on the actual facts and their proximate causes.

In all truth the sunsets through the last week of November and first four or five days of December have been remarkably fine, and consecutively so numerous. But each one, in so far as I have observed, was but an intensification, and sometimes not much of that, of whatever goes to make up an ordinarily fine sunset, as customary to that season of the year and that direction of wind with its concomitant kind of clouds.

The season of the year not only causes the fiery show to last longer than at many other times but enables it to take place while pedestrians are still engaged in their constitutional afternoon walks in pleasant autumn temperature, and before they shut themselves up for the evening in their comfortable homes with artificial lights around them.

Some thirty years ago I used to spend every evening month after month, at the ordinary dinner hour of others, in the open air, watching for, and when seen making quick coloured drawings of, any exceptionally fine sunset; taking in this way three or four completely separate pictures on the same evening between the time of the sun vulgarly going down beneath the horizon, and at the last the stars coming out in the darkness after the last vestige of twilight or high illuminated cirrus-cloud had disappeared.

In this manner I came to know practically that the so-called after-glow, which has been alarming so many persons within the last few days, whenever the temporary disposition and arrangement of the clouds and vapour in the air allow it to appear, is always more richly coloured in reds of various kinds than any of the earlier glows and more luminous splendours; and that the number of modifications which any one sunset may go through, or the number of different pictures it may make up, according to changes in the clouds both above and below the horizon, is bewildering. But the grandest effects, the nearest approaches to the sublime, were always those when the general light in the air was either so faint, or so monochromatic, that the pigments in the colour box could not be distinguished one from another without the aid of artificial light.

On December 3 and 4 of this week, on setting myself to watch and note with my former apparatus, I found all these bizarre effects of colour and form in their old intensity and their old kaleidoscopic quickness of change. On the 3rd especially the reds were so powerful at certain times, and the air so clear between me and them, that the young crescent moon, though low down in the sky, shone by contrast to the scarlet cloudlets around it with a sort of supernatural lustre of blue silver; while the gas-lights under the same contrast, though in reality a gross beery brown in colour, appeared of a delicate sulphur, almost greenish, yellow. Those clouds, therefore, were so red in consequence of something that had happened to the sunlight illumining them which had not happened to that illumining the moon. What was it then? Simply that the lower atmosphere of the earth was so particularly clear of dust, haze, vapour, fogs, and positive obstructions of lower clouds that the sun, though at the time a long way below the horizon, was enabled to send its rays through an unusual length of atmospheric path without experiencing any other diminution than merely the specific elimination of those particular rays in its spectrum-quiver to which the atmosphere, in that particular condition, is antagonistic, leaving the field of glory to others alone.

Had the wind been *south*-west, the stoppage would have been chiefly amongst and of the red rays of light, where the black water-vapour lines are so numerous, chiefly below D, near C, and especially about the region of little "*a*," which then becomes of giant size. But the wind having been really *north*-west, the air was dry, water-vapour lines practically absent, and, as Col. Donnelly most correctly remarked in this week's NATURE (p. 132), the dry air band above D in the citron, and usually called the low sun band in meteorological spectroscopy, was at an immense maximum. Red light was therefore practically unimpeded, green and blue much interfered with, and more and more with every successive instant of further descent of the sun below the horizon. So thus it was that the spectroscope told at any instant through all the varied displays that that coloured light so much admired was simply sunlight that had passed through an extra length of extra-dry air, and was being reflected at the last from thin clouds at an extra height in the atmosphere, where water-vapour is always at a minimum.

But the sunset of December 5 was very different. In the course of the evening there were two or three distinct attempts, as it were, for the clouds to assume red hues, but they lasted for only a few seconds each; and though some aspects of the scene were very fine pictorially, it had to be classed as a "yellow sunset." Next day showed the cause of that in the wind below, as well as above, turning round to east of north. December 6 and 7 had poorer and poorer sunsets of both a yellow and sickly type, and December 8 with a south-west wind has brought in rain.

Thus seems to have ended for the time this fine series of Nature's evening pyrotechnic displays in the west (a similar set having also been witnessed during the mornings in the east); but demands are still made for an explanation of why, and to what end? If we should reply that, given a clear air, not too many clouds, and these high up in the atmosphere and with surfaces well constituted for reflection, the sunsets will always be fine; and that they will be varied exceedingly in their beauty even from moment to moment, according to the exquisite manner in which clouds and cloudlets of cirrus streamers form and dissolve and form again in all varieties of shape and size and density, according to mere temperature changes and other ordinary meteorological conditions of the air; that is not enough to satisfy the present temper of the public, who seem screwed up to a pitch of nervous alarm that what they have been seeing, t ough to them it has been like "music which gives delight and hurts not," may yet have something to do with the green and

blue suns seen in India last September, and they with the great volcanic explosions in Java last August, so destructive of human life!

The said green and blue suns were, however, quite a different phenomenon to our red sunsets. For, instead of appearing extra bright and contrasted in colour with clouds near them, like the crescent moon of December 3 just mentioned, they were abnormally faint, and uniformly tinged with both clouds and fog, and moon and stars at night. Moreover, the spectroscope, in the able hands of Prof. Michie Smith of Madras College, showed that the intervening medium, through which the sun's light was struggling towards these Indian observers, was extra damp instead of extra dry. And in the west of India since then, as we have just heard from private sources, no less than 140 inches of rain have fallen, and the country was in a temporarily impassable condition from sloppy softness of soil.

Prof. Michie Smith has indeed entertained the idea that the particular state of the watery vapour which cut off so largely the red, but passed on the green light of the sun's spectrum in a weakened condition, may have been owing in some degree to particles of pumice dust from the Javan volcanoes. And such dust, once up in the air, may circulate around the earth, after the manner which Commander Maury, U.S.N., was so earnest in teaching with respect to the trade winds and their spiral paths through either hemisphere.

But how long such dust would remain suspended, how high it would rise, and when and where it would fall, are questions that can hardly be answered positively and with exactitude *a priori*. It did not fall, so far as we have heard, in India, where, if present at all, it must have been comparatively low and dense. And it was not falling here during the recent red sunsets, for the lower air was particularly clear, while the supposed criminating redness was too manifestly due to the extraordinary height, as well set forth by Prof. Helmholtz, of the uppermost cloud stratum, a thin kind of cirrus haze, according to my observation, combined with the discriminating action of the atmosphere on the compound coloured solar light.

Why that cloudhaze was so high, and whether dust, and if so what dust, had any part in its constitution, are questions which may worthily be discussed, but no very certain answers expected for years to come. But having been myself much struck during a rather long residence on the Peak of Teneriffe in 1856, with the general and apparently normal existence of dust strata in the atmosphere, higher or lower, but often far above the level of ordinary water-vapour clouds,—and as the meteoric researches of Prof. Newton, corroborated by Prof. C. A. Young, in America, show that not less than 100 tons of meteoric stones (of which the earth encounters nearly 3,000,000,000 in the course of a year) must be dissipated in our upper atmosphere on the average *every day*, as impalpable dust,—it seems more probable that Prof. Helmholtz's very high clouds, if they were assisted in putting in an appearance as clouds by dust of any kind, must have derived it from such disintegrated and sublimed meteor-masses coming down day by day in the regular way of nature from above, or outside, rather than from a supposed continued ascent of one particular charge of volcanic dust from Java, full three months after the cessation of all violent disturbance there.

In fact while it is to be earnestly hoped, as an outcome of the late remarkable sunsets, and the great numbers of the public by whom they have been witnessed,—that our painters will no longer be content to give us so generally mere afternoon pictures slightly yellow ochred and "light red"-ed near the horizon before the sun goes down, as sunsets,—but will more frequently paint the deep red afterglows at their richest;—it is equally desirable that our scientists should gauge the ordinary constitution of the atmosphere at much greater heights than those to which observatories are usually confined.

C. PIAZZI SMYTH,
Astronomer Royal for Scotland

15, Royal Terrace, Edinburgh, ♄ December 8

THE following summary of atmospheric effects seen before sunrise and after sunset between November 25 and December 11 may be useful for comparison with phenomena observed in other parts of the world:—

November 24.—After sunset, yellowish-green striæ in west.

November 25.—Sunset in amorphous apparent cirro-stratus or cirrus haze. Green light above it, and bright greenish-white arc growing from about ten minutes after sunset; above the greenish-white, pale red. Lasted about forty-five minutes after sunset. The sky shone with a strange light somewhat as on November 9, but much feebler, and there was no sharply marked aggregation of cloudy reflecting material as then.

November 26.—Fine clear sunset, followed by phenomena like yesterday, but much stronger, and lasting nearly an hour bright red. No high clouds seen as light receded from the sky. A few rounded morsels of cumulus fringed with green against the red sky. Very strange effect, the greenish-white light in the west, and pink above.

November 27.—Sunset effect like yesterday, beginning to glow about fifteen minutes after sunset, and growing slowly in apparent brightness. Lasted till about 5.20. Slight, thin cirrus.

November 28.—Slight cirrus. Clear sunset. About twenty-five minutes after sunset green and pink glow began and grew bright and finely-coloured till about 4.40. Then slowly receded till about 5.10, when it disappeared, and was succeeded by a faint brass-coloured after-glow reaching high above the horizon. Time of sunset, 3.55.

November 29.—Extraordinary red glow, said to be seen in London from 5.30 to 7.30 a.m. Cloudy evening. At 4.55 a dull faint red glow observed through a small break in the clouds. Time of sunrise, 7.43.

November 30.—At 6.5 a.m. (and probably a few minutes before) a fine deep red glow in the east and overhead, where small quantities of cirro-cumuli seemed to be touched by the reflected light. At 6.15 a faint, deep red glow had spread from north-north-east to south-east, and up to about 40° above the horizon in the north-east, covering a vast portion of the sky. Then gradually became whiter and less striking. The blood-red band in darkness at 6.10 most remarkable. The glow continued (slowly changing in colour and growing in extent), and was evidently independent of ordinary clouds. The bright stars appeared through it. At 6.24 a faint red light extended to the zenith. At 6.40 the red had gone, and was replaced by a primrose colour, the flocks of cirro-cumuli, however, still remaining tipped with bright red, and retaining that colour till sunrise (7.44). There was no cirrus visible, and the reflecting haze was invisible both by night and in full daylight. The cirro-cumulus was moving moderately fast from west-north-west. The red bank in the east was not crowned with shafts of rays or prominences as in the sunsets of November 26, 27, and 28, but the intensity of the light diminished continuously upwards from near the horizon. The afternoon being cloudy, the only thing observed was a dull greenish light about half an hour after sunset.

December 1.—Sunrise cloudy. Sunset (3.53) in cloudy sky, except near horizon. At 4.25 slight tinge appeared on fringes of clouds overhead. Then densely clouded. At 5 the sky had cleared largely, and a fine amber light could now be seen from near the west horizon to about 40°. This gradually sank, following the sun, and grew less bright, finally disappearing about 5.35. Sky clear and starlight, except low strips of cloud near the horizon.

Centre of maximum brightness followed the sun, as usual. The light as it sank near the horizon was quite without definite outline or the ray shafts which appeared on previous evenings with a clear sky.

December 2.—Sunrise cloudy. Cloudy at sunset, but clouds partially clearing off. Thin fog on low ground. Bank of clouds in west. Sunset 3.53. At 4.20 faint amber glow above cloud-bank, growing in strength as darkness came on. At 4.10 the sky towards the zenith from the west was crossed by spokes of light as from the thinnest possible cirrus streaks, diverging from the sun's place as centre, and some of these nearly overhead became somewhat bent after a few minutes. The thin clouds scattered about evidently caught some light from a hidden source. At 5 p.m. the light was pale yellow, and had moved northwards. At 5.10 disappeared behind cloud-bank.

December 3.—Cloudy.

December 4.—Very fine and clear morning at 5 a.m. At 6.5 a.m. the first blush of red appeared over the plantation (about 400 yards off) due east, and by 6.10 was quite bright, like the reflection of a fire. It grew quickly upwards, and by 6.15 must have been 15° above the horizon. It appeared uniform and amorphous. By 6.30 the red had changed slowly to saffron, and being seen less in perspective, the colour seemed less concentrated. The reflecting material, or a part of it, was now seen to consist of ill-defined streaks and patches of very thin misty cloud of some sort, in which after long watching from suitable positions no motion could be detected, though distinct streaks nearly overhead were chosen. At 6.45 some of these streaks were illuminated nearly overhead southwards of a pale straw-colour and bluish white, and their outlines were distinct. Most of the streaks stretched about west-south-west to east-north-east, and towards the north-east the appearance was like a fretwork of the lightest wavy mist. From 6.30 to 6.50 the coloured arc was of a sickly yellowish green, with a pale pink towards the zenith and a rather ghastly steel-white glare below. At 6.53 a second glow much brighter than the first appeared in the east-south-east by south, of a deep red colour, quickly turning to orange. This glow was in a bank or arc much better defined than the first. At 7.10 it had turned quite yellow and had grown up many degrees. At 7.16 the last star disappeared in the bright light now cast on all objects towards the west, the clear sky as the light touched the thin high mist appearing progressively veiled with opaque cloud. Just before the advent of the second glow the thin cloudy streaks had nearly vanished into pure blue sky. At 7.12 the upper part of arc No. 2 was pinkish yellow, with a greenish-white centre below. At 7.20 the part below the arc and along the horizon south and north for some distance was a peculiar steely-bluish white, the lower part of the arc yellow, and the upper pink (at an altitude of about 5°). These effects slowly diminished, but the steely hue remained till sunrise. At 7.23 the sky overhead and towards the west was faint pink, with large billowy streaks and patches, without fibrous structure. In full daylight only faint traces of this cloudiness could be seen, but the rising sun, like the first and second glow, made it manifest. The sun rose (7.50) of a red colour, but after about half an hour was pale bluish white, and surrounded by a silver-white glare. As the sun was setting (3.53), the high haze again appeared by reflection to cloud over the sky. Nothing otherwise very remarkable appeared till about 4.12, when it was evident the phenomenon would recur, the central spot above the sun's place being bright steel or lead colour, and the parts round it a metallic pink. This has been the usual preliminary. The sky in the east was rosy. The rose colour quickly passed over towards the west, and about 4.20 the whole sky between the west horizon and the zenith was flushed with red. At 4.25 or thereabouts the crescent moon appeared blue in this pink haze, but in a few minutes was left behind by it, and looked much as usual. The small, greasy scud from north was lighted up pink in the east against a deep blue and greenish sky. As the glow sank westwards, the sky above seemed perfectly clear. At 4.35 the light was very bright, and at 4.45 was lost to view behind low clouds. As soon as it approached the horizon, the sky again became streaked with the reflecting haze, which assumed a straw-coloured tint. This pale light sank westwards and disappeared soon after 5. The moon and stars gave no indication of a haze canopy.

December 5.—Exactly at 6.5 a.m. the first faint red blush grew up quickly from east-south-east, and in seven or eight minutes had increased largely in brightness and extent. The night was very fine and clear, and the soft, crimson glow hanging above the horizon in the darkness produced an interesting effect. It grew rapidly up towards the zenith, and at 6.18 formed an arc of which the highest point was about 40° above the horizon. After this it quickly changed to orange and yellow, and the colours went off. The arc was more southerly than yesterday, and the peculiar light reached from south-south-west to east-north-east. At 6.55 the second glow began, and rising up quickly, produced a fine red arc, less bright than yesterday's. At 7.6 the arc was olive-green below, yellow in the central, and pink in the outer parts, and hardly any cloudy structure could be discerned. What there was, however, resembled the film of yesterday. The upper edge of the glow was pretty well marked as it advanced, and at 7.12 it crossed the zenith and passed north-westwards, covering a bright star with a thin pink veil. This star remained visible till 7.21. After this the sky was pale yellow, and soon little remarkable remained, except the greenish light in the south-east. Sunrise 7.51 ; red sun, turning silvery white later. Sunset 3.50 in hazy striæ. Clear sky, except slight cirrus. At 4.15 yellow glow, which went through changes as usual. The light was pink overhead, and the margin passed the zenith about 4.26. At this moment it may be supposed the sun was sinking below the horizon at the altitude of the reflecting material. At 4.30 the moon looked blue in a pink haze. Spokes of rays from the glowing bank at 4.45. Some threatening cirro-stratus passed over at 4.45. Horizon misty. Crescent moon greenish all the evening.

December 6.—Sky very clear 6 a.m. First rose colour 6.10. Much fainter than previously. Second glow 6.58. Detached scud from 6.45 tinged with red on blue sky. Sunset clear, except small detached scud. The light in the west was fine, and went through changes, but was red from 4.20 to 5.5 p.m. The glow seemed to be reflected from some strips of apparent cirrus about 15° above the horizon. During all this time the small clouds scattered in all parts of the sky were of a pink colour against a greenish and later a deep blue sky.

December 7.—Cirrus streaks in west turned *black* against pinkish yellow glow, 4.24. Sun looked quite green through telescopic dark glass fifteen minutes before sunset.

December 11.—Fine sunrise and sunset phenomena, the secondary glow after sunset lasting till 5.33. Steel and pink halo from 12.45 p.m. Sky clear blue, at first glance, by night and full daylight, but, examined with light from below at a certain angle, seen to be quite covered with hazy billows or striæ, stretching away from north-north-east to south-south-west, very much higher than the cirrus present, and after long watching showing extremely slow tranverse motion from about west-north-west. Unlike cirrus fibres, whichever way looked at they appeared nearly parallel, without radiant point, even the lines just above the horizon showing their true direction almost exactly. Sun green through dark glass.

It seems pretty clear that the secondary light which has always succeeded the primary after sunset, and preceded

it before sunrise, is due to reflection from the first when this is at a proper angle near the horizon. The interval between the same stages of the secondary and the primary before sunrise, when conditions are most favourable for accurate observation, is about fifty-on minutes, and the interval between the more conspicuous primary and the actual sunrise about fifty-six minutes. The first red colour of the primary glow may be caused by the incidence of the sun's first rays upon the material. It seems that the reflecting material directly overhead receives the sun's rays about thirty-nine minutes earlier at sunrise, and loses them as much later at sunset, than the surface of the earth. I have not found the colour effects in many cases to be subjective. A green cloud remains green when cut off from surrounding light. May not atmospheric sifting produce the surviving colour?

F. A. R. RUSSELL

THE Hon. A. P. Hensman, Attorney-General of West Australia, writes to me as follows, under date of Perth, West Australia, October 27:—"The captain of a ship lately engaged in a survey of our north-western coast at the time of the eruption in the Straits of Sunda told me that the deck was covered to a depth of an inch or more with a fine dust. We are having, and have had for many weeks, very remarkable sunsets. After the sun has set, a glow commences somewhat high up above the horizon, a brilliant rose-colour; this continues for nearly an hour, gradually descending to the horizon, and becoming deeper in colour. It has never been seen here before, and has given rise to much speculation amongst learned and unlearned, both here and in the other colonies; some suggesting that it is caused by the presence of volcanic dust in the atmosphere." This extract may be of interest to your readers, as showing that all over Australia similar phenomena have been observed to those discussed in your pages.

As I am engaged in making a comparative study of the dust which fell at different points during the Krakatoa eruption, I shall feel greatly obliged to any of your readers who can supply me with samples of such dust, accompanied by a note of the time and place of the fall.

JOHN W. JUDD

Science Schools, South Kensington, S.W., Dec. 8

THE uncommon phenomenon witnessed in various parts of India, Ceylon, and the Cape of Good Hope, has made its appearance here. The sun, immediately it sets behind the ridge of Possilipo, throws upwards a group of red rays somewhat irregular in arrangement; the sky begins then to assume a greenish tint. These rays soon disappear, and then the whole horizon for 180° is lit up by a bright orange-red light, which gradually deepens in tint. The height of this light does not usually extend above 25° or 30° at its centre, and gradually descends to the level of the horizon at its two extremities. So far as I can make out, the centre or most brilliant point of this is quite 20° more to the south than the setting sun. All the south-west sides of the houses are suddenly lit up by this peculiar lurid glare, which is best compared to the colour of incandescent iron, and reflected from the surface of the sea makes the gulf look like a veritable lake of molten lava. The effects last at the maximum only an hour after the setting of the sun. On Sunday last the moon, shining through this red glare, had a bluish tinge of the arc electric light colour. The same phenomena precede sunrise. These effects are quite independent of clouds, which, when present, have a deep lead colour, and their edges are not illuminated. The weather is cold, the wind variable, chiefly north or north-east. The magnetic instruments at the observatory show no disturbances, which excludes the possibility of an aurora, as also its presence *only* when the sun is just below the horizon. I send these notes, hoping they may be an addition to the other observations already published in NATURE, to aid in an explanation of this remarkable and widespread phenomenon.

H. J. JOHNSTON-LAVIS

Naples, December 6

SIR ADAM BITTLESTON presents his compliments to the Editor of NATURE and ventures to send him an extract from a letter written by Sir Adam's son at Umballa (lat. 30° N.) on October 30. There seems a long interval of time between the appearances at Ongole (September 10) and those noticed at Umballa.

87, Linden Gardens, Bayswater Road, W.,
December 10

Extract from a Letter from Lieut. G. H. Bittleston, R.H.A., dated Umballa, October 30, 1883

"There has been *for some time* a remarkable appearance in the sky every night. The sun goes down as usual and it gets nearly dark, and then a bright red and yellow and green and purple blaze comes in the sky and makes it lighter again. It is most uncanny, and makes one feel as if something out of the common was going to happen."

THE inclosed from the *Hawaiian Gazette*, October 3 may interest students of meteorology.

F. J. S.

"*Maui.*—With regard to the extraordinary sunsets, a correspondent in Wailuku writes:—'I do not know what kind of sunsets you are having in Honolulu, but here for some time past they have been most extraordinary. Fiery red, spreading a lurid glare over all the heavens, and producing a most weird effect.'

"*Kauai.*—The peculiar sunsets have been noticed and commented on by the Kauai people. No one has ventured on a theory here."

THE line of green suns is carried further west to Panama, where, according to the *Star and Herald*, the phenomenon was observed on September 2 and 3, and it is suggested to be in connection with Krakatoa.

HYDE CLARKE

32, St. George's Square, S.W., December 8

I SEND you a bottle of volcanic dust which Capt. Robert Williams of the bark *Arabella* obtained under the following circumstances. He says:—"On Tuesday morning, August 28, 1883, it commenced to rain something like sand (some of which I collected from off the decks), which kept on all this day and the next day. Lat. at noon of the 28th, 5° 37′ S., long. 88° 58′ E., wind light from the west-south-west, and calm at times. Java Head bearing east half south, distant about 970 miles." Can this shower be connected with the Java eruption?

Falmouth, December 6 HOWARD FOX

AS accuracy of observation is before all things desirable in the elucidation of natural phenomena, I hope you will allow me to point out an error into which some of our physicists appear to have fallen in connection with the green moon which was visible in the evenings of Tuesday and Wednesday of last week. Mr. Norman Lockyer, in his admirable article in the *Times* of Saturday last, refers to "the subjective colouring which cast a green glamour over moon and cloud if one did not take the precaution of preventing the eye being flooded by the rosy pink visible in the zenith long after sunset;" and a writer on recent solar phenomena in the *Daily News* says, "This latest phenomenon has caused a greater amount of astonishment than the earlier ones, but, unlike them, admits of very easy explanation, for a moment's reflection will show that on a pink background a white moon could scarcely appear anything but green," thus, like Mr. Lockyer, attributing the phenomenon to the presence of a complementary colour. What I wish to point out is that there is no foundation for this theory. I observed the effect most carefully on both evenings. On the second evening especially I looked

with the object of ascertaining whether the effect was due to a complementary tint, and am thoroughly convinced it was not. At four o'clock, or a little after, the moon was distinctly green on a blue-gray sky-ground, with very thin gray cloud-drift floating over it. At the same time the whole of the western sky was lit up with a very pale whitish-yellow, to which neither blue nor green would be complementary. There was not a vestige of crimson or rose colour at that time in any part of the sky. Later, when the crimson supervened, the green tint of the moon was only very slightly intensified, so slightly indeed as to leave me still in doubt whether there was any change at all. It stands to reason, moreover, that if the result were due to the presence of crimson in the sky we should frequently see a green moon. Some other cause must therefore be sought in explanation of this new phenomenon. If we may accept Mr. Lockyer's conclusions with regard to volcanic action—and he certainly establishes a very strong case—the cause is not far to seek. It would be especially interesting to ascertain over how wide an area the effect was visible. Some records from observers at a distance would be very valuable.

Ealing, December 10 SYDNEY HODGES

P.S.—In quoting my letter to the *Standard* last week you gave a wrong name—Hooper instead of Hodges.

THERE is one point in connection with this subject to which much attention has not been given, namely, the increase of light, especially in the morning. Having slept out of town lately, I have been able to watch the sunrises, and to be exact I will describe in few words what occurred on Wednesday last, December 5. The eastern horizon is bounded by a hill some 50 feet high as seen from my house. At 6 a.m. I saw, rising in a semicircular form above the horizon, and tolerably defined in outline, a beautiful red coloration of the sky. The colour spread along the horizon in a westerly direction, and at 6.30 the entire vault of heaven was suffused with this red colour. When it was first noticed, namely at 6 o'clock, the light was sufficient to illumine the garden, as in the early morning in summer. At 6.15 the light was sufficiently strong to enable me to read the figures on my pocket-watch at the head of my bed, namely eighteen feet away from the window. The sun rose above the horizon at 8h. 5m., and at 10° farther west than the first burst of colour which I noticed. As the sun rose, the red colour disappeared, and it was entirely lost before the sun was fully in view. I am told by friends who were in Düsseldorf on November 30 that at 6 o'clock on that morning their rooms were lighted up so that everything was plainly visible. They at first supposed that the light was produced by a large fire opposite; but they soon discovered that it arose from this red light which you have now so well explained.

December 10 B. E. BRODHURST

NOT having noticed any letter in NATURE stating that the remarkable red glow seen in so many places after sunset was also observed in Ireland, perhaps you will permit me to mention that during the past fortnight, and especially since the 24th ult., it has attracted much attention here. This day week my steward insisted that the heather was on fire on the hills and that we were only watching its reflection. Since then the phenomenon has been even more remarkable, and the farm labourers have been enabled to remain at work in the fields ten to fifteen minutes later than usual. A bank of cloud generally separates the red glow from the horizon. Before sunrise the sky has sometimes a strange reddish look, and at 4 a.m. on the 29th ult. the brilliant roseate hue (referred to in the *Times* as having been seen in London at 5 a.m.) was witnessed here. RICHARD M. BARRINGTON

Fassaroe, Bray, Co. Wicklow, December 2

ACCORDING to a letter from my brother, dated Yokohama, September 22 last, the sun was completely obscured there two days after the earthquake took place in the Straits of Sunda. He writes:—"What a terrible earthquake that must have been in the Straits of Sunda. Incredible as it may appear, two days afterwards the sun here was completely obscured, and, on its reappearance, was quite *blood red*, while every now and then jets that looked like smoke passed across its disk. This lasted for two days," and he adds that "it is conjectured that this is caused by the volcanic smoke and ashes having been driven up here by the south-west monsoon."

32, Fenchurch Street, E.C., Dec. 8 W. HAMILTON

A FEW days since I was mentioning to my family that I remembered how splendid the colouring of the sky was at Malta after sunset in the year that "Graham's Island" appeared. In this morning's *Times* that island is alluded to, and I think you may be interested in the perusal of the accompanying pamphlet (printed for private circulation only). My father (Capt. Sir le Fleming Senhouse, K.C.H.), you will see, landed on the island, and named it after the then First Lord of the Admiralty. The great beauty of the sunsets we have been having have forcibly reminded me of the colouring I saw so many years since at Malta.

Hillside, Guildford, Dec. 8 ELIZABETH M. PITMAN

A correspondent sends the following:—

IT may interest your readers to know that in reference to the splendid sunsets we have seen in England lately I received in a letter from Lieut. C. K. Hope, R.N. (*en route* by inshore passage to the Cape of Good Hope) the following account of an extraordinary phenomenon witnessed by him on October 26 soon after crossing the equator:—"H.M.S. *Orontes*, October 26.—Last evening shortly after sunset the sky bearing from us between north-west and south-west suddenly burst into a red glowing light; the highest point attained an altitude of probably 35° or 40°, and from there tapered gradually away on both sides to the horizon. It showed brightest about 7.15, it being nearly dark at the time, and lasted till 7.30, gradually dying away till about 8 o'clock, when very little of it was left. I could have understood the phenomenon if we had been 40° further north or 20° further south, but on the edge of the tropics such a thing is very strange."

December 5

THE JAVA ERUPTIONS AND EARTHQUAKE WAVES

THE following communications have been sent us for publication by the Hydrographer of the Admiralty:—

Extract from a letter of Commander the Hon. Foley C. P. Vereker, of H.M.S. *Magpie*, dated Labuan Island, October 1, 1883:—

". . . The noise of the detonations caused by Mount Krakatoa, resembling distant, heavy cannonading, was distinctly heard by us and the inhabitants of this coast as far as Bangney Island on August 27. The weather at that time was also much unsettled, with thick hazy weather, and peculiar clouds to the southward, and the sun while at a low altitude assumed a greenish hue for several days. . . ."

Extract from a letter of Staff-Commander Coghlan, R.N.:—

"*Western Australia, Perth, September* 14, 1883.—This coast has been visited by waves and volcanic disturbances (sounds as of the firing of guns inland, &c.), apparently associated with the Sunda Strait outbreak.

"News is anxiously looked for from our north-west coast, as a wave 15 feet high, coming at high water, would lay Cossack, the mouth of De Grey River, Carnarvon (north of Gascoyne), and other places under water. In Champion Bay a wave rose 8 feet above the usual high-water mark. At Fremantle, King George's Sound,

and along the south coast, a wave of less height was experienced

"The *Meda*, on our passage down from Ashburton River (when distant from 50 to 100 miles off the west coast of Australia, and about 1000 miles south-south-east of Sunda Strait), was visited by a shower of volcanic dust (in appearance like prepared "fuller's earth"), which fell some time between sunset of August 30 and sunrise of August 31, the wind being on-shore at the time.

"If the dust were associated with the disturbances in Sunda Strait of August 27 and 28, it must have travelled 1050 miles in three days."

BICENTENARY OF BACTERIA

[WE have received the two following communications on this subject:—ED.]

AT the present time, when so many anniversaries of great men and great events are celebrated, it seems opportune to remember that exactly two centuries have passed since a discovery of the greatest consequence was made in the Netherlands. In a letter dated September 14, 1683, from Delft, to Francis Aston, F.R.S., of London, Antony van Leeuwenhoek gives notice to the Royal Society that with the aid of his microscope he has discovered in the white substance adhering to his teeth very little animals moving in a very lively fashion ("animalcula admodum exigua jucundissimo modo sese moventia." "Arcana naturæ detecta," Delft, 1695: "Experimenta et Contemplationes," p. 42). *They were the first Bacteria the human eye ever saw.* Among them Leeuwenhoek distinguishes several species, the descriptions and drawings of which are so correct that we may easily recognise them. The rods, with rapid movement penetrating the water like fishes, are *Bacilli;* the smaller ones rotating on the top are *Bacterium;* one undulating species is *Vibrio rugula;* the parallel threads of unequal length but of equal breadth are *Leptothrix buccalis;* though motionless, they belong to the moving Bacilli. Leeuwenhoek wonders how, notwithstanding the scrupulous care with which he cleans his teeth, there could live more animalculæ in his mouth than men in all the provinces of the States-General. Some years later, not perceiving again the movements of the Bacteria between his teeth, he supposes he had killed them by taking hot coffee at breakfast; but very soon he discovers anew the old species, and the new drawings of Bacillus and Leptothrix which he sends to the Royal Society in the middle of September, 1692 (*l.c.*, p. 336) are still more accurate than those of 1683. They have not been surpassed till within the last ten years. It deserves our highest admiration that the first discoverer of the invisible world could already reach a limit which has never been overstepped, though the members of the Royal Society, when considering two hundred years ago the curious communications of the philosopher of Delft, may have scarcely foreseen that his astonishing discovery had opened to science a new path which only in our own days has led to the most important revelations about fermentation and disease. FERDINAND COHN

Breslau, November 27

IT cannot be a matter of indifference to English men of science, and especially to the Fellows of the Royal Society, that the bicentenary of the discovery of those immensely important agents of putrefaction, fermentation, and disease, the Bacteria, is at hand.

It was to the Royal Society of London that Antony van Leeuwenhoek communicated his discovery, and we may be sure that neither he nor the Royal Society of that day anticipated the extraordinary interest which would attach itself in two centuries' time to the organisms discovered by the patient and accurate student of minute life.

Leeuwenhoek's "discovery" is a remarkable example of that unexpected giving of rich gifts to future generations of men which marks the progress of scientific research in all its branches. It is for the Royal Society to devise some means of celebrating this bicentenary in such a fashion as to use the great interest and even fascination which Bacteria have at this moment for the English public, so as to excite sympathy with pure and unremunerative scientific research. Antony van Leeuwenhoek is the type of the single-minded student of living structures. The investigation of the properties and life-history of Bacteria, although commenced by him two hundred years ago, is still in its infancy. Schwann, Pasteur, Lister, Cohn, Nägeli, and Koch have brought us within the last fifty years far beyond Leeuwenhoek's first discovery, but a hundred such men are needed to carry on the work of discovery. Who will employ them? Are we to wait two centuries more for knowledge about Bacteria which lies, as it were, ready to our hands, waiting to be picked up? knowledge which will probably save many thousands of lives annually—if we may judge by the results already attained by the discovery of the relation of Bacteria to the suppuration of wounds and to the production of diseases.

The Royal Society could not better celebrate the bicentenary of its Dutch correspondent's discovery than by taking steps to urge on the English Government the expenditure of ample funds upon a new and vigorous prosecution of the study of the relations of Bacteria to disease, in fact upon the foundation of a national laboratory of hygiene. L.

THE UPPER CURRENTS OF THE ATMOSPHERE

ALL winds are caused directly by differences of atmospheric pressure, just in the same way that the flow of rivers is caused by differences of level; the motion of the air and that of the water being equally referable to gravitation. The wind blows from a region of higher towards a region of lower pressure, or from where there is a surplus to where there is a deficiency of air. Every isobaric map, showing the distribution of the mass of the atmosphere over any portion of the earth's surface, indicates a disturbance more or less considerable of atmospheric equilibrium, together with general movements of the atmosphere from regions of high pressure towards and in upon low-pressure areas. All observation shows, further, that the prevailing winds of any region at any season are merely the expression of the atmospheric movements which result from the disturbance of the equilibrium of the atmosphere shown by the isobaric maps as prevailing at that season and over that region. All observation shows, in a manner equally clear and uniform, that the wind does not blow directly from the region of high towards that of low pressure, but that, in the northern hemisphere, the region of lowest pressure is to the left hand of the direction towards which the wind blows, and in the southern hemisphere to the right of it. This direction of the wind in respect of the distribution of the pressure is known as Buys Ballot's Law of the Winds, according to which the angle formed by a line drawn to the centre of lowest pressure from the observer's position, and a line drawn in the direction of the wind is not a right angle, but an angle of from 60° to 80°. This law absolutely holds good for all heights up to the greatest height in the atmosphere at which there are a sufficient number of stations for drawing the isobarics for that height; and the proof from the whole field of observation is so uniform and complete that it cannot admit of any reasonable doubt that the same law holds good for all heights of the atmosphere.

In low latitudes, at great elevations, atmospheric pressure is greater than it is in higher latitudes at the same height, for the obvious reason that owing to the lower temperature

of higher latitudes the air is more condensed in the lower strata, thus leaving a less pressure of air at great heights. It follows that the steepest barometric gradients for the upper currents of the atmosphere will be formed during the coldest months of the year. At Bogota, 8727 feet in height, where the temperature is nearly uniform throughout the year, the mean pressure for January and July are 22·048 and 22·058 inches. On the other hand, at Mount Washington, 6285 feet high, where the January and July mean temperatures are 6°·4 and 48°·2, the mean pressures for the same months are 23·392 and 23·875 inches. Similarly at Pike's Peak, 14,151 feet high, the mean temperatures are 3°·1, and 39°·7, and the mean pressures 17·493 and 18·069 inches; and since the sea-level pressures in the region of Pike's Peak are nearly 0·500 inch higher in January than in July, it follows that the lowering of the pressure on the top of Pike's Peak due to the lower temperature of January is upwards of 1·000 inch. From the greatly steeper barometric gradients thus formed for upper currents during the cold months of the year from equatorial to polar regions, these currents attain their maximum strength in winter and converge upon those regions of the earth where the mean temperature is lowest.

As is now well known, atmospheric pressure in summer is lowest in the central regions of the continents of Asia, Africa, and America; and highest in the Atlantic between Africa and the United States, and in the Pacific between the United States and Japan, the absolutely lowest being in Asia, where temperature is relatively highest with respect to the regions immediately surrounding, and absolutely lowest in the Atlantic, which is most completely surrounded with highly-heated continental lands. Again, in winter the lowest atmospheric pressures are found in the north of the Atlantic and Pacific Oceans, where temperature is relatively highest, latitude for latitude; and the highest pressures towards the centres of the continents, some distance to southward of the regions where at this season abnormally low temperatures are lowest.

The causes which bring about an unequal distribution of the mass of the atmosphere are the temperature and the moisture considered with respect to the geographical distribution of land and water. Owing to the different relations of land and water to temperature, the summer temperature of continents much exceeds that of the ocean in the same latitudes; and hence results the abnormally high temperature of the interior of Asia, Africa, America, and Australia during their respective summers, in consequence of which the air becoming specifically lighter ascends in enormous columns thousands of miles in diameter. Winds from the ocean set in all round to take the place of the air thus removed, raising the rainfall to the annual maximum, and still further diminishing the atmospheric pressure. On the other hand, since in winter the temperature of the continents and their atmosphere falls abnormally low, the air becomes more condensed in the lower strata, and pressure is thereby diminished in the upper regions over the continents. Upper currents set in all round upon the continents, and thus the sea-level pressures become still further increased. Hence the absolutely highest mean pressure occurring anywhere on the globe at any season, about 30·500 inches, occurs in Africa in the depth of winter.

Now observation conclusively proves that from the region of high pressure in the interior of Asia in winter, from the region of high pressure in the Atlantic in summer, and from all other regions of high pressure, the winds blow outwards in all directions; and that towards the region of low pressure in Asia in summer, towards the region of low pressure in the north of the Atlantic in winter, and towards all other regions of low pressure, whenever and wherever they occur, the winds blow in an in-moving spiral course.

Since enormous masses of air are in this way poured into the region where pressure is low without increasing that pressure, and enormous masses of air flow out of the region where pressure is high without diminishing that pressure, it is simply a necessary inference to conclude that the masses of air poured all round into the region of low normal pressure do not accumulate over that region, but must somehow escape away into other regions; and that the masses of air which flow outwards on all sides from the region of high normal pressure must have their place taken by fresh accessions of air poured in from above. Keeping in view the law of the barometric gradient as applicable to all heights of the atmosphere, it is evident that the ascending current from a low-pressure area, the air composing which is relatively warm and moist, will continue its ascent till a height is reached at which the pressure of the air of the current equals or just falls short of the pressure over the surrounding regions at that high level. On reaching this height, the air, being no longer buoyed up by a greater specific levity than that of the surrounding air, ceases to ascend, and thereafter spreads itself horizontally as upper currents towards those regions which offer the least resistance to it. The overflow of the upper currents is thus in the direction of those regions where pressure at the time is least, and this again we have seen to be towards and over that region or those regions the air of which in the lower strata of the atmosphere is colder and drier than that of surrounding regions.

The broad conclusion is this: the winds on the surface of the globe are indicated by the isobaric lines showing the distribution of the mass of the earth's atmosphere near the surface, the direction of the wind being from regions where pressure is high towards regions where pressure is low, in accordance with Buys Ballot's law. On the other hand, the low-pressure regions, such as the belt of calms in equatorial regions, the interior of Asia in summer, and the north of the Atlantic and Pacific in winter, with their ascending currents, and relatively higher pressure at great heights as compared with surrounding regions, point out the sources or fountains whence the upper currents flow. From these sources the upper currents spread themselves and flow towards and over those parts of the earth where pressure is relatively low. These directions are, speaking generally, from equatorial to polar regions; but more particularly towards and over those more restricted regions where in the lower strata of the atmosphere the air is colder and drier than in neighbouring regions, such as the Atlantic between the United States and Africa in summer, and Central Asia in winter.

This view of the general movements of the upper currents of the atmosphere is in accordance with the observations which have been made in different parts of the globe on the motions of the cirrus cloud, and with observations of the directions in which ashes from volcanoes have been carried by these upper currents. In further corroboration of the same views, reference may be made to the researches made in recent years, particularly by Prof. Hildebrandsson and Clement Ley, into the upper currents of the atmosphere, based on observations of the movements of the cirrus cloud in their relation to the cyclones and anticyclones of north-western Europe.

An important bearing of cyclonic and anticyclonic areas on the distribution of temperature may be here referred to. The temperature is abnormally raised on the east side of cyclonic areas and abnormally depressed on their west sides; but, on the other hand, temperature is abnormally raised on the west sides of anticyclonic areas, and depressed on their east sides—the directions being reversed in the southern hemisphere.[1] Since the temperature is lower in the rear than in the front of a cyclone, it follows that, relatively to the sea-level pressures, pressure will be lower in the upper regions in the rear of a cyclone than in front of it, a result which the Ben Nevis observa-

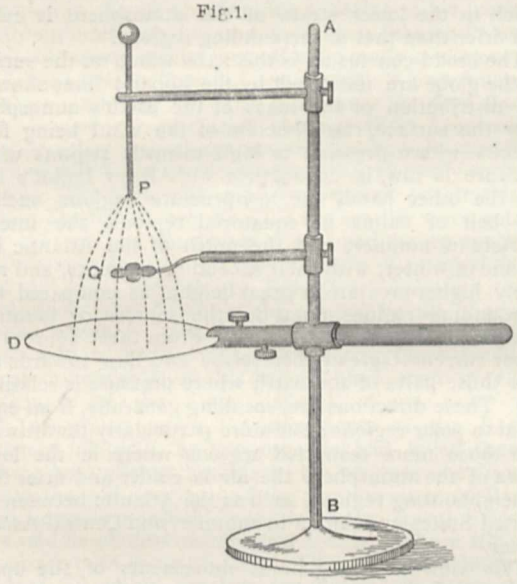
[1] See "Reviews of Weather Maps of the United States," *Nature*, vols xxi., xxii., and xxiii.

tions strongly confirm. Hence relatively warmer and moister upper currents will flow backward over the colder and drier air immediately in the rear of the centres of cyclones; and upper currents also presenting contrasts of temperature and vapour will overlap the outskirts of anticyclones. These considerations suggest how very diverse interpretations of the movements of the cirrus cloud in their relation to cyclones and anticylones have originated, and may also indicate lines of research into some of the more striking optical scenic displays of the atmosphere.

ELECTRIC SHADOWS

THE brilliant researches of Crookes upon the electric discharges in highly attenuated vacua, which some four years ago culminated in the discovery of the phenomena of "radiant matter," revealed, amongst other singular and curious effects, the existence of electric shadows. In the tubes employed by Crookes, wherein the rarefaction had been carried to millionths of the normal air pressure, objects cut out in sheets of metal or other good conductors of electricity were found to cast shadows against the glimmering surfaces of the glass

Fig. 1.



when interposed in the path of the discharge. The deflection of these shadows by the magnet was also observed by Crookes. About eighteen months afterwards some analogous phenomena were observed and described by Prof. W. Holtz of Berlin; the main difference between the phenomena observed by Crookes and by Holtz being that in the experiments of the latter the shadows were obtained at the ordinary pressure of the air by means of the discharge from a Holtz's influence machine. Of these researches some account was given at the time in NATURE (vol. xxiv. p. 130) by the writer of this article. It will be sufficient here to recall the more salient points. In the place of the usual discharging knobs of the Holtz machine were fixed a wooden disk covered with silk on the one side, and a metallic point on the other. The discharge from the latter causes the surface of the former to assume a faint, phosphorescent glow, visible only in complete darkness; and on this faintly illuminated surface shadows were cast when conducting bodies—such, for example, as crosses or rings cut from thin brass or foil, strips of damp cardboard, wires, and other similar objects. It was also noticed by Holtz that these shadow-figures could be temporarily fixed by dusting upon them some fine powder, such as lycopodium. In preparing the notice of these researches for NATURE in 1881, I made the following remark:—"These dust-figures have an obvious relation with those obtained by Wiedemann from the discharge of Leyden jars through a pointed conductor against the surfaces of various bodies. It would be interesting to ascertain whether by this process also shadow-figures can be produced." The suggestion then thrown out has not been lost, for during the current year a memoir has appeared on the subject of electric shadows from the pen of Prof. Augusto Righi, of Padua, giving

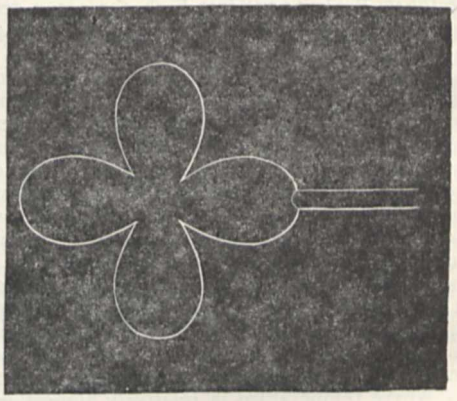


Fig. 2.

the results of an investigation of shadows produced by this very method. I propose to give here a *résumé* of the phenomena observed by Righi.

Righi discusses in an introductory way the suggestion of Crookes as to the relation between the length of the mean free path of the molecules and the distance to which the "radiant" discharge can be traced from the electrode. He observes that even in cases where the mean free path (as determined by the temperature of the

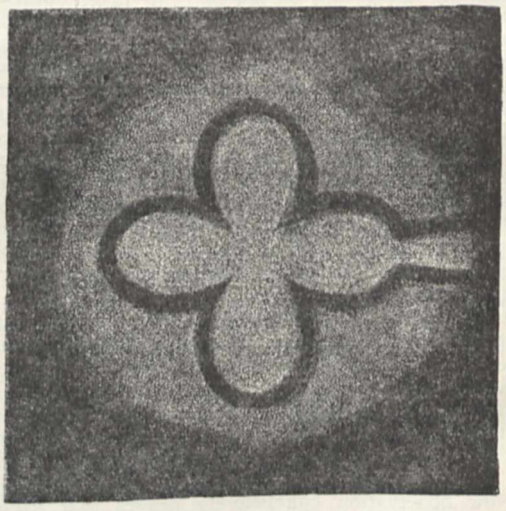


Fig. 3.

gas) be very short, as in air at ordinary pressure, the motion of the gaseous molecules as a whole may yet be in nearly straight lines of considerable length, owing to the fact that the electric force in the space where discharge is taking place will necessarily tend to urge an electrified molecule along the lines of electric force, and will act in the same direction whether the charge on any single molecule remain upon it or whether it be shared with other molecules against which it may impinge in its

flight. The only question was whether the velocity impressed by the electric action could be made relatively sufficiently great. This depended upon the magnitude of the electric density at the surface of the electrified body, and for this reason Righi used a very sharp point for the discharge. Fig. 1 shows the arrangements for obtaining the electric shadows by Righi's process. AB is an ordinary retort-stand of iron, and upon it are clamped three adjustable arms of ebonite. The uppermost of these carries a short metal rod, pointed below and terminated above in a metal ball. The intermediate support carries the object, C, which is to cast the shadow. The lowermost arm is fashioned as a clip in which can be held a disk, D, to receive the shadows. This disk is preferably of ebonite backed on its under side with brass or tinfoil. In certain cases a metal disk varnished on the upper surface is used. Fig. 2 shows a favourite form of object for casting a shadow—a floral or cruciform design cut from thin metal and mounted on a stem of ebonite or glass. To produce the shadow-figures a Leyden jar is charged to such a potential as to be able to yield a spark of 1 to 2 centimetres' length. The outer coating is put in communication with the lower surface of the disk D, and the knob of the jar communicating with its inner coating is then brought into contact with the top of the pointed rod. The jar discharges itself rapidly and almost noiselessly. Then there is immediately sifted over the disk, from a box covered with muslin, some mixed powders of minium and flowers of sulphur, in the usual manner of

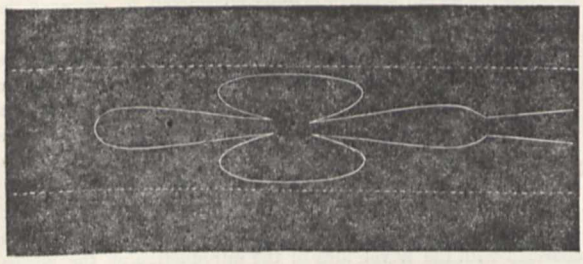


FIG. 4

procuring Lichtenberg's figures. A shadow of the interposed object is at once revealed by the powders. If the discharge has been a positive one, the shadow of the cross will appear in red surrounded by a neutral region, outside which there will be a region tinted yellow with sulphur. The colours will be reversed with a negative discharge. The shadow is depicted in Fig. 3. The size of the shadow varies with the distance of the object. Righi recommends that the object should be three centimetres above the disk, and the point twelve centimetres, or less, above the object. The lines of discharge appear to be hyperbolic in form. If a disk of ebonite only be placed at D, and the brass disk below it be lowered down, the effects are less distinct. If a narrow strip of foil or thin brass be placed below the ebonite disk, the shadow becomes compressed laterally and shows itself only on the region over the strip, and takes the form shown in Fig. 4. Similar shadows can be obtained according to Righi, on metallic disks covered with non-conducting varnish, but in this case by the use, not of the Leyden jar, but of an influence machine. This method is identical with one of Holtz's suggestion. Righi also finds that if the metal disk be previously coated with a conducting powder, such as finest zinc filings, minium, or even powdered glass, a shadow can be obtained. This method affords indeed very sharp shadows, so that thin wires and even wire gauze can be projected in shadow on the disk. Righi has gone still further, and by substituting a sensitive gelatino-bromide plate, has photographed the shadows produced during a five or ten minutes' discharge. In this experiment two figures showed themselves: one, the genuine electric shadow; the other, the genuine photographic shadow cast by the opaque object under the faint star of light emanating from the electrified point above.

If the object whose shadow is to be thus obtained is itself electrified, a curious effect is observed. If it be electrified with a charge of the same sign as that of the point above it, the shadow swells out. If electrified with a charge of opposite sign, the shadow becomes attenuated. Connecting the object to earth has the same effect as in the latter case. The presence of an electrified body on the right or left of the region in which the discharge is taking place has the effect of causing the shadow to be displaced. In fact the presence of such a body alters the equipotential surfaces, and therefore alters the lines of electric force in the field. If the discharge takes place through two points placed side by side at a short distance apart over two objects respectively beneath them, the two electric shadows are mutually repelled from the positions where their geometrical shadows lie. Similar observations of electrostatic influence were made two years ago by Messrs. Fine and Magie of Princetown, New Jersey.

Much as has been done of late years, especially by the late Mr. Spottiswoode in conjunction with Mr. J. F. Moulton, by Drs. De La Rue and Hugo Müller, by Crookes, by Goldstein, and others, to elucidate the phenomena of electric discharges, there probably still remains much to be discovered, and to be explained. The phenomena of electric shadows are amongst the matters best worthy of study in this rapidly progressing department of science. SILVANUS P. THOMPSON

NOTES

WE give this week a further instalment of notices of the strange coloured effects recently observed in the skies, and our readers in all parts of the world will render a service if they will communicate any similar facts they may have observed, giving, as far as possible, accurate dates. In an article in Saturday's *Times*, Mr. Norman Lockyer shows that the body of evidence already to hand connects them with the eruption of Krakatoa but, to place the matter beyond doubt, further information is required. The study of direction and of dates, and the facts touching the variation in the phenomena from August to December, all point in the same direction.

NO one will be surprised, though all must regret, that his state of health and advanced years have compelled Prof. Owen to resign his appointment as Superintendent of the Natural History Department of the British Museum. Prof. Owen's pre-eminent services to science, pure and applied, are too well known to require recapitulation in these columns, especially as very recently we referred to them in detail in connection with his portrait as one of our "Scientific Worthies." Advanced in years as he is, the venerable naturalist's interest in science seems as strong as ever; to each of the last two meetings of the Royal Society he contributed an important paper: we hope they will be by no means the last of such contributions.

WE learn with the greatest pleasure that Prof. Sylvester has been appointed to succeed the late Prof. Henry Smith in the Savilian Chair of Geometry at Oxford. No more worthy successor to the late Savilian Professor could have been found, and it is satisfactory to know that at last the services of one of our greatest living mathematicians have been permanently secured for his native country.

THE ceremony of distributing the prizes to the successful students of the Finsbury Technical College and the South London Technical Art School took place on Monday evening in the Hall of the Clothworkers' Company, Mincing Lane. The Lord Mayor presided, supported by the President of the Royal Society, the Sheriffs, Sir

F. Bramwell, Sir F. Abel, the newly-elected chairman of the Society of Arts, and a large number of gentlemen interested in promoting technical education, the hall being filled with students. The prizes were delivered by Prof. Huxley, who afterwards gave an address. After speaking of the progress in technical education which had been made since 1877, and speaking in high terms of the system pursued at the Finsbury Technical College, Prof. Huxley said that all his life he had been trying to persuade people that if they wanted to teach physical science it was no use to attempt to proceed by filling the minds of the students with general propositions which they did not understand, from which they were to deduce details which they comprehended still less. If they went to the Exhibition Road, South Kensington, they would see a very splendid pile of buildings which had already cost 75,000*l.*, and which he sincerely trusted would cost a very great deal more. That building was the mere bricks and stones of the Central Institute, and the business upon which Sir Frederick Bramwell, the Chairman of the Committee, he (Prof. Huxley), and his colleagues had lately been so largely occupied was making a soul for this body. It was an immensely difficult operation, as they were always in danger, like Frankenstein in the story, of making something which would eventually devour them instead of being useful to them. Their great anxiety had been to make it good and useful, so that the great scheme of technical education might be thoroughly carried into effect. He was perfectly sure that they had in the system of technological examination, and in such institutions as Finsbury College, the Kennington School, and the Central Institution, something which would most indubitably be the nucleus of a vast growth of similar organisations. He had not the smallest doubt that, before this generation had passed away, instead of 150 centres at which such examinations were conducted, they would be counted by hundreds, and instead of the two or three high-class places of technical instruction which had been enumerated they would be counted in different parts of this island by the score, and that they would have in the Central Institute the great uniting point for the whole of this network through which the information and the discipline which were needful for carrying the industries of the country into operation would be distributed into every locality in which such industries were carried on. He regarded it as even a more important function of such organisations that they would be places to which every young artisan of industry and ability could look to gratify his legitimate ambition. His study of history had led him to the conclusion that there never had been, and there never was likely to be, any great cause of widespread social discontent except hunger of some kind or other. There was physical hunger of the body, and there was intellectual hunger arising in the minds of capable and energetic men who were prevented by the accidents of life, or the organisation of society, from taking the places for which they were fitted. Everything which spreads a knowledge of technical processes among our industrial classes tended to fit them to fight better that great battle of competition in which they had hitherto maintained themselves victoriously in virtue of the inward natural powers and capacity of the race, but in which the struggle became more difficult, not only because on the continent of Europe training and discipline were supplementing whatever might be lacking of energy and capacity, but because on the other side of the Atlantic there was a people as numerous as ourselves, of the same stock, blood, race, and power, who would run us harder than any competitors had hitherto done. If we were to hold our own in this great world competition, it must be because the native force and intelligence were supplemented by careful training and discipline, such as were proposed to be given by the system of technical education.

At the meeting last week in connection with the memorial to the late Mr. Spottiswoode, a committee was formed for the purpose of procuring a portrait or bust for presentation to the Royal Society, and also to consider the question of establishing a further memorial of his connection with the Society. Prof. Huxley, Mr. W. De La Rue, Mr. Bowman, Dr. Evans, the Astronomer-Royal, and Mr. F. Galton, were appointed as members of the committee.

We have received from the publishers, Messrs. De la Rue and Co., a sample of their pocket-books, date cards, and pretty Christmas cards, which each year seem to become more and more attractive. The pocket-book, a *spécialité* which Messrs. De la Rue have brought to great perfection, is indeed a *multum in parvo*. Not only does it contain the usual almanac, but also much useful information. The mean time of high water in all parts of the world, the length of a degree of latitude and longitude, a table of magnetic elements, which, as inferred for next year, are declination 18° 12′ W., inclination 67° 32′, horizontal force 3·92, vertical force 9·50, total force 10·27, a table of specific gravities, the various tables of weights and measures together with the French measures, the dates of eclipses, and the mean time of the sun's southing, &c., all given with the usual exactness which has caused this pocket-book to be looked to by many scientific men as a help in their daily work. The date cards are in all shapes and sizes, for hanging on an office wall or to stand on the writing table in the study. The Christmas cards are now produced with such care in drawing and colour as to have become veritable works of art, and it is truly a difficult task to select from amongst the different series before us those which may be considered to carry off the prize. Mention must, however, be made of the beautiful etchings on satin and the coloured drawings of child and bird-life, the latter particularly showing both artistic and scientific knowledge, and it was a happy thought to produce these on such a material as satin, which gives a wonderful softness and finish to the pictures, and makes them suitable for adorning screens, panels, sachets, and the various dainty trifles which will be eagerly sought for this Christmas. The hunting series is drawn with great spirit, and many a child, both old and young, will be charmed with the novel idea of the introduction of the persistence of vision by building up a hunting scene by the hunters and hare on one side and the horses and dogs on the other of a rapidly spun card. Other cards too are arranged to introduce Wheatstone's principle of the wheel of life. The flower series, which is drawn with the same delicacy that we noticed in the colouring of the birds' plumage, is this year enriched by some Alpine favourites, which will carry many of us back to our summer haunts, and cause us to thank Messrs. De la Rue for enabling us to recall at this inclement season one of the many enjoyments of our yearly holiday.

The *Times* of Friday last contains an account of the results obtained in the *Dacca* and *International*, which were sent out to take soundings in the Atlantic for the purpose of laying a cable between Spain and the Canaries. Mr. Buchanan accompanied the expedition, and his observations on the corals, which seem to be creating a "coming Atlantis," are of much interest. The precise information obtained about some of the banks which stud this part of the Atlantic is a valuable addition to existing knowledge on the subject.

The naturalist Petit has returned to France from the Congo region, where he has spent several years, especially between the Gaboon and the Congo. He brings home large collections, especially in ornithology.

One necessary result of the scattered population of the United States of America has been the co-education of the sexes. Other countries have inquired as to the effect of the mixing together of boys and girls not only in schools but also in classes, and this has led the Bureau of Education to take the opinions of the

school officers of 144 towns of less than 7000 inhabitants, and 196 larger cities, as to the good or evil result therefrom. There is an almost uniform reply in its favour. Only 19 out of the whole number separate the sexes, and only 12 out of these speak decidedly against it. The general morality and tone of society in America prevent its having any mischievous effect, while their innumerable small schools necessitate a large supply of female teachers who are the better qualified by their early competition and parallel education with boys. The Bureau, however, calls attention to the fact that both advantages may be absent in an older and more thickly populated country where concentration and division of labour is more practicable.

THE Report of the Manchester Public Free Libraries is a very satisfactory one, showing that since 1876-77, when the issues of books had been decreasing for several years, a steady revival has set in and their circulation has increased more rapidly than the population. Nothing also speaks so well for the successful work, present as well as prospective, of both central and district libraries as the new catalogues of first one and then another which have followed each other at average intervals of six months only.

ON November 22, at about 9 a.m., a remarkable phenomenon was observed at Alfta in the province of Helsingland. The weather was mild and calm, and the sky clear, when from the north the rays of an aurora began to develop, and soon bathed the northern heavens. Down by the eastern horizon a heavy dark cloud rested, from which a magnificent meteor suddenly darted forth. It traversed almost the entire heavens, spreading a deep lurid light over every object, before which even the aurora paled. The simultaneous observation of a starlight sky, a flaming aurora, and a splendid meteor in the depth of winter is described as very striking.

THE *Revue Positive*, which has been edited by the late M. Littré, and latterly by M. Wirouboff, has published its last number. The reason alleged is the want of interest now felt in France for merely theoretical questions, and the success obtained in a number of special directions by the principles of positive philosophy. It has lived fifteen years.

PART III. VOL. II. of the *Memorie della Società Geografica Italiana* is entirely occupied with the working out of the zoological collections made during the Italian Expedition to Equatorial Africa. Signor Vinciguerra treats on the freshwater fishes, M. A. de Bormans on the Orthoptera, M. C. Oberthür on the Lepidoptera, and M. Lethierry on the Hemiptera; in all cases there were new forms to describe, and the most interesting Lepidoptera are illustrated on a large folded plate. These memoirs appeared originally in the *Annali del Museo Civico di Storia Naturale di Genova*, but will be useful in their collected form.

EARTHQUAKES are reported (1) from Steinbruck (Styria), where a severe shock was felt on November 7 at 3 p.m., and a second one six minutes later, both in a vertical direction; (2) from Kaltenbach, near Müllheim, where a loud subterranean noise was heard, accompanied by a shock on November 11 at 9 p.m. The phenomenon was also observed in the surrounding villages, and was preceded in the daytime by a severe thunderstorm; (3) from the neighbourhood of Trawnik (Bosnia), where, on November 15 at 9.45 p.m., a violent undulatory earthquake was felt, accompanied by subterranean noise. The phenomenon lasted five seconds, and its direction was from north-west to south-east. An earthquake is also reported from Patra (Greece), where a violent shock occurred on November 14 at 3.40 a.m.

IN connection with the Quekett Microscopical Club, six demonstrations upon elementary subjects connected with microscopy will be given at University College, in Class Room No. 8, at 7.30, on the following evenings:—December 14, 1883, Cutting Sections of Hard Tissues, by T. Charters White, M.R.C.S.; January 11, 1884, Microscopical Drawing, by J. D. Hardy; February 8, the Sponge Skeleton as a means of recognising Genera and Species, by J. G. Waller; March 14, How to Work with the Microscope, by E. M. Nelson; May 9, Polarised Light, by Charles Stewart, F.L.S.; June 13, Staining Vegetable Tissues, by W. H. Gilburt.

ON the Zuiderzee interesting experiments were recently made with fog-horns of a novel construction. They are sounded by steam, and are worked after the fashion of Morse telegraphs with long and short sounds. Two ships were provided with the fog-horns; on each there were telegraphists working the horn, and the signals were distinctly heard and understood even if the distance between the ships was such that they lost sight of each other.

A GERMAN Meteorological Society was founded at Hamburg on November 18 last, when many eminent men of science were present. Dr. Neumayer was elected president; the object of the Society was defined as—"The cultivation of meteorology as a science and in its relations to practical life." The Society will support meteorological research and publish a meteorological serial. At the first meeting Dr. Hellmann spoke on twilight phenomena, Dr. van Bebber on barometrical minima with erratic movement, and Dr. Köppen on his method of testing the results of weather forecasts.

THE additions to the Zoological Society's Gardens during the past week include two Lesser White-nosed Monkeys (*Cercopithecus petaurista*) from West Africa, presented respectively by the Rev. W. C. Willoughby and Mr. S. E. Sims; twenty Barbary Turtle Doves (*Turtur risorius*) from India, presented by Mr. A. T. Hirsch, F.Z.S.; two Bearded Titmice (*Panurus biarmicus*), European, presented by Mr. H. D. Astley, F.Z.S.; a Water Rail (*Rallus aquaticus*), British, presented by Mr. E. G. B. Meade Waldo; an Indian Crocodile (*Crocodilus palustris*) from India, presented by Sir Joseph Fayrer, K.C.S.I., F.Z.S.; two Scaly-breasted Lorikeets (*Trichoglossus chlorolepidotus*), from New South Wales, a St. Thomas's Conure (*Conurus xanthol æmus*) from St. Thomas, West Indies, four West African Love Birds (*Agapornis pullaria*) from West Africa, two Undulated Grass Parrakeets (*Melopsittacus undulatus*), a Cockateel (*Colopsitta novæ-hollandiæ*) from Australia, two Indian Crocodiles (*Crocodilus palustris*) from India, deposited; a Hairy Porcupine (*Sphingurus villosus*) from Brazil, on approval; two Cirl Buntings (*Emberiza cirlus*), British, purchased.

OUR ASTRONOMICAL COLUMN

ENCKE'S COMET.—On October 16 M. Otto Struve presented to the Imperial Academy of Sciences of St. Petersburg a new memoir on the motion of Encke's comet, by Dr. Backlund, of the Observatory at Pulkowa, who has continued the researches commenced by the late Dr. von Asten. Shortly before the decease of the latter, in August, 1878, he had completed a memoir upon this comet, in which it was proved that the appearances between 1819 and 1858 might be comprised, so to say, under a single formula, adopting one value for the effect of a resisting medium; or an acceleration of 0″·104 in the mean motion in each revolution. Nevertheless the observations at the different returns were not represented with such a degree of precision as to exclude a probable error of 9″·0 for each co-ordinate of a normal position, and for certain appearances the agreement with the formula was so little satisfactory that a suspicion arose of the existence, besides gravitation and a resisting medium, of other agents which had affected the motion of the comet. The suspicion was further increased when it was found by Asten that

the appearance in 1871 could in no way be included under the general formula, without admitting that the resisting medium had ceased to operate, or that the comet during the revolution immediately preceding had undergone a sudden retardation through the intervention of some unknown force. Following up at first the latter hypothesis, he was able to assign approximately the time when such perturbation must have taken effect, and found that at this time the comet was traversing the region of the small planets between Mars and Jupiter. This circumstance led Asten to conjecture that the attraction of one of these bodies, which the comet had encountered, might have occasioned the retardation.

A similar retardation was indicated again by the last appearance of the comet in 1881, and, following a similar method, Dr. Backlund was able to fix the time and the approximate place, which was again found to be in the midst of the zone of small planets. Thus, as M. Otto Struve remarks in his report upon Dr. Backlund's memoir, there was reason to think that we were upon the traces of a very interesting discovery, which added much to the interest attaching to his new researches on the last four appearances of the comet, as a complement to the investigations of Asten for the period 1819–1868. This additional work has not, however, led to a confirmation of the above-named hypothesis, but has replaced it by results of a more positive character and of greater scientific importance.

Dr. Backlund had found, on following rigorously the rules of calculation adopted by his predecessor, that the last four appearances, and particularly those of 1871 and 1881, could not be represented without admitting that the acceleration had diminished considerably, and had even disappeared for the last two returns. But on a closer examination it was discovered that a strange error had entered into the combination of the appearance of 1868 with the two preceding ones; in one of these revolutions where the observations made after perihelion were combined with those made before the succeeding one, Asten, though he supposed he had taken into account the resistance, had in fact not done so. This being rectified, the errors of 1871 and 1881, which amounted to many minutes, were destroyed in great measure, and the discordances reduced to tolerable though still unsatisfactorily large quantities. After a revision of the formulæ employed, Dr. Backlund succeeded in reducing the probable error remaining in each co-ordinate of a normal position to 4″·1. The introduction of the mass of Jupiter, according to the determination of Bessel-Schur, further reduced this probable error to 2″·8, assigning for the acceleration during the period in question 0″·054 for each entire revolution, and M. Struve considers that Dr. Backlund's researches have thus put us in possession of a theory of the comet for its later returns which leaves little or nothing to be desired.

It has been mentioned that for the period 1819-1868 the probable error in the normal positions given by Asten amounted to 9″·0. Partly, perhaps, the larger error is attributable to the inferiority of the instrumental means available in the first half of the century, but probably in a greater degree to imperfections detected in the theory adopted for this earlier period, upon which M. Struve's report enters into some detail. For this reason Dr. Backlund has charged himself with the construction of a new theory for the interval 1819-1868, in which he will be much assisted by the earlier work of Asten, described as having been left in admirable order, and thus admitting of being followed and verified at every step.

While awaiting the results of these further investigations, M. Struve draws attention to a very singular fact, which will not be affected by them. He remarks there is no reason to doubt that the acceleration has much diminished in the interval between the mean epochs of the two periods referred to above. He asks: Is it that the volume of the comet has diminished in the interval? The observations afford no trace of such diminution. Or again,—has the matter of which the comet is composed been increased? On this we can say nothing. There is, further, the supposition that the so called resisting medium has altered in density, or again, that the acceleration attributed to the effect of a resisting medium is produced by forces of a totally different nature.

All this for the moment must remain enigmatical, but the fact is established that the acceleration has diminished; we cannot say whether this diminution has been produced instantaneously or gradually; it is a point upon which the new researches undertaken by Dr. Backlund may enlighten us.

Encke's comet returns to perihelion in March, 1885.

GEOGRAPHICAL NOTES

THE eleventh number, 1883, of Petermann's *Geographische Mittheilungen* opens with a minute account of the archipelago of Chiloe, by Dr. C. Martin, who in former numbers of the *Mittheilungen*, in the *Revista cientifica de Chile*, and in other publications, has already communicated important information on this part of the earth's surface. The present contribution has special reference to vol. viii., recently published at Santiago, of the *Anuario de la Marina de Chile*. The next article gives an interesting sketch of the progress of the knowledge of Kafiristan by Europeans from 1829, when it first became known to Elphinstone, down to the present year, when Mr. McNair, the Indian Government surveyor, penetrated as far as the Dorah Pass; and an account of the present state of the inhabitants ethnographically, ethologically, socially, morally, and religiously, according to the reports of the Rev. Mr. Hughes and other recent visitors. The third article traces the route of the Russian Embassy of 1878-79 through Afghanistan and the Khanate of Bukhara, following the descriptions of Dr. J. Jaworski, member of the Russian Geographical Society, who as physician accompanied the Embassy, and has recently published an account of the expedition in two thick octavo volumes in Russian. In a long paper illustrated by a map by Bruno Hassenstein, which also embraces Dr. Junker's expedition through those parts, Dr. Emin-Bey prosecutes his travels to the west of the Bahr-el-Jebel in October and November of last year. Starting from Bedden, on the White Nile, on October 9, he penetrated south-westwards as far as Janda, the extreme southern post in the Kakuák country, whence he proceeded north-westwards through the Fadjelu Land, the station Kabajendi, the region of the Makraka and of the Abuka, as far as the station of Gosa. From this point Dr. Emin-Bey turned south-eastwards through the Abukaja country, and the Makraka-Ssgaire stations, and on November 26 arrived at the station of Wandi. The Makraka are described as a people dowered, both men and women, with a remarkable profusion of hair, which by means of fat, the sap of trees, &c., they studiously arrange in plaits, pigtails, &c., producing very surprising effects. The name Makraka, though now universally applied to the people of that region, was, it appears, not the original name, but, signifying cannibals, was at first used by the natives to designate a body of invaders of the Iddo race from the south. Dr. K. Zöppritz, in the next following article, discusses Dr. Emin-Bey's measurements of heights and atmospherical pressure at Lado.

WE have also received the *Mittheilungen* of the Geographical Society in Hamburg for 1880–81. It contains a very copious account of the Island of Chios (or Scio) geographically, geologically, ethnologically, and commercially; a lecture on the cola-nut, delivered before the Geographical Society of Hamburg on January 5 of last year, and an instructive description of the "sacred" Japanese town of Kioto. Next follows a very careful and comprehensive account in 250 pages, by Dr. H. Sieglerschmidt, of the results of the North Polar expeditions of this century. After summing up our knowledge of the North Polar regions in the year 1818, the review traces the history of North Polar investigation since that date, taking stock, in particular, of our knowledge of East Greenland, Spitzbergen, the Siberian glacial sea, and other hyperborean tracts. Lastly, it draws up the total results down to the present date in respect of hydrography, meteorology, magnetism, astronomy, &c. In the next article Herr E. R. Flegel gives the first of a series of sketches intended to comprise (1) the mangrove swamps of the delta of the Niger; (2) the mountains of Cameroon; and (3) the banks of the lower Niger. In this first sketch we are introduced to the long and narrow sandy strip of land rising but little above the level of the sea, and running parallel with the coast of the Bight of Benin.

THE *Verhandlungen* of the Berlin Geographical Society, Band x., No. 7, contains a very copious article on Wisconsin; and the *Zeitschrift* of the same society, No. 105, gives the conclusion of Dr. Richthofen's account of his travels in China, as also, among other valuable papers, a contribution to the ethnography of the extreme north-east of Asia, by Herr G. Gerland.

WE have further received the *Bulletin de la Société de Géographie* for the second and third quarters of this year. An article by M. Grandidier briefly describes the province of Imerina, the central, as also the most populous and important, province of Madagascar. The province is mountainous, traversed by numerous watercourses, entirely bare of tree or shrub, or often even of cultivated plant, scarcely inhabited in the hilly grounds, but thickly peopled

in the valleys. The hills covering most of the country, of hard and compact red clay, through which blocks of granite crop largely up, are not fertile. To the west of the capital, in the very centre of the province, is a large plain, about 30 km. long by as many broad, formerly a lake or marsh, now an immense field of rice, where emerge hamlets and houses like so many islets. There is also an interesting account of the Fuegians. The fluctuations of the Indian population in the United States are discussed by M. de Semalle in an article to which M. Simonin shortly replies. The kingdom of Perak, the Peninsula of Malacca, is described by M. De La Croix. Commandant Gallieni, of the French Naval Infantry, furnishes a mass of information on the races and populations of the Upper Niger, while Dr. Audray relates at considerable length his personal impressions and reminiscences of Hué during the eighteen months he passed there at the French Legation. M. Fernandez also communicates a paper on the Argentine Republic.

THE *Bulletin of the American Geographical Society* has a paper on the Philippine Islands by Dr. Kneeland, and another on the currents of the Pacific Ocean, by Dr. Antisell.

IN an article in the last number of the *Bremen Geographical Journal* on the inhabitants of the Chukche Peninsula, in the north-east extremity of Asia, Dr. Aurel Krause, after a brief sketch of voyages of discovery and scientific expeditions to that region, sums up the views of the different authorities with reference to the population of the peninsula, and endeavours to reconcile and supplement them with immediate observations of his own. As the result of his studies he distinguishes two different races on the peninsula—the Chukches and the Eskimo. The Chukches, again, are either nomadic or settled. The nomadic Chukches, who are also distinguished by the possession of reindeer, are scattered over the country to the west of Behring Strait, as far as Chaun Bay and the sources of the Great and Little Anjui, and south to the Anadyr River, some 5000 (German) square miles of land, with a population hardly numbering over 2000. The settled Chukches dwell on the shores of the Arctic Ocean from Chaun Bay to Behring Straits, and in some spots on the east coast in villages counting up to forty huts. There is also a third class of Chukches, intermediary between the aristocratic reindeer proprietors and the fishers, a class of merchants. A different race, looked down upon by the Chukches, occupy the south coast from Point Chaplin (or Indian Point) to Anadyr, as also parts of the east coast. That these are of the same race as the Eskimo of the opposite American coast their mode of living, their language, and bodily structure testify beyond all doubt, according to Herr Krause, his opinion on this point differing from that of the *Vega* staff. According to Dall these Eskimo are slowly drifting southwards towards Kamtschatka. The Eskimo on the Asiatic side of Behring Straits, including those of St. Lawrence Island and of the Diomedes Islands, should hardly exceed 2000. An ethnographical map and a list of Chukche and Eskimo words in connection with the Chukche Peninsula are appended to this valuable paper.

DR. EMIL RIEBECK of Halle, the well-known traveller, is preparing for a second African journey, which will be directed to the Niger. He will be accompanied by the naturalist Herr G. A. Krause, well known as an excellent linguist and mathematician.

THE NOVEMBER MEETING OF THE NATIONAL ACADEMY OF SCIENCES[1]

FOR the first time in nineteen years, and the second time in its history, the National Academy held its mid-year meeting in New Haven, November 13–16. Thirty-three of the ninety-three members were in attendance, and during its four days' session twenty papers were presented.

The meeting was conspicuous for the discussion which most of the papers called forth, and for the general participation of the members in these discussions. It was interesting also, for the report of the committee on the solar eclipse of last May, which included the detailed reports of the expedition to Caroline Island, undertaken under the auspices of the Academy, by the principal participants, Profs. Holden and Hastings. It will further be remembered by the members from other cities for the marked hospitalities they received at the hands of their *confrères* of New Haven, and for its many social pleasures, culminating in the brilliant public reception given them by the president, Prof. Marsh, at his residence. The new buildings recently finished, or in process of erection, for the furtherance of scientific research and instruction in Yale College, were also examined with interest, together with the treasures of the Peabody Museum, where the finely-mounted collections of Profs. Verrill and E. S. Dana, and the fossil vertebrates of Prof. Marsh, called forth much admiration.

The generous discussion to which the papers gave rise was provoked at the very start by the paper of Dr. Graham Bell upon the formation of a deaf variety of the human race, which had a broad, practical interest, and which consumed the entire morning session of the first day. Mr. Bell claimed that, from purely philanthropic motives, we were pursuing a method in the education of "deaf-mutes" distinctly tending to such a result, supporting his assertions by statistics drawn from the published reports of the different institutions in this country devoted to the care of these unfortunates. They are separated in childhood from association with hearing-children, and taught what is practically a foreign language—a practice which isolates them from the rest of the community throughout their lives, and encourages their intermarriage. Such marriages were increasing at an alarming ratio, and with calamitous results. As a remedy for this danger, Dr. Bell would have the children educated in the public schools, thus bringing them into contact with hearing-children in their play, and in instruction wherever they would not be placed at a disadvantage, as in drawing and blackboard exercises. He would also entirely discard the sign-language, and cultivate the use of the vocal organs, and the reading of the lips.

The report on the solar eclipse covered a variety of topics, and will fill some hundred and fifty printed pages. In presenting it, Prof. E. S. Holden merely touched upon the principal points, and gave the leading results, in much the same form as they have already been given in this journal. The objects of the expedition were successfully carried out; and Prof. Holden regarded his special work—the search for a possible planet interior to Mercury—as proving the non-existence of the small planets reported by Profs. Watson and Swift.

Dr. C. S. Hastings read in full the greater portion of his report upon the spectroscopic work, which concluded with a critical review of the generally-received theories of the solar atmosphere, and suggested, instead, that the corona was a subjective phenomenon, largely due to the diffraction of light.

The presentation of these reports occupied the entire morning session of Wednesday, and their discussion the greater part of the afternoon session.

In criticising the current use of the word "light" in physics, Prof. Newcomb opened a long and interesting discussion. He urged that photometric measurements were comparatively valueless, because they estimate a part only of the radiant energy of the sun; whereas the quantity which should be determined was the number of ergs received per square centimetre. Prof. Langley, however, asserted that it would be impossible to estimate the radiant energy received from the stars with our present appliances; not all the stars combined would produce deflection, even in so sensitive an apparatus as the bolometer.

Another feature of marked interest was Prof. Rowland's exhibition of photographs of the solar spectrum, obtained by his new concave gratings, by which he had prepared a map of the spectrum much more detailed than heretofore secured, and free from the defects of scale found in previous photographs.

Prof. Asaph Hall communicated the results of his researches upon the mass of Saturn, based upon new measurements of the distances of the outer satellites. He determines the mass of the sun to that of Saturn to be as 1 to 1/3482.

Prof. Brewer took the occasion of the Academy's meeting in the city of his residence to exhibit samples of his experiments of many years' duration upon the subsidence of particles in liquids. They showed the action of saline and organic matter, of acids and of freezing, upon the precipitation of sediments. Most of the samples had been undisturbed for five or six years, and showed varying degrees of opalescence, resulting from the suspension of matter in the fluid.

We have mentioned only the more important papers, or those which provoked a fuller discussion than usual. The following complete list will show how largely the physical side of science predominated at the meeting. In astronomy, besides the reports on the eclipse of May 6, papers were read by A. Hall, on the mass of Saturn; by S. P. Langley, on atmospheric absorption;

[1] *Science*. From advance sheets; favoured by the Editor.

and by O. T. Sherman (present by invitation), on personality in the measures of the diameter of Venus: in mathematics, by S. Newcomb, on the theory of errors of observation, and probable results: in physics, by S. Newcomb, on the use of the word "light"; by W. H. Brewer, on the subsidence of particles in liquids; and by H. A. Rowland, on a new photograph of the solar spectrum: in meteorology, by E. Loomis, on the reduction of barometric observations to sea-level: in geology, by T. S. Hunt, on the Animikie rocks of Lake Superior; by J. D. Dana, on the stratified drift of the New Haven region; by B. Silliman, on the mineralogy and lithology of the Bodie mining district; and by J. S. Newberry, on the ancient glaciation of North America: in chemistry, by W. Gibbs, on phospho-vanadates, arsenio-vanadates, and antimonio-vanadates, and on the existence of new acids of phosphorus: in physiological chemistry, by R. H. Chittenden (present by invitation), on new primary cleavage forms of albuminous matter: in palæontology, by J. Hall, on the Pectinidæ and Aviculidæ of the Devonian system; and by O. C. Marsh, on the affinities of the dinosaurian reptiles: and in anthropology, by A. G. Bell, on the formation of a deaf variety of the human race; and by J. W. Powell, on marriage institutions in tribal society.

The report of the Committee on Glucose, appointed by the President in conformity with a request from the Governmen', was accepted by the Academy, and will be transmitted to Congress with the President's report. This will also embody the proceedings of recent meetings of the Academy, the report of the Committee on Alcohol, and that on the eclipse of the sun, together with the thanks of the Academy to the Secretary of the Navy and the officers of the *Hartford* for their cooperation in the expedition to Caroline Island. It will also include an expression of the approval of the Academy of the efforts now making to secure a system of uniform time.

The next stated session of the Academy will be held in Washington in April next, and it is probable that the following mid-year session will be held in Cambridge.

RIPPLE-MARKS[1]

IN the first series of experiments a cylindrical vessel, like a flat bath, with upright sides, was placed on a table, which was free to turn about a vertical axis. Some fine sand was strewn over the bottom to a depth of about an inch, and water was poured in until it stood three inches deep over the sand. It was found that rotational oscillation with a jerking motion of small amplitude gave rise almost immediately to beautiful radial ripples all round the bath. If the jerks were of small amplitude the ripples were small, and if larger they were larger. The radiating ripples began first to appear at the outer margin of the bath and grew inwards; but the growth stopped after they had extended to a certain distance. If the jerking motion was violent, ripples were not formed near the circumference, and they only began at some distance inwards.

An analysis of the observations was made on the hypothesis that the water remained still, when the bath oscillated with a simple harmonic motion. The problem was to find whether λ, the wave-length of ripple (in inches) was directly proportional to v, the maximum velocity of the water relatively to the bottom during the oscillatory motion; also to find the values of v_1 and v_2, the least and greatest velocities of the water compatible with the formation of ripple-mark.

It appears that, for the particular sand used, v_1 is half a foot per second, and v_2 a foot per second; and that the wave-length of ripple, λ, is $\cdot 00245v$ when v is measured in inches per minute. The several results were as fairly consistent with one another as could be expected. The hypothesis that the water as a whole executes a simple harmonic oscillation relatively to the bottom is not, however, exact, and does not give the maximum velocity of the water in contact with the sand relatively thereto. The quantity called v is not in reality the maximum velocity of the water in contact with the bottom relatively thereto, but it is 6·283 times the amplitude multiplied by the frequency. Thus we cannot conclude that a current of half a foot per second is just sufficient to stir the sand. In the state of oscillation corresponding to v, it is probable that part of the water at the bottom is moving with a velocity much greater than half a foot per second relatively to the sand.

[1] "On the Formation of Ripple-mark in Sand." Abstract of a paper by G. H. Darwin, F.R.S., Plumian Professor and Fellow of Trinity College, Cambridge, read before the Royal Society on November 22, 1883.

It was after making these experiments that what appears to be the key-note of the whole phenomenon was discovered.

A series of ripples extending inwards for some distance having been made by oscillation, and the water having come to rest, the bath was turned slowly and nearly uniformly round. The uniform current flattened the tops of the ripples, but made the lee-side steeper.

It was conjectured that there would be eddies or vortices on the lee-side, and in fact minute particles lying on the surface of the sand were observed to climb up the lee-slope of the ripples apparently *against* stream. This proved conclusively the existence of the suspected vortices.

If when the bath was at rest a sudden motion was given in one direction, the sand on the lee-side of each ripple was observed to be churned up by a vortex. By giving a short and sudden motion the direct stream might be seen to pile up the sand on the weather-side and the vortex to pile it up on the lee-side. The sand so displaced formed two little parallel ridges, that on the lee-side being a little below the crest of the ripple-mark.

For the purpose of examining the vortices a glass tube was drawn out to a fine point and fitted at the other end with a short piece of india-rubber tube. With this a drop of ink could be squirted out at the bottom of the water. This method was adopted in all subsequent observations, and it proved very valuable. It may be worth mentioning that common ink, which is heavier than water, was better than aniline dye.

A drop of ink was placed in the furrow between two ripples; as soon as the continuous stream passed, the ink was parted into two portions, one being sucked back apparently against stream up the lee-side of the ripple-mark, and the other being carried by the direct stream towards the crest. These points being settled, it remained to discover how the vortices were arranged which undoubtedly must exist in the oscillatory formation of regular ripples.

The observations were made in two ways, first with a glass trough so arranged that it could be gently rocked by hand, and secondly with an oscillating sheet of glass.

When the trough is half filled with water, and sand is sprinkled on the bottom, it is easy to obtain admirable ripple-marks by gently rocking the trough.

When a very small quantity of sand is sprinkled in and the rocking begins, the sand dances backwards and forwards on the bottom, the grains rolling as they go.

Very shortly the sand begins to aggregate into irregular little flocculent masses, the appearance being something like that of curdling milk. The position of the masses seems to be solely determined by the friction of the sand on the bottom, and as soon as a grain sticks, it thereby increases the friction at that place.

The aggregations gradually become elongated and rearrange themselves. As soon as the formation is definite enough to make the measurement of the wave-length possible, it is found that the wave-length is about one-half of what it becomes in the ultimate formation.

Some of the elongated patches disappear, and others fuse together and form ridges, the ridges then become straighter, and finally a regular ripple-mark is formed, with the wave-length double that in the initial stage.

If, after the formation of regular ripples, and the deposition of a drop of ink at the bottom, a very gentle oscillation be started, the layer of ink on the crest of a ripple becomes thicker and thinner alternately, swaying backwards and forwards; then a little tail of ink rises from the crest, and the point of growth oscillates on each side of the crest; the end of the tail flips backwards and forwards. Next the end of the tail spreads out laterally on each side, so that a sort of mushroom of ink is formed, the stalk of the mushroom dancing to and fro. The height of the mushroom is generally less than a millimetre.

The elongated hollows under the mushroom are the centres of vortices, and the stem is the upward current. If the ink be thick, these spaces are clouded, and the appearance is simply that of an alternate thickening and thinning of the ink on the crest. The oscillations being still gentle, but not so gentle as at first, streams of ink from the two mushrooms on adjacent crests creep down the two slopes into the furrow between the adjacent ridges, and where they meet a column of ink begins to rise from the part of the water whose mean position is in the centre of the furrow.

The column is wavy, and the appearance is strikingly like that of smoke rising from a fire in still air.

The column ascends to a height of some five, ten, or perhaps twenty times the height of the ripple-marks, according to the violence of the agitation. It broadens out at the top on each side, and spreads out into a cloud, until the appearance is exactly like pictures of a volcano in violent eruption; but the broad flat cloud dances to and fro relatively to the ascending column. The ink continues to spread out laterally and begins to fall on each side. In this stage if the ink is not thick it is often very like a palm-tree, and for the sake of a name this appearance is called an ink tree. The branches (as it were) then fall on each side, and the appearance becomes like that of a beech tree, or sometimes of an umbrella. The branches reach the ground, and then creep inwards towards the stem, and the ink, which formed the branches, is sometimes seen ascending again in a wavy stream parallel to the stem.

Perhaps a dozen or twenty oscillations are requisite for making the ink go through the changes from the first growth of the tree.

The descending column of a pair of trees comes down on to the top of the mushroom, but the successful manufacture of the tree necessitates an oscillation of sufficient violence to render the simultaneous observation of the mushroom very difficult.

With violent oscillation, when the stem of the tree is much convoluted, it cannot be asserted that the mushroom vortices exist, and the author is inclined to believe them to be then evanescent.

Each side of the ink tree is clearly a vortex, and the stem is the dividing line between a pair, along which each vortex contributes its share to the ascending column of fluid. The vortex in half the tree is clearly in the first place generated by the friction of the vortex in its correlated mushroom, and is of course endued with the opposite rotation. The ascending stem of the tree is a swift current, but over the mushroom the descending current is slow until close to the mushroom, when the current is seen to be impelled by pulses.

If the adjoining crests are of unequal height, the stem of the tree is thrown over sideways away from the higher crest; and indeed it requires care to make the growth quite straight. The ink in the stem ascends with a series of pulses, and it is clear that there is a pumping action going on which renders the motion of each vortex intermittent, and the two halves of the tree are pumped alternately.

The amount of curvature in the stem of the tree depends on the amplitude of the oscillation of the water.

The ink is propagated along the convolutions of the stem of the ink tree, but the convolutions are themselves propagated upwards, and each convolution corresponds to one oscillation. The motion of the ink along the convolutions soon becomes slow, but the convolutions become broader and closer. Thus the upper part of the tree is often seen to be most delicately shaded by a series of nearly equidistant black lines.

In the transition from the mushroom stage to the tree stage it appeared that it was very frequent that only half the ink tree was formed.

If the agitation is very gentle, the sand on the crests of the ripple-marks is just moved to and fro; with slightly more amplitude, the dance is larger, and particles or visible objects, such as minute air-bubbles in the furrow also dance, but with less amplitude than those on the crests. The dance is not a simple harmonic motion like that of the main body of the water relatively to the bottom, but the particles dash from one elongation to the other, pause there, and then dash back again.

As the amplitude further increases, the furrows are completely scoured out, and the sand on the crests is dashed to and fro, forming a spray of sand dancing between two limits. With violent agitation, this dance must have an amplitude of more than half a wave-length. If the agitation be allowed to subside, the dance subsides, and when the water is still the ripple-mark is left symmetrical on both sides. With extremely violent oscillation, all the water becomes filled with flying dust, and it is no longer possible to see what is happening. This seems to be the condition when the agitation is too strong for the formation of ripple-mark. It is probable that the rush of water sweeps away the existing ripple-mark, and there is then no longer anything to produce a systematic arrangement of vortices.

The author illustrates the dance of the vortices by a succession of figures.

It is hardly possible to explain the series of changes in words, but we may here state that the mechanism by which the ripples are made and maintained depends on the fact that the upward current of a pair of vortices lingers over the ripple crest, and then darts across with extreme rapidity to the adjoining crest. Thus each pair of vortices is associated with two crests, spending nearly half the time over one, and half the time over the other.

As above stated, it has seemed that only one of each pair of tree vortices is set up at first, and the author is disposed to regard this as the transitional state from the mode of oscillation, which produces the half wave-length with small height of ripple-crest, to the fundamental wave-length with considerable height.

The results of the observations may be summarised as follows:—

The formation of irregular ripple-marks or dunes by a current is due to the vortex which exists on the lee of any superficial inequality of the bottom; the direct current carries the sand up the weather slope and the vortex up the lee slope. Thus any existing inequalities are increased, and the surface of sand becomes moulded over with irregular dunes. The velocity of the water must be greater than one limit and less than another, the limiting velocities being dependent on the average size and density of the particles. Existing regular ripple-mark is maintained by a current passing over it perpendicular to the ridges. A slight change in form ensues, the weather slope becoming less steep and the lee slope steeper. The ridges are also slowly displaced to leeward. The regular ripple-mark may also thus be somewhat prolonged, so that although a uniform current probably cannot form regular ripple-mark, yet it may increase the area over which it is to be found.

Regular ripple-mark is formed by water which oscillates relatively to the bottom. A pair of vortices, or in some cases four vortices, are established in the water; each set of vortices corresponds to a single ripple-crest and the vortices oscillate about a mean position, changing their shapes and intensities periodically, but not with a simple harmonic motion.

The successive changes in the vortex motion, whilst ripple-mark is being established, and when the amplitude of oscillation over existing ripple-mark varies, are complex, and we must refer the reader to the original paper for an account of the phenomena.

It is important to note that when once a fairly regular ripple-mark is established, a wide variability of amplitude in the oscillation is consistent with its maintenance or increase. No explanation of ripple-making can be deemed satisfactory which does not satisfy this condition.

The last section gives some account of the valuable papers of MM. Hunt,[1] Casimir de Candolle,[2] and Forel[3] in this field. The author agrees in the main with these observers, but considers that some of their conclusions are open to criticism.

He next remarks that it is not easy to understand precisely the mode in which the oscillation of the water over the undulating bottom gives rise to vortices, but that there are familiar instances in which nearly the same kind of fluid motion must occur.

In the mode of boat propulsion called sculling, the sailor places an oar with a flat blade through a rowlock in the stern of the boat, and, keeping the handle high above the rowlock, waves the oar backwards and forwards with an alternate inclination of the blade in one direction and the other. This action generates a stream of water sternwards. The manner in which the blade meets the water is closely similar to that in which the slopes of two ripple-marks alternately meet the oscillating water; the sternward current in one case, and the upward current in the other are due to similar causes. We may feel confident that in sculling, a pair of vortices are formed with axes vertical, and that the dividing line between them is sinuous. The motion of a fish's tail gives rise to a similar rearward current in almost the same way. These instances may help us to realise the ripple-making vortices.

Lord Rayleigh has considered the problem involved in the oscillations of a layer of vortically moving fluid separating two uniform streams.[4] At the meeting of the British Association at Swansea in 1880 Sir William Thomson read a paper discussing

[1] "On the Formation of Ripple-mark." *Proc. Roy. Soc.*, April 20, 1882 vol. xxxiv. p. 1.

[2] *Archives des Sciences Physiques et Naturelles Genève*, No. 3. vol. ix., March 15, 1883. "Rides formées," &c.

[3] "Les Rides de Fond." *Archives des Sciences Physiques et Naturelles Genève*, July 15, 1883.

[4] "On the Stability or Instability of certain Fluid Motions." *Proc. Lond. Math. Soc.* (February 12, 1880), vol. xi. p. 57.

Lord Rayleigh's problem.[1] He showed that, in a certain case in which the analytical solution leads to an infinite value, there are waves in the continuous streams in diametrically opposite phases, and that the vortical stratum consists of a series of oval vortices. The uniform current flowing over existing ripple-mark exhibits almost a realisation of this mode of motion, one of the streams of fluid being replaced by the sandy undulations. The same kind of motion must exist in air when a gust of wind blows a shallow puddle into standing ripples.

It seems probable that what is called a mackerel sky is an evidence of a mode of motion also closely similar to that described by Sir William Thomson. M. de Candolle's suggestion that cirrus is aërial ripple-mark may then be regarded as substantially correct.

If two horizontal currents of fluid exist one above the other, the layer of transition from one to the other is dynamically unstable, but it is probable that if a series of vortices be interpolated, so as to form friction rollers as it were, it becomes stable. It is likely that in air a mode of motion would be set up by friction, which in frictionless fluid would be stable.

The formation of clouds is probably due to the saturation with moisture of one current and the coldness of the other.

The direction of striation and velocity of translation of mackerel clouds require consideration according to this theory.

It appears that if a mackerel sky be formed beween two aërial currents, the striations are parallel to that direction in which the two currents have equal component velocities, and the component velocity of the clouds parallel to the striations is equal to the component velocity of either current in the same direction.

The resultant velocity of the clouds is equal to a half of the resultant velocity of the two currents, and the component velocity of the striations perpendicular to themselves is the mean of the components of velocity of the two currents in the same direction.

The account which is given in this paper of the formation of ripple-marks shows it to be due to a complex arrangement of vortices. The difficulty of observation is considerable, and perhaps some of the conclusions arrived at may require modification. It is to be hoped that other experimenters may be induced to examine the question.

The reader is referred to the original for the figures, which are necessary to an adequate explanation of the phenomena and conclusions.

NOTE ON DEAFNESS IN WHITE CATS[2]

THIS curious occurrence has long been a matter of interest to me, originally because cats have always been very favourite pets in my household, and still more because the occurrence amongst them of deafness was used by Mr. Darwin in his first edition of "Animals and Plants under Domestication" as an illustration of correlated variability. He was under the impression that white cats with blue eyes were invariably deaf.

I had collected a number of observations which I had personally made, and I found that some white cats were deaf which had the ordinary yellow eyes, and that some white cats with blue eyes could hear perfectly well. I have never heard of deafness in any but a white cat, and all the deaf white cats I had personally examined were males. Therefore, in NATURE, 1873, I published a brief note pointing out Mr. Darwin's error. In his second edition Mr. Darwin established two cases of deafness in female white cats, so that the conclusions of both of us were upset, and this wholesale destruction of theories has been completed by the birth in one of my feline families of a white kitten, female, with perfectly yellow eyes, and absolutely deaf. She lived with us for two years, and her misfortune was quite permanent. My conclusions from the facts observed by myself now may be formulated in this way, that congenital deafness is not known to occur in any animal but the cat, though I am not quite sure but that one white mouse I had some years ago was deaf, and that no cats but those entirely white are ever deaf. As female cats are far more common than males (and this seems to be true of white cats as well as those of other colours), and as I have known only one deaf female cat for some twenty deaf males, I think I may assume that deafness is more common among males than among females. The colour of the eyes has evidently nothing to do with the deafness, though it has with the colour of the fur, and seems to be dependent on the same process—an arrest of development. The eyes of nearly all kittens are blue for some weeks after birth, and the same cause which arrests the pigmentation of the fur arrests in a very much smaller number the pigmentary growth in the eye. I have been told of two cases of complete absence of pigment in the eyes of two cats (albinism) as is seen so commonly in rabbits, guinea-pigs, rats, and mice, but I have not been able properly to authenticate them. These cats were said to be not deaf.

In 1872 I obtained a cat from Hertfordshire as an example of the polydactilism which is very common there, and when he arrived I found that he was white, that he had one eye a bright blue and the other a bright yellow, and that he was profoundly deaf. He was by far the most interesting cat I have ever possessed, and must be well remembered by many members of this Society who have favoured my house with their presence as "Old Pudge," possessed of all the feline virtues, and many of a more human type—and free from vice of every kind. He lived with us for eleven years, and died last winter of peritonitis. Whilst living with us we made many observations concerning his deafness, and I easily determined that it was purely tympanic—that is, he was deaf to impressions conveyed through the air, but his intelligence could be reached by impressions conveyed through solid media. When I wanted him to come to me I gave a peculiar sharp stamp on the floor, and he immediately responded to the signal, even if he was on a chair or table. It is very remarkable that this congenital deafness is in no way associated in the cat with mutism. Human deaf-mutes generally are those in whom deafness is cochlear as well as tympanic, and the result of such disease as scarlet fever in very early life. One other peculiarity he had is that for about four years he suffered from occasional fits of epilepsy of a very severe kind. They came on always during his sleep, and for their first indication had the painful peculiarity that the cat seized the tip of his tail and bit it off, and in this way his tail was shortened considerably. Every kind of white animal I have kept as a pet has been the subject of epilepsy, and the association is suggestive when we are told, as I have been frequently, that the disease is unknown amongst negroes.

I sent the body of my old cat to Prof. Flower for the purpose of having an investigation made into the cause of his deafness. Prof. Flower had a most careful investigation of the condition of his ears made by two most competent investigators—Dr. Cumberbatch and Dr. Heneage Gibbs. The result, briefly stated, is that all the structures in the ears were normal save the tympanic membranes, in which there were triangular gaps extending from the roof to just below the centre, the bases of the gaps being directed upwards, and their anterior side being formed by the handles of the mallei. The gaps appeared to be congenital, and were quite symmetrical; all the other apparatus of the ears was normal, and the auditory nerves were of normal size and structure.

The only congenital defect known in the human tympanum is a very minute aperture, of rare occurrence, and due to the patency of the fissure of Rivinus. The tympanic deficiency in the white cat seems to be in no way associated with this form of arrest.

The results of the observation are interesting, though the subject may perhaps be regarded as trivial, as by it the point raised by Mr. Darwin is finally established. It really is a case, and a very well marked one, of correlated variability, and its great interest is that the three structures affected—the fur, the iris, and the tympanic membrane—have a common origin from the epiblast. Had the defects observed in this cat been cochlear, the difficulty of understanding them would have been very great, as the structures of the internal ear arise from the mesoblast, according to Balfour.

LAWSON TAIT

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The recent recommendations of the General Board of Studies have all been passed. These include the appointment of a Professor of Pathology next term, of Readers in several subjects, including Comparative Philology and Botany, of University Lecturers in connection with Special Boards, including Medicine (four), Mathematics (five), Biology and Geology (six), History and Archæology (five), Moral Science (one),

[1] NATURE, November 11, 1880, pp. 45-46, and see correction on p. 70.
[2] Read before the Birmingham Philosophical Society, October 11.

and of a number of Demonstrators and Assistants. Plans for new buildings for Comparative Anatomy, Botany, and Mechanism are to be obtained.

Dr. Besant will lecture on Analysis (Schedules II. and III.) during two terms; Mr. Pendlebury on Analytical Optics, next term, and on Laplace's and Bessel's Functions in the Easter Term; Mr. Webb on Elementary Rigid Dynamics in the Easter Term, and on Higher Dynamics in the Long Vacation.

Inasmuch as the University Table at the Naples Zoological Sation has been constantly occupied by students of animal morphology, and there are students in physiology and botany for whom study at Naples is very desirable, it is proposed to extend the advantages of study to students of biology generally. Dr. Dohrn has unofficially expressed his willingness to receive, when desired, two members of the University at a time for a payment of 100*l.* instead of 75*l.* a year.

It is hoped that the new Biological and Physical Laboratory, connected with Newnham College, which is being fitted up in Downing Place, may be ready for use by the beginning of next term. The nearness of the site to the new museums will enable students of Newnham to attend professors' lectures there and carry out practical study at the laboratory with the least possible loss of time.

With regard to the statement made last week that "St. John's does not as yet open any of its advanced lectures to other than its own students," we are informed that the advanced lectures have for a long time been open to members of the University, and lectures are provided in some subjects not lectured on elsewhere. The sentence in the report was to the effect that the list for next year was not yet issued. It has now appeared, and no less than six courses of open lectures are announced for the remainder of the academical year.

NEW ZEALAND.—The Queen has been pleased to direct Supplementary Letters Patent to be passed under the Great Seal granting and declaring that the Degrees of Bachelor and Doctor in Science granted or conferred by the University of New Zealand shall be recognised as Academic distinctions and rewards of merit, and be entitled to rank, precedence, and consideration in the United Kingdom and in the Colonies and Possessions of the Crown throughout the world, as freely as if the said Degrees had been conferred by any University of the United Kingdom.

SCIENTIFIC SERIALS

THE *American Naturalist* for November, 1883, contains:—The Pre-cambrian rocks of the Alps, by T. Sterry Hunt.—The achenial hairs of Townsendia, by G. Macloskie.—The hibernacula of herbs, by Aug. J. Foerste.—The hair-sac mite of the pig, by Prof. R. Ramsay Wright.—The geology of Central Australia, by Edward B. Sanger.—The number of segments in the head of winged insects, by A. S. Packard, jun.

Gegenbaur's Morphologisches Jahrbuch, Bd. ix., Heft 1, contains:—Researches on marine Rhipidoglossa, by Dr. Béla Haller, No. 1 (plates 1 to 7).—On developmental relationships between the spinal marrow and the spinal canal, by Dr. W. Pfitzner.—Contribution to the comparative anatomy of the posterior limbs in fishes, part 3, Ceratodus, by Dr. M. Davidoff (plates 8, 9).—On some anatomical marks of distinction between the house dog and the wolf, by Prof. H. Landois.

Rivista Scientifico-Industriale, October 23, 1883.—On the influence of static electricity on the needle, by Prof. Michele Cagnassi.—Experiments with the radiometer (continued), by Prof. Constantino Rovelli.—On the conditions which determine the least and greatest deviation of a ray passing through a prism, by Prof. G. Buzzolini.—On the employment of copperas in testing iodides blended with alcoholic bromides and chlorides, by Dr. Alfredo Cavazzi.—On the advantages that may be derived by medical jurisprudence from entomological studies, especially in determining the approximate date and cause of death, by P. Megnin.—Note on the *Titanophasma fayoli*, a new fossil insect found in the carboniferous formations of Commentry, Allier, by the Editor.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, November 15.—"On *Sceparnodon ramsayi*," a fossil mammal from Australian Pleistocene deposits, by Prof. Owen. The first indication of this species was transmitted to the author, in 1881, in the form of casts of detached teeth, all representing an anterior incisor, the most entire specimen being 5½ inches in length, 35 mm. in breadth, with uniform thickness of 8 mm., the tooth, slightly curved, with persistent pulp-cavity at the base, and a sharp chisel-shaped cutting margin at the opposite end. The author deferred notice of this indication in hope of receiving a specimen of the tooth itself. This was needed in order to make the requisite microscopical researches as to structure, the wombat and some small rodents alone possessing, in Australia, ever-growing scalpriform incisors, but markedly differing in shape as well as size from the fossil. Prof. Owen was favoured by receiving, in the present year, from the bed of King's Creek, Queensland, a tooth, identical in character with the cast, and the present paper records the results of his scrutiny of structure. They led to the conclusion of the former existence in Australia of a mammal with rodent upper incisors, as in the wombat, but of distinct shape, and indicative of a species as large as a tapir. The microscopic characters of both dentine and enamel weighed in favour of the marsupial affinities of *Sceparnodon*. The author referred to the fact that the first indication of the genus *Thylacoleo* was a single carnassial tooth submitted to him in 1833 by Sir Thomas Mitchell, and a similar evidence of *Diprotodon* was an incisor brought by the same explorer from the caves he had discovered in the district named, after the Colonel's old commander, "Wellington Valley."

At the same meeting Prof. Owen gave a minute description of a fossil humerus which had been transmitted to him by Mr. Ramsay, F.L.S., who had discovered it in the breccia cave in "Wellington Valley." The bone was partially mutilated, but gave sufficient evidence of its having come from a Monotreme, with so close a conformity, save in size, with that of the existing *Echidna hyotrix*, as to lead to its reference to an extinct species of that genus. It, however, far surpassed it in size, exceeding, as it did, the corresponding bone in the larger Monotrematous ant-eaters which have been found living in New Guinea. Drawings of the subjects of both papers accompanied the text.

Geological Society, November 21.—J. W. Hulke, F.R.S., president, in the chair.—The following communications were read:—On the skull and dentition of a Triassic mammal (*Trity-lodon longævus*, Ow.) from South Africa, by Prof. Owen, C.B., F.R.S. The specimen described in this paper formed part of a collection containing remains of some of the known South-African Triassic reptilian genera, and agreed with them in its mode of fossilisation. It was submitted to the author by Dr. Exton, of Bloemfontein. The specimen is a nearly entire skull, wanting only the hinder part, and it measures about 3¾ inches in length, from the broken end of the parietal crest to the point of the united premaxillaries. The upper surface shows the anchylosed calvarial portions of the parietals, and the frontal bones divided by a suture; the contiguous angles of these four bones are cut off, so as to leave an aperture, occupied by matrix, which may be a fontanelle, or a pineal or parietal foramen. The frontals form the upper borders of the orbits, which are bounded in front by the lacrymal and malar bones, and were not completed behind by bone. Each frontal is narrowed to a point at the suture between the nasal and maxillary. The nasals are narrow, but widen in front to form the upper border of the exterior nostril, which is terminal, and is completed by the premaxillaries. The maxillaries are widened posteriorly, then constricted, and again widened before their junction with the intermaxillaries. The teeth include a pair of large round incisors, broken off close to the sockets and showing a large pulp-cavity, surrounded by a complete ring of dentine, which is covered by a thin coat of enamel on the front and sides. At 2 mm. behind each of these teeth is the socket of a smaller premaxillary tooth; this tooth apparently had a thin wall and a pulp-cavity relatively larger than in the anterior tooth. It is separated by a ridged diastema from the series of six molar teeth on each side, the first of which has a sub-triangular crown with the base applied to the second tooth. The latter and the four following teeth are nearly similar, subquadrate in form, with the crowns "impressed by a pair of antero-posterior grooves, dividing the grinding surface into three similarly disposed ridges, and each ridge is subdivided by cross notches into tubercles. Of these there are, in the second to the fourth molar inclusive, four tubercles on the mid-ridge, three on the inner ridge, and two on the outer ridge." The author discussed the relations of this new form of mammal, especially as indicated by the structure of the teeth, which he showed to resemble those of *Microlestes*, from

the Keuper of Würtemberg and the Rhætic of Somersetshire, and those of the Oolitic genus *Stereognathus*, the former having on each tooth two multituberculate ridges, and the latter three ridges, but with only two tubercles on each. The fossil presents no characters to show definitely whether the animal it represents was a placental or a non-placental mammal.—Cranial and vertebral characters of the crocodilian genus *Plesiosuchus*, Owen, by Prof. R. Owen, C.B., F.R.S. In this paper the author, with the view of showing that the Kimmeridgian *Steneosaurus manselii*, Hulke, really forms the type of a distinct genus, discussed the characters by which Cuvier divided the fossils referred by him to the Crocodiles into three principal groups, to which Geoffroy St.-Hilaire gave generic names, and those by which the latter author afterwards distinguished his genus *Steneosaurus*, including Oolitic forms, from the Liassic genus *Teleosaurus*. From his exposition of these characters the author concluded that the above-named species does not belong to *Steneosaurus*, Geoff., and he proposed to make it the type of a new genus, *Plesiosuchus*, characterised by the convergence of the frontal bones to a point nearer the apex of the skull than in *Steneosaurus*, by the extension of the gradually attenuated nasal bones into a point penetrating the hind border of the nostril, and by other peculiarities of the skull, teeth, and vertebræ. The author pointed out that this form, like *Steneosaurus*, helped to bridge over the space between the Liassic Teleosaurs and the Tertiary and recent Crocodiles, even approaching nearer to the latter than the older Oolitic type.—On some tracks of terrestrial and fresh-water animals, by Prof. T. McKenny Hughes, M.A., F.G.S. The author's observations have been made on certain pits in the district about Cambridge which are filled with the fine mud produced in washing out the phosphatic nodules from the "Cambridge greensand"—a seam at the base of the chalk marl. As the water gradually dries up, a surface of extremely fine calcareous mud is exposed. This deposit is often very finely laminated, and occasionally among the laminæ old surfaces can be discovered, which, after having been exposed for some time to the air, had been covered up by a fresh inflow of watery mud into the pit. The author described the character of the cracks made in the process of drying, and the results produced when these were filled up. He also described the tracks made by various insects, indicating how these were modified by the degree of softness of the mud, and pointed out the differences in the tracks produced by insects with legs and elytra, and by Annelids, such as earthworms. The marks made by various worms and larvæ which burrow in the mud were also described. Marks resembling those called *Nereites* and *Myrianites* are produced by a variety of animals. The groups of ice-spicules which are formed during a frosty night also leave their impress on the mud. The author concluded by expressing the opinion that *Cruziana*, *Nereites*, *Crossopodia*, and *Palæochorda* were mere tracks, not marine vegetation, as has been suggested in the case of the first, or, in the second, the impression of the actual body of ciliated worms.

Anthropological Institute, November 27.—Prof. Flower, F.R.S., president, in the chair.—Dr. J. G. Garson read a paper on the cranial characters of the natives of Timor-Laut. The osteological remains described in this paper were obtained by Mr. H. O. Forbes from the district of Larat, and consist of a series of eleven skulls and crania. The four male skulls are all of a round form, and resemble one another in general appearance; of the females, five correspond in form to the male skulls in being short and broad, but the sixth differs markedly from the others in being narrow in proportion to its length.—Mr. H. O. Forbes read a paper on the ethnology of Eastern Timor, referring especially to the great intermixture of race that has taken place, and to the occurrence of a red-haired, blue-eyed race in the interior; to the numerous dialects, many of them unintelligible at a short distance from the district in which they are spoken; to the religious rites of the people of certain regions, conducted by a priest in what is called the Uma Lulik (or Taboo House) with an intricate and imposing ceremonial; to their marriage ceremonies and customs, which in some districts remind one of the Australian totem system in the occurrence of husband clans and wife clans; to their death and burial rites; to their system of law and justice, under which, though the chief was king and judge, each freeman had the right—or took it—of private war, retaliating on the wrong-doer with his own hands for loss in his property or person. "Eye for an eye" ran their code, like our own Old English one, "and life for life, or for each fair damages." Mr. Forbes had directed special inquiries into the alleged habit of the Timorese in intentionally artificially distorting their infants' heads. No such custom was found to prevail in the districts traversed by him.

The Victoria Institute, December 3.—A paper on recent Egyptological research in its Biblical relations was read. In it the author, the Rev. H. G. Tomkins, described the results up to the present of those researches which are now being made in Egypt, alluding in warm terms to the assistance rendered him in the preparation of his summary of these results by M. Naville and Prof. Maspero.

The Institution of Civil Engineers, November 27.—Mr. Brunlees, president, in the chair.—The paper read was on the new Eddystone lighthouse, by Mr. William Tregarthen Douglass, Assoc. M. Inst. C. E.

CAMBRIDGE

Philosophical Society, Nov. 26.—The following communications were made to the Society:—On the measurement of electric currents, by Lord Rayleigh. The author referred to the method of measuring currents by the silver voltameter as suitable for currents from ·05 ampere to 4 amperes, and stated that the electrochemical equivalent of silver as determined at the Cavendish Laboratory was $1{\cdot}119 \times 10^{-2}$. A second method was described, suited for larger currents; it consists in balancing the difference of potential between two points in the circuit through which the current is running against the effects of a standard cell working through a large resistance such as 10,000 ohms. The author suggested as a third method the use of the rotation of the plane of polarisation of light passing through a piece of heavy glass, round which the current circulates in a coil of thick wire. A current of 40 amperes will produce a rotation of 15° if the coil have one hundred turns.—On the measurement of temperature by water-vapour pressure, by Mr. W. N. Shaw.—On some measurements of the well-known dark rings of quartz, by Mr. J. C. McConnel.—On the origin of segmentation in animals, by Mr. A. Sedgwick.

EDINBURGH

Royal Society, December 3.—The Right Hon. Lord Moncreiff, president, in the chair.—This being the opening meeting of the 101st session, it had been the intention of the President to give a Review of the Hundred Year's History of the Society; but, on account of his indisposition, the meeting permitted its postponement. Mr. Robert Gray, one of the vice-presidents, occupied the chair during the remainder of the evening.—Prof. Turner communicated a paper by Prof. Haycraft on the limitations in time of conscious sensation. The paper contained the result of experiments on the limitations in time of tactile and thermal sensations, and dealt also with the limitations in the case of the different senses.—Prof. Tait read a paper by Mr. W. F. Petrie on the old English mile. The old mile was longer than the present, and consisted of 5000 feet of 13 inches. It seemed to be identical with the old French mile. The furlong had no connection originally with the mile, which was modified to suit the former.—Mr. Patrick Geddes read a communication on the re-formation of the cell theory. In a second paper, in order to explain muscular contraction, he advanced an hypothesis based on the existence of surface tension in fluids.

DUBLIN

Royal Society, November 19.—Section of Physical and Experimental Science: G. Johnstone Stoney, F.R.S., vice-president, in the chair.—Prof. W. F. Barrett read a paper on hearing-trumpets and an attempt to determine their relative efficiency by physical means. With the view of obtaining a steady and comparable source of sound of a pitch and quality resembling the human voice, a reed pipe was inclosed in a padded box with an opening on one side, and blown by a steady current of air from a holder, a manometer showing the pressure, which was kept constant. The distance at which sound from this source ceased to be audible was noted, and in cases of slight deafness a sliding shutter was added. In other arrangements devised by the author, the principle of interference of sonorous waves was utilised, the degree of deafness being estimated by the departure from complete interference. An induction balance, in which the interrupter was a C tuning-fork, was also tried; as also a siren driven by a falling weight and blown by a current of air at constant pressure; but none of these arrangements were so simple and uniform as the reed. An attempt was made to test the value of ear-trumpets by means of a sensitive flame. The flame was, however, less sensitive than the ear to sounds of the pitch of the human voice. The author

contended that the main object of a hearing-trumpet should be clearness, not loudness, and for this purpose the portable whispering tube was undoubtedly the best for conversation. For other purposes the principles laid down by Lord Rayleigh should be more generally adopted, the telescopic jointed instrument of gradual slope being the nearest approach to theory.—Prof. G. F. Fitzgerald, F.R.S., read a paper on the quantity of energy communicated to the ether by a variable current. The author shows that an alternating electric current, if it produces radiations of the nature of light, as it would do upon the most probable interpretations of Maxwell's electromagnetic theory of light, would radiate energy equal to $m^2 \times N^4 \times 10^{-29}$ ergs per second, where m is the magnetic moment of the current and N is the number of its alternations per second.—W. E. Wilson exhibited a simple form of reflecting spectroscope with a diffraction grating, which was described by Howard Grubb, F.R.S. By employing a pair of mirrors, by which the light is twice reflected, the necessity for having an instrument of inconvenient length is avoided.—R. J. Moss, F.C.S., exhibited a remarkable specimen of crystallised stibnite from Japan. The crystallographic characters of similar specimens have recently been described by E. S. Dana. Mr. Moss found that this stibnite may be regarded as practically pure antimony tersulphide; a very minute trace of iron is the only impurity present in appreciable quantity.

Section of Natural Science: Prof. V. Ball, F.R.S., in the chair.—H. St. John Brooks, M.B., read a paper on the osteology and arthrology of the haddock (*Gadus æglefinus*). The chief feature of this paper was a description of the articulations of all the bones and the attachments of the various ligaments. The author drew attention to the beautiful arrangement of the articulations of the upper jaw of fishes which is seen to great advantage in this form. Ligaments passing from the palate bones to the premaxillæ of the opposite side are crossed by others passing from the ethmoid to the maxillæ, the whole forming a lattice like arrangement. By these ligaments the component parts of the upper jaw are kept in contact with a nodule of cartilage, which lies between them and the ethmoid.—Prof. V. Ball, F.R.S., exhibited and drew attention to a conglomerate of quartz pebbles which is found at the base of the chalk in certain parts of the county of Antrim, and which appeared to him to be inconsistent with a deep-sea origin. He also exhibited bones of red deer, ox, pig, fragments of pottery and flint flakes, &c., from a kitchen midden at White Park, Bray, Co. Antrim. Among specimens recently contributed to the Geological Museum, samples of spherical phosphorite from Southern Russia were exhibited. One of them, which had been sliced, shows a beautifully radiated internal structure; this, it is hoped, will be figured and published with details shortly.—Dr. W. Frazer read a note on bones and shells obtained from drainage cuttings at Sandymount.—G. Johnstone Stoney, F.R.S., exhibited cores of limestone found in the drift overlying Cambrian slates near Greystones, Co. Wicklow. Water percolates through the drift, and, on reaching the Cambrian slates, makes its way horizontally through the lowest layer of the drift, corroding the limestone boulders, which form one of its constituents; cores of solid limestone are frequently found of some fantastic form in the heart of a friable mass which remains in the part of a boulder that has been acted on by water charged with carbonic acid. This shows that the corrosion is still actively progressing, and that the drift is here undergoing a change which is rapid from a geological point of view. The water also washes away the fine particles of clay, and the result of the change is to alter a clay drift containing a great number of limestones with some stones of other kinds into a gravel containing chiefly these other stones.—A. G. More, F.Z.S., exhibited as a specimen recently acquired by the Natural History Museum the mountain Goat (*Mazama americana*) from the Rocky Mountains. This animal is remarkable for the abundance of its soft white hair; it has the general appearance of the goat, and its horns somewhat resemble those of the chamois.

PARIS

Academy of Sciences, December 3.—M. Blanchard, president, in the chair.—Note on the universal hour proposed by the Conference in Rome, by M. Faye. The author urges several objections against the adoption of Greenwich astronomical time and meridian, calculating the longitudes from 0 to 24h. east, which might be convenient for navigation and astronomical purposes, but unsuitable for railways, telegraphs, government offices, and the public generally. For the formula, universal time = local time − (L + 12h.), where L indicates the longitude calculated east from Greenwich, he proposes to substitute, universal time = local time − L. The formula would thus be simplified by the suppression of the last term, and, instead of Greenwich astronomical time, the civil hour would be adopted as the universal hour. Thus would be avoided the inconvenience of disagreement between local and univeral time, which would otherwise be felt precisely in the most densely peopled regions of the globe.—Remarks on M. Piarron de Mondésir's so-called mechanical problem of the two chains, by M. H. Resal.—On preventive inoculation with artificially developed charbon germs attenuated by the method of rapid heating, by M. A. Chauveau. Of a large number of sheep inoculated with germs heated to + 80° C., not one succumbed, although further tests showed that the germs themselves had lost none of their prolific vitality.—Summary reports on the results of the French mission to Cape Horn: astronomial observations by M. H. Courcelle-Seneuil; terrestrial magnetism, magnetic registers, and photographic work, by Lieut. E. Payen; magnetic observations made at Orange Bay by M. Le Cannellier; *résumé* of the meteorological observations made at Orange Bay between September 26, 1882, and September 1, 1883, by Lieut. J. Lephay.—On the absorption line produced by diluted blood in the violet and ultra-violet region of the spectrum; photographic reproduction of this line in solar light, by M. J. L. Soret.—On the secular variation in the direction of terrestrial magnetic force at Paris (continued), by M. L. Descroix.—Description of an "aëroplane" constructed for the purpose of furthering aërial navigation, by M. de Sanderval.—Supplement to a previous note on M. Tisserand's formula connected with the celestial mechanism, by M. Radau.—Determination of the mutual distances of the three masse. in the mechanical problem of the three bodies, by M. A. Lindstedt.—Theory of the ricocheting action of spherical projectiles on the surface of the water, by M. E. de Jonquières.—On the theory of Abelian integrals, by M. E. Goursat.—On a theorem of Riemann connected with the functions of independent n variables admitting $2n$ systems of periods, by MM. H. Poincaré and E. Picard.—On the geometrical curve of the fourth degree with two double points, by M. Humbert.—On the integration of a homogeneous rational function, by M. C. Stéphanos.—Measurement of the difference of potential of electric layers on the surface of two liquids in contact, one illustration (continued), by MM. E. Bichat and R. Blondlot.—On M. Desains' optical experiment: determination of the optical constants of a birefractive crystal of one axis, by M. Lucien Lévy.—Researches on the stability of solidified superfused sulphur, by M. D. Gernez.—On the artificial production of spessartine (manganesiferous garnet), by M. Alex. Gorgeu.—Experimental researches on the development and accumulation of saccharine (the phenomenon of "saccharogénie") in beetroot, by M. Aimé Girard.—On the acetate of biprimary bichloretted ethyl $\left(\begin{matrix}\mathrm{ClCH^2-CH^2}\\ \mathrm{ClCH^2-CO}\end{matrix}\right\rangle \mathrm{O}$), obtained by the reaction of the monochloretted chloride of acetyl on monochlorhydric glycol, by M. Louis Henry.—On the conditions suitable for accelerating the oxidation of siccative oils, by M. Ach. Livache.—On copper as a preservative against infectious diseases, and on the absolutely harmless character of the powders of this metal employed by workers in copper, by M. V. Burq. From his further researches the author maintains, against recent statements to the contrary, that copper undoubtedly possesses certain prophylactic properties against several infectious maladies, and especially against cholera.—Construction of the scapulo-clavicular cincture in the series of Vertebrates, by M. A. Lavocat.—On the sexual and larval polymorphism of the plumicole Sarcopidæ, by MM. E. L. Trouessart and P. Mégnin.—Researches on the physiological properties of maltose (continued), by M. Em. Bourquelot.—On the Adapisorex, a new genus of mammals occurring amongst the Lower Eocene formations of the neighbourhood of Reims, by M. V. Lemoine.—On the discovery of the genus Equisetum in the Kimmeridge clays of Bellême, department of Orne, by M. L. Crié.—On the quaternary lignites of Bois-l'Abbé, near Épinal, by M. P. Fliche.—On the remarkable sunsets observed at Paris and elsewhere in France on November 26 and 27, by M. L. Renou. The author considers that this phenomenon may be connected with a condition of the atmosphere which recurs on the same day every year. Electric disturbances have been regularly observed between November 26 and 28 ever since the shower of meteors, which occurred on November 27, 1872.

BERLIN

Physical Society, November 16.—The experiments with a view to determining the neutral point in the spectrum in the case of the colour-blind, which Dr. König communicated to the Society in March last, have since been further prosecuted by him. With the help of the apparatus, formerly described, consisting of a prism, a movable collimator, and a telescope directed towards the prism's edge, Dr. König had now succeeded in determining in thirteen different cases of colour-blindness the place of the spectrum at which these colour-blind persons felt the impression of white—of the place, namely, which appeared to them exactly of the same hue as would a surface covered with magnesia and shone upon by the light of white clouds. Each measurement was carried out eight times, and then the average taken, by which it appeared that the error in the single measurement was confined probably between ± 0·09 and ± 0·5 millionths of a millimetre. Measurements carried out with an individual for the second time after an interval of fourteen days, showed likewise the same exactness. In the case of the thirteen colour-blind persons who were examined, among them being both red- and green-blind, the neutral point lay between 491·7 and 504·7 millionths of a millimetre, wave-length. If the persons so examined were ranged in accordance with the wave-lengths of their neutral point, it was found that within the limits above specified they formed a fairly continuous series in which red- and green-blind persons took their places indiscriminately, a result in perfect agreement with former conclusions. In his first investigations into the subject, Dr. König had further found that the intensity of light exercised an influence on the situation of the neutral point, and had now further prosecuted this question by experiments on three individuals. For the graduation of the intensity of light he made use of two Nicol prisms in front of the collimator tube, and found, in the case of all three individuals, that with increasing intensity of light the neutral point approached closer to the violet end of the spectrum. Let the wave-length be taken as abscissa, and the intensity of light as ordinate, then would the curve of the neutral points form no straight line, and would, under great increase of intensity, mount upwards almost perpendicularly.—Prof. Schwalbe had in the summer of this year, as in former years, visited several glacial cavities, a branch of inquiry in which he particularly interests himself. In these investigations he took special note of the cold winds issuing from fissures and clefts of the places in question. At Questenberg, for example, in the Southern Harz, he found a place where from a fissure in a steep gypsum wall of about 100 feet high, and having a southern situation, a wind issued with a temperature of 3° C., while the temperature of the air immediately surrounding it was 20° C. warmer. The temperature in the stone fissures was found by him to be still lower, the thermometer often showing zero there, while in the cavities themselves the temperature he had generally observed (in July) was 5° C. Prof. Schwalbe brought out the fact of the great diffusion of such glacial cavities. Besides two in the Harz, he had this summer counted as many as twenty to twenty-five glacial cavities, mostly quite unknown hitherto, in the Karst Mountains on the southern frontiers of Carniola. With regard to the explanation of this phenomenon he still held by the view formerly set forth by him, that the cold was caused by the water which had been cooled to 4° C. filtering through the porous stone, and he deemed a resumption of Herr Jungk's experiments on the cooling of the trickling water necessary to a definite decision on the cause of glacial cavities.

Physiological Society, November 23.—In the cortex of the vertical lobe of the brain, Prof. Munk had, as is known, demonstrated that the separate groups of voluntary muscles had each of them a definite central area whence their movements could be induced. One part of this cortical area was recognised as the central seat of the muscles of the nape and neck, and after these two groups had been topically distinguished, Prof. Munk conjectured that the voluntary muscles of the larynx and jaws would be found to have their centre in the section of the membrane appropriate to the jugular muscles. Dr. H. Krause had put this conjecture to experimental proof, and found it confirmed. On bending back a dog's epiglottis and drawing forward its tongue, the larynx could very readily be observed by daylight, and when the jugular part of the cerebral membrane was irritated by moderate electrical currents, he invariably noticed the rise of the larynx, the movement of the chordæ vocales to a place situated in the middle between expiration and phonation, the rise of the palate, the contraction of the constrictor pharyngis, and movements of the hindermost parts of the tongue. That the part of the membrane in question was the centre of the laryngeal movements was further confirmed by experiments of extirpation which were performed successfully on both sides with ten dogs. The part of the membrane was experimented on in this way first on one side and then on the other, and after all inflammatory symptoms had disappeared, and the cerebral wounds were cicatrised or in process of cicatrisation, it was found that eight dogs had entirely lost the capability of barking, and, on attempting to bark, uttered either no sound or only a hoarse whine, such as new-born puppies emitted. In the case of the two dogs which after the operation continued capable of barking, it appeared that the excision had been made too far on the outside, or not deep enough. Some dogs which after the operation were no longer capable of barking were, after several days, killed, when Dr. Krause searched for the nerve passages, which, in consequence of the removal of the cortical part, were degenerated. In the *ganglion mamillare* he found a part of the nerve fibres in a collapsed, discoloured, and degenerated state, and concluded that the fibres extending from the membranous centre of the larynx to its motory nerves passed through this ganglion. At the invitation of the President, Prof. Munk gave a brief plan of the topography of the membrane of the cerebrum, on which were projected the different sensible and motory nerves of the separate parts of the body. On a drawing of the cerebral surface he showed the particular sites which were the centres of seeing, hearing, feeling, and motion for the muscles of the eyes and the ear, for the face, tongue, nape, neck with larynx and throat, and for the thorax. A particular locality was also pointed out for the muscles of expiration and for those of inspiration. The centres for the extremities had not yet been experimentally demonstrated, but no doubt they were situated on the inside in the large fissure of the cerebrum, where, on account of the unavoidable profuse bleeding which occurred, operations were impracticable.

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