THURSDAY, SEPTEMBER 21, 1882

PSYCHOLOGICAL DEVELOPMENT IN CHILDREN

Die Seele des Kindes, Beobachtungen über die geistige Entwickelung des Menschen in den ersten Lebensjahren. Von W. Preyer, ordentlichem Professor der Physiologie an der Universität und Director des physiologischen Instituts zu Jena, etc. (Leipzig: Th. Grieben, 1882.)

THIS is a large octavo volume, extending to over 400 pages, and consisting of daily observations without intermission of the psychological development of the author's son from the time of birth to the end of the first year, and of subsequent observations less continuous up to the age of three years. Prof. Preyer's name is a sufficient guarantee of the closeness and accuracy of any series of observations undertaken with so much earnestness and labour, but still we may remark at the outset that any anticipation which the reader may form on this point will be more than justified by his perusal of the book. We shall proceed to give a sketch of the results which strike us as most important, although we cannot pretend to render within the limits of a few columns any adequate epitome of so large a body of facts and deductions.

The work is divided into three parts, of which the first deals with the development of the Senses, the second with the development of the Will, and the third with the development of the Understanding.

Beginning with the sense of Sight, the observations show that light is perceived within five minutes after birth, and that the pupils react within the first hour. On the second day the eyes are closed upon the approach of a flame; on the 11th the child seemed to enjoy the sensation of light; and on the 23rd to appreciate the rose colour of a curtain by smiling at it. Definite proof of colour discrimination was first obtained in the 85th week, but may, of course, have been present earlier. When 770 days old the child could point to the colours yellow, red, green, and blue, upon these being named.

The eyelids are first closed to protect the eyes from the sudden approach of a threatening body in the 7th or 8th week, although, as already observed, they will close against a strong light as early as the second day. The explanation of their beginning to close against the approach of a threatening body is supposed to be that an uncomfortable sensation is produced by the sudden and unexpected appearance, which causes the lids to close without the child having any idea of danger to its eyes; and the effect is not produced earlier in life because the eyes do not then see sufficiently well. On the 25th day the child first definitely noticed its father's face; when he nodded or spoke in a deep voice, the child blinked. This Prof. Preyer calls a "surprise-reflex"; but definite astonishment (at the rapid opening and closing of a fan) was not observed till the 7th month. The gaze was first fixed on a stationary light on the 6th day, and the head was first moved after a moving light on the 11th day; on the 23rd day the eyeballs were first moved after a moving object without rotation of the head; and on the 81st day objects were first sought by the eyes. Up to this date the motion of the moving object must be slow if it is to be followed by the eyes, but on the 101st day a pendulum swinging forty times a minute was followed. In the 31st week the child looked after fallen objects, and in the 47th purposely threw objects down and looked after them. Knowledge of weight appeared to be attained in the 43rd week. Persons were first distinguished as friends or strangers in the 6th month, photographs of persons were first recognised in the 108th week, and all glass bottles were classified as belonging to the same genus as the feeding-bottle in the 8th month.

With regard to the sense of Hearing, it is first remarked that all children for some time after birth are completely deaf, and it was not till the middle of the 4th day that Prof. Preyer obtained any evidence of hearing in his child. This child first turned his head in the direction of a sound in the 11th week, and this movement in the 16th week had become as rapid and certain as a reflex. At 8 months, or a year before its first attempts at speaking, the infant distinguished between a tone and a noise, as shown by its pleasure on hearing the sounds of a piano; after the first year the child found satisfaction in itself striking the piano. In the 21st month it danced to music, and in the 24th imitated song; but it is stated on the authority of other observers that some children have been able to sing pitch correctly, and even a melody, as early as 9 months. One such child used at this age to sing in its sleep, and at 19 months could beat time correctly with its hand while singing an air.

Concerning Touch, Taste, and Smell, there is not so much to quote, though it appears that at birth the sense of taste is best developed, and that the infant then recognises the difference between sweet, salt, sour, and bitter. Likewise, passing over a number of observations on the feelings of hunger, thirst, satisfaction, &c., we come to the emotions. Fear was first shown in the 14th week; the child had an instinctive dread of thunder, and later on of cats and dogs, of falling from a height, &c. The date at which affection and sympathy first showed themselves does not appear to have been noted, though at 27 months the child cried on seeing some paper figures of men being cut with a pair of scissors.

In the second part of the book it is remarked that voluntary movements are preceded, not only by reflex, but also by "impulsive movements"; the ceaseless activity of young infants being due to purposeless discharges of nervous energy. Reflex movements are followed by instinctive, and these by voluntary. The latter are first shown by grasping at objects, which took place in Preyer's child during the 19th week. The opposition of the thumb to the fingers, which in the ape is acquired during the first week, is very slowly acquired in the child, while, of course, the opposition of the great toe is never acquired at all; in Preyer's child the thumb was first opposed to the fingers on the 84th day. Up to the 17th month there is great uncertainty in finding the mouth with anything held in the hand—a spoon, for instance, striking the cheeks, chin, or nose, instead of at once going between the lips; this forms a striking contrast to the case of young chickens which are able to peck grains, &c., soon after they are hatched. Sucking is not a pure reflex, because a satisfied child will not suck when its lips are properly stimulated, and further, the action may be originated centrally, as in a sleeping suckling. At a later stage biting is as instinctive as sucking, and was first observed to occur in the 17th week with the toothless gums. Later than biting, but still before the teeth are cut, chewing becomes instinctive, and also licking. Between the 10th and the 16th week the head becomes completely balanced, the efforts in this direction being voluntary and determined by the greater comfort of holding the head in an upright position. Sitting up usually begins about the 4th month, but may begin much later. In this connection an interesting remark of Dr. Lauder Brunton is alluded to ("Bible and Science," p. 239), namely, that when a young child sits upon the floor the soles of its feet are turned inwards facing one another, as is the case with monkeys. When laid upon their faces children at earliest can right themselves during the 5th month. Preyer's child first attempted to stand in the 39th week, but it was not until the beginning of the 2nd year that it could stand alone, or without assistance. The walking movements which are performed by a child much too young to walk, when it is held so that its feet touch the ground, are classified by Preyer as instinctive. The time at which walking proper begins varies much with different children, the limits being from 8 to 16 months. When a child which is beginning to walk falls, it throws its arms forwards to break the fall; this action must be instinctive. In the 24th month Preyer's child began spontaneously to dance to music and to beat time correctly.

A chapter is devoted to imitative movements. At the end of the 15th week the child would imitate the movement of protruding the lips, at 9 months would cry on hearing other children do so, and at 12 months used to perform in its sleep imitative movements which had made a strong impression while awake—*e.g.* blowing; this shows that dreaming occurs at least as early as the first year. After the first year imitative movements are more readily learnt than before.

Shaking the head as a sign of negation was found by Preyer, as by other observers, to be instinctive, and he adopts Darwin's explanation of the fact—viz. that the satisfied suckling in refusing the breast must needs move its head from side to side. In the 17th month the child exhibited a definite act of intelligent adjustment, for desiring to reach a toy down from a press it drew a travelling-bag from another part of the room to stand upon. We mention this incident because it exhibits the same level of mental development as that of Cuvier's orang, which on desiring to reach an object off a high shelf drew a chair below the shelf to stand upon. Anger was expressed in the 10th month, shame and pride in the 19th.

Between the 10th and 11th month the first perception of causality was observed. Thus on the 319th day the child was beating on a plate with a spoon and accidentally found that the sound was damped by placing the other hand upon the plate; it then changed its hands and repeated the experiment. Similarly at 11 months it struck a spoon upon a newspaper, and changed hands to see if this would modify the sound. In some children, however, the perception of causality to this extent occurs earlier. The present writer has seen a boy when exactly 8 months old deriving much pleasure from striking the keys of a piano, and clearly showing that he understood the action of striking the keys to be the antecedent required for the production of the sound.

The third part of the book is concerned, as already stated, with the development of the Understanding. Here it is noticed that memory and recognition of the mother's voice occurs as early as the second month; at 4 months the child cried for his absent nurse; and at 18 months he knew if one of ten toy animals were removed. In Preyer's opinion—and we think there can be no question of its accuracy—the intelligence of a child before it can speak a word is in advance of that of the most intelligent animal. He gives numerous examples to prove that a high level of reason is attained by infants shortly before they begin to speak, and therefore that the doctrine which ascribes all thought to language is erroneous.

Highly elaborate observations were made on the development of speech, the date at which every new articulate sound was made being recorded. The following appear to us the results under this head which are most worth quoting.

Instinctive articulation without meaning may occur as early as the 7th week, but usually not till the end of the first half year. Tones are understood before words, and vowel sounds before consonants, so that if the vowel sounds alone are given of a word which the child understands (13 months), it will understand as well as if the word were fully spoken. Many children before they are six months old will repeat words parrot-like by mere imitation, without attaching to them any meaning. But this "echo-speaking" never takes place before the first understanding of certain other words is shown—never, *e.g.* earlier than the 4th month. Again, all children which hear but do not yet speak, thus repeat many words without understanding them, and conversely, understand many words without being able to repeat them. Such facts lead Prof. Preyer to suggest a somewhat elaborate *schema* of the mechanism of speech, both on its physiological and psychological aspects; but this *schema* we have not sufficient space to reproduce.

Although the formation of ideas is not at first, or even for a considerable time, dependent on speech (any more than it is in the case of the lower animals), it constitutes the condition to the learning of speech, and afterwards speech reacts upon the development of ideation. A child may and usually does imitate the sounds of animals as names of the animals which make them long before it can speak one word, and, so far as Preyer's evidence goes, interjections are all originally imitative of sounds. Children with a still very small vocabulary use words metaphorically, as "tooth-heaven" to signify the upper gums, and it is a mistake to suppose that the first words in a child's vocabulary are invariably noun-substantives, as distinguished from adjectives or even verbs. As this statement is at variance with almost universal opinion, we think it is desirable to furnish the following corroboration. The present writer has notes of a child which possessed a vocabulary of only a dozen words or so. The only properly English words were "poor," "dirty," and "cook," and of these the two adjectives, no less than the noun-substantive, were always appropriately used. The remaining words were nursery words, and of these "ta-ta" was used as a verb meaning to go, to go out, to go away, &c., inclusive of all possible moods and tenses. Thus, for instance, on one occasion, when the child was wheeling about her doll in her own perambulator, the writer stole away the doll without her perceiving the theft. When she thought that the doll had had a sufficiently long ride, she walked round the perambulator to take it out. Not finding the doll where she had left it she was greatly perplexed, and then began to say many times "poor Na-na, poor Na-na," "Na-na ta-ta, Na-na ta-ta"; this clearly meant—Poor Na-na has disappeared. And many other examples might be given of this child similarly using her small stock of adjectives and verbs correctly.

According to Preyer, from the 1st week to the 5th month the only vowel-sounds used are *ü* and *a*. On the 43rd day he heard the first consonant, which was *m*, and also the vowel *o*. Next day the child said *ta-hu*, on the 46th day *gö*, *örö*, and on the 51st *arra*. All the vowel sounds were acquired in the 5th month. We have no space to go further into the successive dates at which the remaining consonants were acquired. In the 11th month the child first *learnt* to articulate a certain word (*ada*) by imitation, and afterwards repeated the taught word spontaneously. The first year passed without any other indication of a connection between articulation and ideation than was supplied by the child using a string of different syllables (and not merely a repetition of the same one) on perceiving a rapid movement, as any one hurriedly leaving the room, &c.; but this child nevertheless understood certain words (such as "Handchen geben") when only 52 weeks old. Inefficient attempts at imitative speaking precede the accurate attempts, and at 14 months this inefficiency was still very apparent, being in marked contrast with the precision whereby it would imitate syllables which it could already say; the *will* to imitate all syllables was present, though not the *ability*. At the beginning of the 14th month on being asked—"Wo ist dein Schrank?" the child would turn its head in the direction of the cup board, draw the person who asked the question towards it (though the child could not then walk); and so with other objects the names of which it knew. During the next month the child would point to the object when the question was asked, and also cough, blow, or stamp on being told to do so. In the 17th month there was a considerable advance in the use of sign-language (such as bringing a hat to the nurse as a request to go out), but still no words were spoken save *ma-ma*, *pa-pa*, &c. In the 20th month the child could first repeat words of two unlike syllables. When 23 months old the first evidence of judgment was given; the child having drunk milk which was too hot for it, said the word "heiss." In the 63rd week this word had been learnt in imitative speaking, so it required 8½ months for it to be properly used as a predicate. At the same age on being asked—"Where is your beard?" the child would place its hand on its chin and move its thumb and fingers as if drawing hair through them, or as it was in the habit of doing if it touched its father's beard; this is evidence of imagination, which, however, certainly occurs much earlier in life. At the close of the second year a great advance was made in using two words together as a sentence—*e.g.* "home, milk," to signify a desire to go home and have some milk. In the 1st month of the 3rd year sentences of three or even four words were used, as "Papa, pear, plate, please." Hitherto the same word would often be employed to express several or many associated meanings, and no words appeared to have been entirely invented. The powers of association and inference were well developed. For instance, the child received many presents on its birthday, and being pleased said "bursta" (= Geburtstage); afterwards when similarly pleased it would say the same word. Again, when it injured its hand it was told to blow upon it, and on afterwards knocking its head it blew into the air. At this age also the power of making propositions advanced considerably, as was shown, for instance, by the following sentence on seeing milk spilt upon the floor—"mime atta teppa papa oï," which was equivalent to "Milch fort (auf den) Teppich, Papa (sagte) pfui!" But it is interesting that at this age words were learnt with an erroneous apprehension of their meanings; this was particularly the case with pronouns—"dein Bett," for example, being supposed to mean "das grosse Bett." All words which were spontaneously acquired seemed to be instances of onomatopœia. Adverbs were first used in the 27th month, and now also words which had previously been used to express a variety of associated or generic meanings, were discarded for more specific ones. In the 28th month prepositions were first used, and questions were first asked. In the 29th month the chief advance was in naming self with a pronoun, as in "give me bread"; but the word "I" was not yet spoken. When asked—"Wer ist mir?" the child would say its own name. Although the child had long been able to say its numerals, it was only in this month that it attained to an understanding of their use in counting. In the 32nd month the word "I" was acquired, but still the child seemed to prefer speaking of itself in the third person.

The long disquisition on the acquirement of speech is supplemented by a chapter conveying the observations of other writers upon the same subject. This is followed by an interesting chapter on the development of self-consciousness, and the work concludes with a summary of results. There are also lengthy appendices on the acquirements of correct vision after surgical operations by those who have been born blind, and on the mental condition of uneducated deaf mutes; but we have no space left to go into these subjects. Enough, we trust, has been said to show that Prof. Preyer's laborious undertaking is the most important contribution which has yet appeared to the department of psychology with which it is concerned.

GEORGE J. ROMANES

SCLATER'S "JACAMARS AND PUFF-BIRDS"

A Monograph of the Jacamars and Puff-birds, or Families Galbulidæ and Bucconidæ. By P. L. Sclater, F.R.S., &c. 1 vol. roy. 4to, half-bound Morocco. (London: Dulau and Co., 1882.)

THE completion of another illustrated Ornithological Monograph is an event worthy of record in the columns of NATURE, although the subjects of it are, perhaps, of somewhat limited interest to the scientific world in general. "Jacamars" and "Puff-birds" are, no doubt, well-known groups to the ornithologist, but confined as they are in life to the dense forests of South and Central America, and invisible to most persons even as inhabitants of our Zoological Gardens, their names certainly do not convey any very definite ideas to the uninitiated. We will, therefore, endeavour to explain in a few words what "Jacamars" and "Puff-birds" are.

The Jacamars or family "Galbulidæ" of naturalists form a small group of birds somewhat resembling the kingfishers in general external structure, but with zygodactyle feet, *i.e.* the toes placed two before and two behind, and with brilliant metallic plumage. They inhabit the forests of America from Guatemala to Southern Brazil, and are generally met with perched upon the outer branches of the trees, and capturing their insect-prey by short flights, after which they return to their former station—like our common flycatcher. The known Jacamars are nineteen in number, referable to six genera. Of all of these species and, in most cases, of both sexes of them, full life-sized figures are given in the present work, from the artistic pencil of M. Keulemans. Of the accompanying letterpress it need only be said that it embraces an account of all the particulars yet known respecting these birds, which at the present time in several cases amounts to very little, and in nearly every instance leaves much to be done before we can be said to have anything like a perfect knowledge of them.

Of the closely allied family of the Bucconidæ or Puff-birds nearly the same may be alleged as regards our knowledge of their life-history. The dense wilds of South America need many further years of constant exploration and minute investigation before such particulars can be duly recorded. The Puff-birds are a more numerous group than the Jacamars. Mr. Sclater recognises forty-four species of the family Bucconidæ, divisible into seven genera. These are treated in exactly the same way as the Jacamars, and illustrated in a similarly artistic manner. No one we think will be likely to find fault with the life-like way in which the artist has represented the various species. Even as a picture-book the Jacamars and Puff-birds form a most attractive volume.

The work now completed is uniform in size and style with Mr. Sharpe's "Kingfishers," Messrs. Marshalls' "Barbets," and Capt. Shelley's "Sun-birds," and forms one of the same series of illustrated Ornithological Monographs prepared by different Members of the British Ornithologists' Union. Nor is the series likely to end here, for we are informed that Mr. Dresser has a companion volume on the "Bee-eaters" in a very forward state, and that other similar works are already projected.

OUR BOOK SHELF

An Illustrated Essay on the Noctuidæ of North America, with "a Colony of Butterflies." By Augustus Radcliffe Grote, A.M., &c. 8vo. (London: Van Voorst, 1882.)

THE main feature in this beautifully-got-up little book consists in the four coloured plates, which depict forty-five of some of the most charming insects of the family of moths, to which the author has devoted his special attention. The species have all been previously described, but all those who have studied *Lepidoptera* know that it is often practically impossible to identify these insects from descriptions only, and will feel grateful to Mr. Grote for the help afforded by these plates, which are very beautiful. They will likewise thank him for identifying many of the North American species "described" by Walker, according to the types in the British Museum. This process of identifying Walker's types appears likely to occupy the attention of entomologists at least to the end of the present century. The long introductory "Preface" (which forms more than a third of the entire text, and is paged continuously with it) is open to the suggestion of being too rambling in character, and of containing general matter, and polemics, foreign to the title of the book. The chapter on structure and literature will prove very useful. Here, as in the "Preface," a want of concentration in the remarks is observable. The supplementary "Colony of Butterflies" is the most successful part of the work from a literary (and perhaps also from a scientific) point of view. A curious butterfly of a genus of boreal proclivities (*Œneis semidea*) inhabits the summit of Mount Washington (in the White Mountains), above an elevation of 5600 feet to the summit (6293 feet), and is there isolated. Naturally this is associated with the glacial theory (and it might find many parallels in the Alps of Europe, &c.), and the author has contrived to give us a very instructive chapter on this subject, but we do not gather how he came to know that the "colony" first settled "about one hundred thousand years ago."

Six Months in Persia. By Edward Stack. 2 vols. (London: Sampson Low and Co., 1882.)

NOTWITHSTANDING some serious drawbacks, this work will be accepted as a useful contribution to our knowledge of a country about which much ignorance still prevails. It embodies the results of a journey made through the central provinces of Persia last year by a promising member of the Bengal Civil Service *en route* for England. By departing, wherever possible, from the beaten tracks along the main highways between the Persian Gulf and the Caspian, the traveller has succeeded in collecting much useful information regarding many districts about which very little was hitherto known. But the journey having been specially undertaken at some personal inconvenience in the interests of geographical research, it seems all the more surprising that more forethought was not shown by the explorer in qualifying himself for the task. A little time devoted to a study of the broad principles of geology and botany, as well as to the simple methods of taking altitudes, would have enabled him to turn his opportunities to far better account. As it is, these branches of science are almost entirely neglected, and the space which might have been usefully occupied, with such subjects, is too often sacrificed to trivial details irritating to the reader, and swelling the work to undue proportions. As Damávand was ascended, it would have been more satisfactory, for instance, to have checked the altitude of that famous cone (18,600 feet), taken some years ago by the Russian Caspian Survey, than to be told that at one place there were two little shrines "with small blue domes, date groves and water," at another a ruined mud fort, further on many other ruined mud forts, that one man asked him "endless questions about England which I answered to the best of my ability for the space of two hours," that another "gave me a good dinner," and so on for page after page. Nevertheless some important work, chiefly of a topographical character, was carried out and carefully recorded in the region between Shiraz and Lar, in the Saidábád and Karmán districts, in the neighbourhood of Yazd, and especially in the Bakhtari highlands west of Isfahán. Here the orography and hydrography of the Chahar Mahal and Zarda-kuh uplands were carefully surveyed, and a fresh route explored thence northwards to Gilpaigan. As, according to the latest accounts, the Bakhtari hillmen are again threatening to give trouble to the Prince-Governor of Isfahán, this information may soon prove valuable. These fierce nomads are of the same race and speech as the Kurds, who committed such havoc in the Urmia district last year, and who seem to be again preparing for fresh raids on the Turco-Persian frontier between Azerbaiján and Armenia.

In every respect the most interesting and valuable part of the work are the concluding chapters of vol. ii., in which all the fresh geographical materials are conveniently summed up, the land revenue system of Persia dealt with probably for the first time in a really satisfactory manner, and the present condition of the country made the subject of some opportune remarks. It is pleasant to learn that this venerable monarchy, so far from being "played out," is even beginning to show signs of renewed vitality. The famine-stricken districts are gradually recovering, the peculiar underground system of irrigation is being largely extended, brigandage has been almost everywhere suppressed, the governors are beginning to show some regard for the interests of the people, while many will perhaps be surprised to hear that the people themselves are, on the whole, more comfortable, better clad, and better fed than the Indian rayats. There is, of course, "much to be done in the way of governing and reducing things to order;" but notwithstanding much maladministration and many local grievances, "the progress made by Persia within the last ten years is unmistakable."

The work is supplied with a series of excellent sectional maps of the regions traversed by the explorer. But there is neither index nor a table of contents beyond the briefest chapter-headings. The stages, however, along the routes are in all cases carefully recorded, with their distances and time occupied in covering the ground.

A. H. KEANE

Notes on Chemical Calculations, with Examples, for use in the Leys School. By A. Vinter, M.A. (Batley: J. S. Newsome, 1882.)

THE selection of calculations contained in this little book, while exhibiting nothing new, is satisfactory; the notes, in so far as they are explanatory of the calculations, are clear, and to the point, but when they deal with such subjects as atoms, molecular weights, and equivalency, they become sadly confused; on these points they must, we are afraid, be very misleading to the boys who make use of this book in the Leys school.

A Pocket Guide to British Ferns. By Marian S. Ridley. (London: Bogue, 1881.)

MISS RIDLEY'S book merits its title; for it is of a most convenient size for the pocket. Whether a new book on British ferns was needed may fairly be doubted; but this little volume will be useful to many beginners. The characters of each fern are given in tabular form, each occupying a page; and the principal points of distinction are clearly brought out.

LETTERS TO THE EDITOR

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

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

A Meteorological Spectroscope

As a considerable amount of interest seems to have been awakened lately in meteorological spectroscopy, it may be of service to observers to call their attention to a form of pocket spectroscope specially adapted for this purpose which Mr. Adam Hilger, of 192, Tottenham Court Road, prepared for me some months ago. The compound triple prism of flint glass is mounted as nearly as possible at the minimum angle of deviation for "C." We thus obtain a much better view of the red end of the spectrum than with the ordinary pocket spectroscope. Mr. Hilger has also managed to secure an increased dispersion, which, with very perfect definition, enables me to see the lines in the so-called "rain-band" at "D" with great ease.

Besides the ordinary achromatic object-glass between the adjustible slit and the prisms, the spectroscope is fitted with a telescope, *i.e.* a sliding tube carrying a lens, or second object-glass, in front of the slit—proposed by Mr. Lockyer—to bring the light from external objects to a focus on it. By this means one is able to differentiate, or localise, the spectra of different parts of the sky. I feel sure that the use of the telescope would prevent people falling into some of the mistakes one sees in publications about rain-band spectroscopy.

September 14 J. F. D. DONNELLY

The New Comet

ON Sunday morning, the 17th inst., at 10.45 a.m., I found a bright comet near the sun. The nucleus was bright, stellar in appearance; the tail was about 4′ long, and brightest at the outside edges, giving a double appearance. The direction of the comet was to the centre of the sun. The comet preceded the sun's centre at 10.59 by 6m. 50s., at 12h. 0m. by 5m. 44s. The distance from the sun's limb on the parallel was at 11h. 10m, 18′ 8″ (of arc), and at 12h. 6m., 13′ 4″.

I hoped to get more and better measures, but the sky overcast, and with the exception of a short time on Monday morning, when I looked but did not see, the comet has remained so.

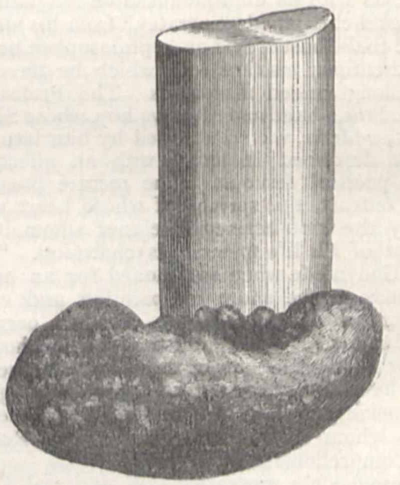
I used a helioscope of six inches' aperture.

Ealing, September 19 A. A. COMMON

Contact Makers of Delicate Action

I HAVE allowed an error to creep into the sectional elevation of the contact-maker described in your last issue. The bent wire merely *dips* into the capsule at D, and is separate from the wire, which passes up the tube. This latter wire merely forms part of the circuit, being connected with the terminal as shown in the plan. It should be noted that the plug K is only inserted when the contact-maker is being moved about. Except when this is the case, the mercury passes freely through the opening at M, and nothing but the *friction of mercury* resists the motion of the wire.

Some remarks made in the discussion on the paper have led me to carefully examine the end of the platinum wire dipping into the mercury at D. It is shown (highly magnified) in the annexed figure. This end being softened, and no doubt



End of Platinum Wire.

brought to a welding state by the heat, of which the spark is the visible evidence, has, in rapidly beating upon the mercury, been apparently hammered into this shape. The nodules upon it are probably those referred to in books on chemistry as due to the expulsion of occluded hydrogen. The result shown in the figure, produced with a strong current (15 Groves cells) and a small wire, could in practice be easily prevented.

H. S. HELE SHAW

University College, Bristol, September 15

Bobbers

IN his well-known account of the habits of the Pearly Nautilus, Rumphius (D'Amboinsche Rariteitkamer, door G. E. Rumphius, Amsterdam, 1705, p. 61) states that the animal crawls sometimes into the hoop nets set for fish or "bobbers." For a long time I have been unable to discover the meaning of the word "bobbers." It occurs in no Dutch dictionary. I inquired from several Dutch friends without success, and an appeal to *Notes and Queries* was similarly without result. On visiting Leiden this summer I asked again about the word, and my friend, Prof. Serrurier, promised to find out about it for me. He now writes that "bobber" is a Dutch mutilation of the Malay word *boeboe*, meaning a hoop-net, so that Rumphius merely adds the Malay term for the hoop-net to his statement, and does not mention some other kind of trap besides this, in which nautilus is to be caught as I had expected. This matter may seem scarcely worth troubling the readers of NATURE with, but Nautilus is so important a form, so little is known about its habits, and naturalists so eagerly look forward to the day when it shall be caught somewhere in numbers, and its developmental history worked out, that every statement as to possible modes of trapping it is of importance. It is just possible that suitably baited lobster pots or hoop-nets, used in depths of 100 fathoms or thereabouts, might be found efficacious.

H. N. MOSELEY

PROFESSOR HAECKEL IN CEYLON[1]

V.

THE long account of his six week's stay in Belligam (or Bella Gemma, "schöner Edelstein" as, in defiance of etymology he delights to call it) contributed by Professor Haeckel to the September number of the *Deutsche Rundschau* will be disappointing only to those who imagine that the theoretical and scientific results of such a visit can be analysed, combined and presented to the public within the compass of an article and in a sufficiently popular form to interest the readers of a magazine devoted to general literature.

All, whether scientific or not, will find interest in the graphic and spirited account of Belligam, its Rest-House, its inhabitants, and the surrounding nature, animate and inanimate, which is here presented to us. The Rest-House keeper with an unpronounceable Singhalese name Prof. Haeckel christened "Socrates," from his striking resemblance to the bust of that great philosopher, heightened by the sententious maxims with which he flavoured his somewhat long-winded discourses. The Professor's devoted attendant, a handsome Rodiya boy, whose Singhalese name, Gama-Meda, was classicised by him into "Ganymede," is described in detail with an affection that rises into poetical fervour. The picture presented by this poor outcast, the springs of whose heart were first opened by the kind-hearted foreigner whom it became the delight of his life to serve, is charming. "Who so happy as Ganymede when summoned for an expedition to the woods or the shore for painting and collecting, hunting and shooting? When, on such occasions, I allowed him to carry the paint-box or the photographic camera, or to sling the gun or the botanical case over his shoulder, he would stride after me, his face aglow with delight, looking proudly around on the wondering villagers, to whom such favour shown to a Rodiya was utterly incomprehensible.

"To Ganymede's unwearied skill and zeal I owe the most highly prized objects of my collection. With the sharp eye, the cunning hand, and the flexible agility of all Singhalese youths, he could catch the fish as it swam, the butterfly as it flew, and would bound into the thickest jungle, or climb the loftiest trees like a cat, in search of the prey that had fallen to my gun."

Another pleasant figure, standing out sharp and clear among Professor Haeckel's memories of Belligam, is that of the second chief, or headman of the village, the Arachy Abayawira. His superior character and acquirements were known to the government agent of the southern province, who had given the Professor a special introduction to him.

[1] Continued from p. 390.

"I found the Arachy," he says, "an unusually intelligent and enlightened man, of about forty years of age, with a circle of interests and an amount of knowledge far beyond those of his fellow-countrymen in general. The prevailing stupidity, laziness, and indifference of the Singhalese gave place in him to a lively interest in education, and a genuine wish to extend its advantages to all within the range of his influence. He spoke English fairly well, and expressed himself with a natural good sense, and a clearness of judgment which often surprised me.

"Indeed, the Arachy might claim the title of a philosopher, in a higher sense than that of old Socrates at the Rest House, and I recall with lively pleasure our many and earnest conversations on subjects the most varied and comprehensive. He was free from the superstition and fear of evil spirits which universally prevail among his Buddhist fellow-countrymen, and with open eyes for the wonders of Nature and their explanation by natural laws; he had worked his own way to the position of a free-thinker, prepared to receive with delight the explanations of many of the riddles of Nature which my better knowledge enabled me to give him. I seem to see him still, a fine, dignified, bronze-coloured figure, with regular expressive features, and an eye that lighted up with intelligence as I instructed him on some of the phenomena of Nature; and I seem still to hear his gentle, vibrating voice, as he modestly and respectfully asked my explanation of this or that problem which had puzzled him. The highest and most amiable qualities of the Singhalese national character, a gentle and impressionable temper, and a natural intelligence were developed in the Arachy in the most attractive degree; and when, looking back, I seek to repeople my verdant Paradise with the slender bronze figures of its inhabitants, the images of the Arachy and Ganymede rise before me as their ideal types."

The section of his article headed by the Professor "A Zoological Laboratory in Ceylon," will be read by his fellow collectors, and, indeed, by all who appreciate perseverance in spite of obstacles, and entire devotion to a scientific object, with feelings of lively sympathy mingled with admiration. The difficulties arising from want of furniture and appliances, from the absence of all skilled assistance, from destructive insects, and above all, from the climate of Ceylon, were such as would have daunted any less ardent believer in the cause for which he laboured. We wish that we had space to extract at length for the benefit of youthful experimenters the Professor's account of his improvised tables, cabinets, and shelves, and of the semi-despairing resignation with which, after a long day's collecting, he would empty the contents of his jars and glasses to find nine-tenths of his treasures dead before their time from the heat and moisture of the air, and useless as specimens. Another infliction which he seems to have borne with admirable patience consisted in the intrusive curiosity of the natives, who crowded uninvited into his work-room, or thronged round him on his return from a fishing expedition, often causing him to lose the precious minutes which would have saved some of his half dead specimens. The Arachy's explanation that all the white sand and queer little fishes contained in the glasses and jars were to be used to increase knowledge in the world was received with derision by the villagers, the more simple of whom believed that the stranger was inventing a new dish of curry, while the wise-heads looked upon him as a European madman. The want of glass windows was another serious drawback to the preservation of the collection when once safely housed. The green wooden jalousies, which are universal in Ceylon, kept the room too dark for work with the microscope, while admitting an amount of wind and dust (not to mention the more serious incursion of hosts of insects) very detrimental to the specimens and instruments. All these hindrances and others notwithstanding, Prof. Haeckel amassed at Belligam materials for the study of a lifetime, and even obtained some consolation from finding confirmation of the fact which has recently been strikingly demonstrated by the *Challenger* expedition, namely, that life does not exist in anything like the same diversity of form in different oceans as on different continents; and that in essential features the marine fauna of one tropical coast differs very little from that of another. The account which Prof. Haeckel gives at some length of the daily routine of his life in Belligam is interesting. The Professor begins by congratulating himself on this accident of position as affording him twelve clear working hours in the day.

"I rose," he says, "regularly before the sun, and had enjoyed my first morning bath by the time he showed himself from behind the palm-woods of Cape Mirissa, exactly opposite my Rest-House. As I stepped on to the verandah to enjoy the sudden awakening of the glorious day, I was sure of finding Ganymede with an open cocoa-nut of sweet, cool milk, than which there could be no more refreshing morning drink. William, in the meantime, was shaking my clothes free from the millipeds, scorpions, and other insects, which had crawled into their folds during the night. Then came Socrates and served me with tea, accompanied by a bunch of banana fruit and the maize bread of the country. My usual beverage, coffee, is, strange to say, so bad in Ceylon as to be undrinkable, principally because the extreme moisture of the climate prevents the berry from drying properly.

"At seven o'clock my boatmen appeared to carry down my nets and glasses for the daily canoe expedition. This lasted from two to three hours, and on my return I busied myself in disposing my captures in glasses of different sizes, and saving such as could be saved among the few survivors. The more important specimens were microscoped and drawn at once. Then I had my second bath, and at eleven o'clock appeared my so-called 'breakfast,' consisting chiefly of curry and rice. The rice was simply boiled, but in the preparation of the curry my old cook, Babua, exerted all the ingenuity with which nature had endowed his diminutive brain to present me with a fresh combination every day. Sometimes the curry was 'sweet,' sometimes 'hot;' sometimes it appeared as an undefinable *mixtum compositum* of vegetables, sometimes as a preparation of the flesh of various animals. Babua seemed to divine that as a zoologist I was interested in every class of animal life, and that he could not do better than turn my curry into a sort of daily zoological problem. . . . He was apparently a staunch upholder of the theory of the near relationship of birds and reptiles, and held it to be immaterial what particular species of *Saurian* were prepared for the table.

"Fortunately for my European prejudices, I only became acquainted by degrees with the zoological variety of my daily dish of curry; usually not until I had swallowed a considerable portion of it in silent resignation. . . . My great resource as an article of diet was the fruit which abounded at every meal and made up for all that I suffered from Babua's curries. Next to the bananas of every variety, of which I consumed several at every meal, my standing dessert consisted of mangoes (*Mangifera indica*), egg-shaped green fruit, from three to six inches long; their cream-like golden pulp has a faint but distinct aroma of turpentine. The fruit of the passion-flower (*passiflora*) was very pleasant to my taste, reminding me of the gooseberry. I was less pleased with the renowned custard-apple, the scaly fruit of the *Annona squamosa*, and with the Indian almond, the hard nut of the *Terminalia catappa*. There are singularly few apples and oranges in Ceylon; the latter remain green, and are sour and not juicy; but the want of cultivation is doubtless chiefly answerable for the inferiority of this and other fruits; the Singhalese are far too easy-going to make any progress in horticulture. Refreshed with my modest repast, I employed the hot hours of mid-day—from twelve to four o'clock—in anatomical or microscopic work, in making observations and drawings, and in the preservation and storing of my collected objects. The evening hours, from four to six o'clock, were generally occupied with some lovely country excursion; sometimes I made a water-colour sketch, sometimes I sought to perpetuate one of the beautiful views in photography. Now and then I shot apes and birds in the woods, or collected insects and snails, or hunted among the coral reefs on the shore, adding many curious objects to my collection. Richly laden, I return to the Rest House an hour or less before sunset, and worked for another hour at the preservation and arrangement of my specimens. At eight o'clock, my second chief meal, or dinner, was served. The *pièce de résistance* at this was again the inevitable curry and rice, followed sometimes by a fish or a crab, which I enjoyed immensely, and then by some dish composed of eggs or meal, and finishing again with delicious fruit. . . . The important question of 'what to drink,' seemed likely at first to prove a difficult one. The ordinary drinking water of the lowlands of Ceylon is considered very bad and unwholesome, the highlands, on the contrary, being rich in springs of the purest and freshest water. The great rains which fall daily on the island bring down a mass of mineral and vegetable deposit into the rivers and the stagnant water of the lagoons is not unfrequently in communication with them. It is not customary to drink the water unless boiled or made into tea, or with the addition of claret or whisky. My friend Scott had given me an abundant supply of the last-named beverage, but on the whole, I found no drink so pleasant and refreshing as well as wholesome, as the fresh milk of the cocoa-nut.

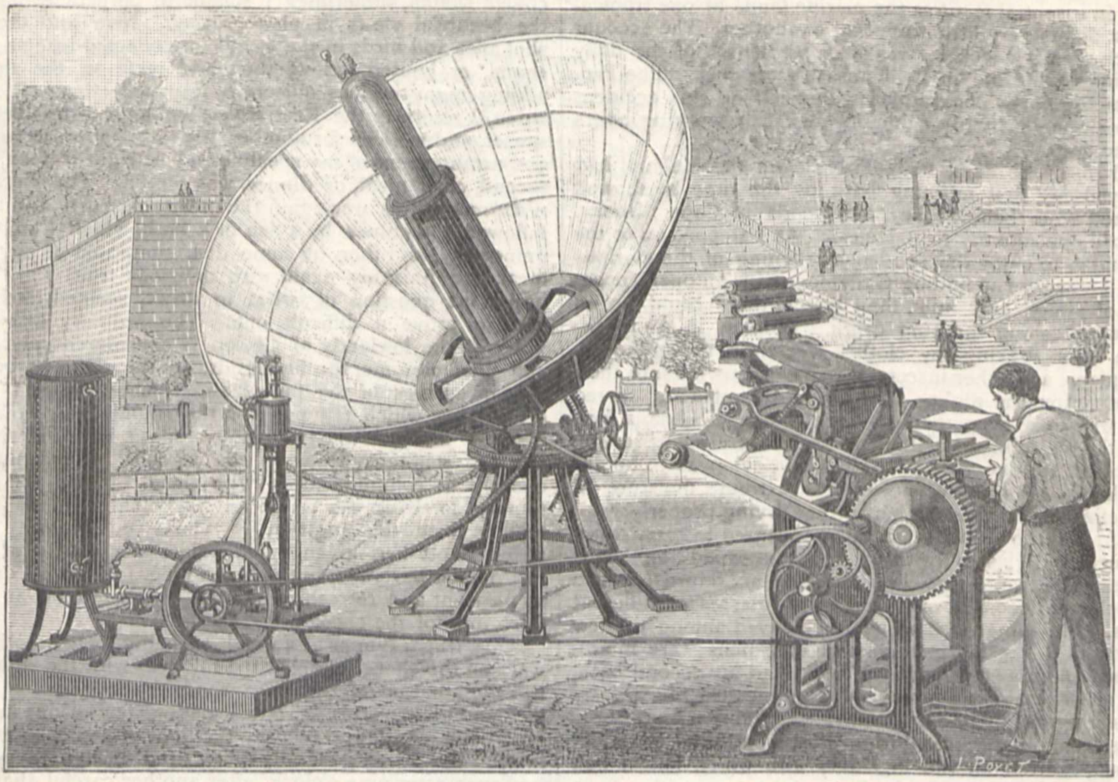
"My frugal dinner at an end, I usually took a solitary walk on the shore, or delighted my eyes with the sight of the illumination of the palm woods by myriads of fire-flies and glow-worms. Then I made a few entries in my note-book, or tried to read by the light of a cocoa-nut oil lamp. But I was generally quite tired enough to go to bed soon after nine o'clock, after another careful shaking of the clothes for the expulsion of scorpions and millipeds.

"The great black scorpion (nearly a foot long) is so common in Ceylon that I once collected half a dozen in the course of an hour. Snakes exist also in great numbers. Slender green tree-snakes hang from almost every bough, and at night the great rat-snake (*Coryphodon Blumenbachii*) hunts rats and mice over the roofs of the huts. Although they are harmless and their bite not poisonous, it is by no means a pleasant surprise when one of these rat-snakes, five feet long, suddenly drops through a hole in the roof into one's room, occasionally alighting on the bed.

"On the whole, however, my nights in Belligam were but little disturbed by animal intruders, although I was often kept awake by the howling of jackals and the uncanny cry of the Devil-bird (a kind of owl, *Syrnium Indrani*) and other night-birds. The bell-like cry of the pretty little tree-frogs which make their dwelling in the cups of large flowers, acted rather as a slumber song. But I was far oftener kept awake by the whirl of my own thoughts, by the recollection of the many events of the past day, and the anticipation of that which was to come. A brilliant succession of lovely scenes, of interesting observations and varied experiences mingled in my brain with plans of fresh enterprise and new discoveries for the morrow."

A SOLAR PRINTING PRESS

IT was mentioned in a recent number of this journal that a printing press worked by solar heat had been exhibited in the Tuileries Garden in Paris on the occasion of a *fête*. We are enabled to give some particulars of the contrivance from an account published in *La Nature*, from which the accompanying illustration is borrowed by permission of the editor. The solar generator was one of those devised by M. Abel Pifre, who has improved in some points on the original invention of M. Mouchot. The insolator, shown in the middle of the picture, measured 3·50 m. diameter at the aperture of the parabolic mirror. It was set up in the garden, near the large basin, at the foot of the flight of steps of the Jeu de Paume. The steam from the boiler placed in its focus



A Solar Printing Press.

was utilised by means of a small vertical motor (shown on the left), having a power of 30 kilogrammetres, which actuated a Marinoni press (on the right). Though the sun was not very ardent, and the radiation was hindered by frequent clouds, the press was worked with regularity from 1 p.m. till 5.30 p.m., printing on an average 500 copies an hour, of a journal specially composed for the occasion, viz., the *Soleil Journal*. This result, though not indicating a revolution in the art of printing, may enable one to judge of the services these *insolators* may render in climates with a radiation more powerful and constant.

NOTES ON THE AYE-AYE OF MADAGASCAR

HAVING recently passed through that part of Madagascar which is the habitat of the Aye-aye, and having made careful inquiries from the Malagasy respecting the habits of this strange creature in its native haunts, I have thought that the information gained might be of interest to the readers of NATURE, and therefore note down the result of my inquiries.

The Aye-aye lives in the dense parts of the great forest that runs along the eastern border of the central plateau of the island, but only in that part of it which separates the Antsihànaka province from that of the Bétsimisàraka, and which is about twenty-five miles from the east coast, in latitude 17° 22′ S., or thereabouts. Possibly there are other parts of the country where the Aye-aye is found; but so far as my knowledge extends—and I have made inquiries in different parts of the island—this is the only region where the creature finds its home. In Carpenter's "Zoology" the Aye-aye is said to be "very rare in its native country"; and Mr. Gosse in one of his books conjectures that it is probably nearly extinct; but, from what I gathered from the natives, it seems to be pretty common, its nocturnal habits and the superstitious awe with which it is regarded (and of which I shall presently speak), accounting for its apparent rarity.

The native name of the animal is Haihay (Hīhī); but this is not derived from the "exclamations of surprise" which the natives "exhibited at the sight of an unknown animal," but is simply onomatopœetic, the creature's call being "Haihay, Haihay." The animal, as is well known, is nocturnal in its habits, prowling about in pairs—male and female. It has but one young one at a birth. It builds a nest of about two feet in diameter, of twigs and dried leaves, in the dense foliage of the upper branches of trees. In this it spends the day in sleep. The nest is entered by a hole in the side.

The teeth are used in scratching away the bark of trees in search of insects, and the long claw in dragging out the prey when found. A white insect called *Andraitra* (possibly the larva of some beetle) seems to form its chief food. I was told that it frequently taps the bark with its fore feet, and then listens for the movement of its prey beneath, thus saving itself useless labour. It does not flee at the sight of man, showing that for generations it has not been molested by him; which is indeed true, as the following will show. The natives have a superstitious fear of the creature, believing that it possesses some supernatural power by which it can destroy those who seek to capture it, or do it harm. The consequence of this is that it is with the greatest difficulty one can obtain a specimen. With most of the people no amount of money would be a sufficient inducement to go in pursuit of the creature, "because," say they, "we value our lives more than money." It is only a few of the more daring spirits among them who, knowing the *òdiny*, *i.e.* the secret by which they can disarm it of its dreaded power, have the courage to attempt its capture. Occasionally it is brought to Tamatave for sale, where it realises a good sum. Now and then it is accidentally caught in the traps which the natives set for lemurs, but the owner of the trap, unless one of those versed in the Aye-aye mysteries, who knows the charm by which to counteract its evil power, smears fat over it, thus securing its forgiveness and goodwill, and then sets it free. The story goes that occasionally, when a person sleeps in the forest, the Aye-aye brings a pillow for him—if a pillow for the head, the person will become rich; if for the feet, he will shortly succumb to the creature's fatal power, or at least will become bewitched. Such is the account which the natives give of the curious *Cheiromys Madagascariensis*.

R. BARON,
L.M.S. Missionary

Antananarivo, Madagascar, April, 1882

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

(FROM A CORRESPONDENT)

THIS body held its thirty-first annual meeting at Montreal during the week beginning August 23, under the presidency of Dr. J. W. Dawson, LL.D., F.R.S. Ample accommodation for the Association was found in the buildings of McGill University, and the attendance was very large, 939 persons having been registered. Besides the American and Canadian Fellows and Members of the Association, there were several guests from abroad, among them, Dr. W. B. Carpenter, Dr. J. H. Gilbert, Prof. Wiltshire, and Dr. Phené, of London; Dr. Samuel Haughton and Prof. Fitzgerald from Dublin, together with Messrs. Szabo of Budapest, Kowalesky of Moscow, and König of Paris, all of whom made communications to the Association.

After the opening ceremonies on the morning of the first day, the nine sections into which the Association is now divided listened to the addresses of their respective vice-presidents. These sections are as follows:—A. Mathematics and Astronomy; B. Physics; C. Chemistry; D. Mechanical Science; E. Geology and Geography; F. Biology; G. Histology and Microscopy; H. Anthropology; and I. Economic Science and Statistics. According to custom, the retiring president of the Association, Dr. George J. Brush, gave his address on the first Wednesday evening, taking for his theme, The Progress of American Mineralogy. This was followed by a reception of the Members of the Association by the Local Committee, its chairman, Dr. Sterry Hunt, acting as host. On Thursday evening the New Redpath Museum of Natural History, lately erected at a cost of 100,000 dollars by Mr. Peter Redpath, and by him presented to the University, was formally opened with addresses by Mr. James Hall and Dr. W. B. Carpenter, a reception being given therein by the President and Mrs. Dawson to the Association and others. Thursday and Friday were devoted to the work of the sections, but Saturday was given to excursions to Ottawa and to Quebec, in both of which cities entertainments were provided by the citizens. Public lectures were given on Monday and Tuesday evenings by Dr. W. B. Carpenter and Prof. Meville Bell, on The Temperature of the Deep Sea, and On Visible Speech. The reading of papers, however, occupied both the morning and afternoon of these days, and of Wednesday the 30th, on the evening of which day the closing meeting was held, the Association adjourning to meet next August at Minneapolis, in Minnesota, under the presidency of Dr. C. A. Young, of Princeton, New Jersey. The number of papers entered was 256, of which nearly all were read either at length or in abstract, and will be published in the Proceedings.

In addition to the excursions already noticed was one provided by the Harbour Commissioners, and another through South-eastern Canada, to Lake Memphramagog at the close of the meeting. An entertainment in the galleries of the Montreal Fine Art Association should also be mentioned, and various garden parties and *fêtes* by the citizens, who vied with each other and with the railways and steamboat lines in their hospitalities to the members of the Association.

Mention should here be made of a Handbook of Montreal, an illustrated volume of 159 pages, prepared for the meeting by Mr. S. E. Dawson, of the Local Committee, and presented to the members. This little book is remarkable for its excellent historical introduction, and also for a valuable coloured geological map of the environs of the city, prepared by Dr. Sterry Hunt.

After the meeting a small party, including Dr. Carpenter, Prof. Wiltshire, and Dr. Szabó, were conducted by Dr. J. W. Dawson and Dr. Sterry Hunt to the remarkable locality of *Eozöon Canadense*, near St. André Avellin, among the Laurentide Hills, not far from the City of Ottawa.

PROFESSOR PLANTAMOUR

THE daily journals notify the decease on the 7th instant, at Geneva, of Prof. Plantamour, for many years Director of the Observatory and Professor of Astronomy in the University of that city.

Emile Plantamour was born at Geneva in 1815, and received his early education in the old college founded by Calvin. He entered the Geneva Academy in 1833, where he became a pupil of Alfred Gautier, then in the Chair of Astronomy, and on graduating, adopted this science as his profession. He studied two years at Paris under Arago, and subsequently proceeded to Königsberg, where he became a pupil of the illustrious Bessel. His inaugural dissertation was upon the methods of calculating the orbits of comets, and he obtained the degree of Doctor in 1839. He subsequently visited Berlin where Encke was then one of the great masters of astronomical science of the day. On returning to Geneva he was appointed Professor of Astronomy and Director of the Observatory; these positions he continued to occupy nearly up to the time of his decease. The observations made under his direction were published in various parts, commencing in 1843, and related to astronomy, magnetism, and meteorology. He took part in a number of geodetical operations in Switzerland, and was the representative of Geneva on the Swiss Geodesic Commission.

Plantamour was a man of considerable private means, and hence was independent of the very modest salary attaching to his official position. A few years since he presented a 10-inch refractor to the Observatory of Geneva, and a building suitable for it was erected at his expense. This instrument has already done good work in the hands of Dr. Meyer. Plantamour devoted much attention to cometary astronomy, one of his most elaborate investigations being his determination of definitive elements of Mauvais' comet of 1844, which was observed from July 7 in that year, to the middle of March, 1845, and therefore offered a favourable opportunity for the calculation of the true form of orbit. Plantamour's result was a somewhat notable one: after taking into account the effect of the attraction of the planets during the comet's visibility, he concluded that at the passage through perihelion in October, 1844, the comet was moving in an elliptical orbit with a period of revolution of 102050 ± 3090 years. In 1846 he made extensive calculations bearing upon the motion of the two heads of Biela's comet, the results of which will be found in No. 584 of the *Astronomische Nachrichten*. He further discussed the elements of what was called at the time "Galle's second comet," 1840 II. (*Astron. Nach.*, No. 475-6). In this paper he pointed out some anomalies in the intensity of the comet's light, similar to what has been observed from time to time in other comets.

Plantamour was placed on the list of Associates of the Royal Astronomical Society in 1844; he was a corresponding member of the Academy of Sciences of the Institute of France, and honorary member of the Academy of Turin. Few of those colleagues who were at work at the commencement of his astronomical life now remain.

ON SIR WILLIAM THOMSON'S GRADED GALVANOMETERS

TWENTY years ago the experimental sciences of electricity and magnetism were in great measure mere collections of qualitative results, and, in a less degree, of results quantatively estimated by means of units which were altogether arbitrary. These units, depending as they did on constants of instruments and conditions of experimenting which could never be made fully known to the scientific public, were a source of much perplexity and labour to every investigator, and to a great extent prevented the results which they expressed from bearing fruit to the furtherance of scientific progress. Now happily all this has been changed. The absolute system of units introduced by Gauss and Weber and rendered a practical reality in this country by the labours of the British Association Committee on Electrical Standards has changed experimental electricity and magnetism into sciences of which the very essence is the most delicate and exact measurement, and enables their results to be expressed in units which are altogether independent of the instruments, the surroundings, and the locality of the investigator.

The record of the determinations of units made by members of the Committee, for the most part by methods and instruments which they themselves invented, forms one of the most interesting and instructive books in the literature of electricity, and when the history of electrical discovery is written the story of their work will form one of its most important chapters. But besides placing on a sure foundation the system of absolute units, they conferred a hardly less important benefit on electricians by giving them a convenient nomenclature for electrical quantities. The great utility of the practical units and nomenclature, which the Committee recommended, soon became manifest to every one who had to perform electrical measurements, and has led within the last year to their adoption, with only slight alterations, by nearly all civilised nations. Although it is not yet quite twelve months since the late Congress of Electricians at Paris concluded its sittings, the recommendations which it issued have been widely adopted and appreciated by those engaged in electrical work, and have thus begun to yield excellent fruit by rendering immediately available for comparison and as a basis for further research the results of experimenters in all parts of the world. Soon even the ordinary workmen in charge of dynamo machines or employed in electrical laboratories will be able to tell the number of volts and amperes which a generator can give at a certain speed and under certain conditions, to determine the number of amperes of current required to light an incandescence lamp to its full brilliancy, or to measure the capacity of a secondary cell in coulombs per square centimetre.

But in order that the full benefit of the conclusions of the Paris Congress may be obtained it is essential in the first place that convenient instruments should be used, adapted to give directly, or by an easy reduction from their indications the number of amperes of current flowing in a particular circuit, and the number of volts of difference of potentials between any two points in that circuit. To be generally useful in practice these instruments should be easily portable, and should have a very large range of sensibility; so that, for example, the instrument, which suffices to measure the full potential produced by a large Siemens or Edison machine, may be also available for testing, if need be, the resistances of the various parts of the armature and magnets by the only satisfactory method; namely by comparing by means of a galvanometer of high resistance the difference of potential between the two ends of the unknown resistance with that between the ends of a known resistance joined up in the same electrical circuit. In like manner the ampere measurer should be one that could be introduced without sensible disturbance into a circuit of low resistance to measure either a small fraction of an ampere, or the whole current flowing through a circuit containing a large number of electric lamps. These conditions are fulfilled by two instruments recently invented and patented by Sir William Thomson and called by him Graded Galvanometers. To give a short account of these instruments is the object of the present article.

I. The Potential Galvanometer.

The galvanometer used for measuring differences of potential in electrical circuits is shown in Fig. 1 which is engraved from a photograph of the actual instrument. It consists of two essential parts, a coil and a magnetometer. The coil is made of silk covered copper or German silver wire of No. 32 B.W.G. When made of German silver wire it contains about 2,200 yards of wire wound in 7,000 turns, and has a resistance of over 6,000 ohms. It is made in the form of an anchor ring having an outside diameter of fourteen centimetres and an inside diameter of six centimetres. The diameter of section is thus four centimetres. The coil is wound within a mould of proper shape and dimensions, and is then impregnated with melted paraffin under the receiver of an air-pump. A solid compact ring is thus obtained, which does not require a wooden case; and which served round with a covering of silk ribbon looks well and is not at all liable to get out of order. The coil thus constructed is attached to one end of the horizontal wooden platform P shown in the drawing, and kept firmly in its place by a pair of wooden clamps fitted to the lower half of the coil, and screwed firmly to the end of the platform. When in position the plane of the coil is vertical, and at right angles to a V groove that runs along the middle of the platform. The centre of the coil is opposite to and about one and a half centimetres above the bottom of this groove.

On the platform P rests the magnetometer M (shown in plan in Fig. 2), which consists essentially of a system of magnets properly supported so as to be free to turn round a vertical axis, and shielded from currents of air by being enclosed in a quadrantal shaped box having a closely fitted glass cover. Each magnet is fully one centimetre in length, and is made of glass-hard steel wire of No. 18 B.W.G. Four of these magnets mounted in a frame with their poles turned in similar directions from the "needle" of the instrument. The frame carrying the magnets is made of two thin bars of aluminium placed side by side with their planes vertical and about a centimetre apart; and connected by a bridge of sheet aluminium. The ends of the magnets are fixed in holes in the vertical sides of the aluminium frame so that the four steel needles form a set of four horizontal parallel edges of a rectangular prism.

In the bridge connecting the two sides of the frame a sapphire cap is fixed, and this rests on an iridium-tipped point standing up from the bottom of the containing box. The sides of the frame are made long enough to form when brought together at one end an index about nine centimetres long of the shape shown in Fig. 2. The point of the index ranges round a scale of tangents placed round the curved edge of the bottom of the box. To prevent error from parallax the bottom of the box, with the exception of the narrow strip occupied by the scale, is covered with a mirror of silvered glass. The observer when taking a reading places his eye in such a position that the point of the index just covers its reflected image, and reads off the deflection indicated by the position of the point of the index on the scale of tangents. The scale is engraved on paper, and firmly fixed to the bottom of the box by photograper's glue; and thus any change of length due to varying amount of moisture in the atmosphere is avoided.

The magnetometer box rests on three feet and a flat spring. Two of these feet, which are in a plane perpendicular to the plane of the box and passing through the supporting point and the zero of the scale, slide in the V groove cut along the middle of the platform: the third foot rests on the plane surface on one side of this groove, the spring on the other side. By this arrangement the magnetometer is rendered perfectly steady and can be moved with perfect freedom along, but only along the platform. A small circular level carried by the box shows when the plane of the magnetometer is horizontal. This adjustment is made by means of the two screws which support the platform at the end remote from the coil.

To lift the system of magnets and index off the bearing cap when the instrument is not being used, or when it is being carried from one place to another, a small collar-piece free to move round the supporting point is raised up by a horizontal screw turned by a head outside the magnetometer box. When raised this collar-piece forms a supporting platform for the needles and securely prevents them from moving about and sustaining damage.

To increase the directive force on the needles when required, the semi-circular magnet shown in the drawing is used with the instrument. This magnet is made of the best steel, and is tempered glass-hard. It is magnetised by sending a current through a semi-circular coil containing it. When in position on the instrument it is supported on two flat pieces of brass projecting from the radial sides of the magnetometer box. The magnet terminates at one end in a cross piece of brass having on its under side at one end a small projecting brass knob. This knob fits into a hollow in one of the projecting arms of brass, while the other end of the cross piece rests simply on the plane surface of the arm. The other end of the magnet is brought to a rounded point which rests in a V notch cut round a cylindrical shoulder on a screw spindle (seen on the right-hand side of Fig. 2), which works through a nut fixed to the other projecting arm of the magnetometer box. The magnet thus rests with its magnetic axis as nearly as may be in the horizontal plane through the axis of the needle, and nearly at right angles to the line joining the centre of the needle's axis with the zero of the scale. Its axis may be placed accurately at right angles to this line by turning the screw until the needle points accurately to zero. The magnet thus mounted remains in the same position relatively to the magnetometer.

The coil is so adjusted that its centre is on a level with the magnetic axis of the needle when the magnetometer is in position. The centre of the magnetic axis, the zero of the scale, and the horizontal V groove in the platform are in the vertical plane through the centre of the coil. Hence if the magnetometer guided by its feet in the V groove be moved along the platform it will carry its magnet with it without disturbing its zero adjustment of the needle, and the magnets will in every position of the magnetometer be in the same field of force.

On the boxwood slip in which the V groove is cut is marked a series of positions of the front or circular edge of the magnetometer, for which the corresponding numbers of divisions of deflection for one volt difference of potentials, when the intensity of the magnetic field at the needle is one C.G.S. unit, are the terms of the geometric series . . . 8, 4, 2, 1, $\frac{1}{2}$ . . . These numbers are stamped on the boxwood slip opposite the marks indicating the corresponding positions. The number of divisions of deflection for the nearest position of the magnetometer, that at which the centre of the magnetic axis of the needle is as nearly as may be at the centre of the coil, is not generally a term of this series, but it is determined in every case, and like the others is stamped on the platform.

The instrument is used for the measurement of high potentials with the semicircular magnet in position; but for low potentials the magnet is dispensed with, and the needle left under the earth's directive force alone. The field intensity given by the magnet of each instrument is determined before the instrument is sent out, and is painted on the magnet. The intensity of the field without the magnet, at the place at which the instrument is used has if necessary to be determined. In practice it will generally be found convenient to use some position of the magnetometer which gives a convenient number of divisions of deflection per volt for the field employed. This position is determined by the user of the instrument, who marks it on the platform by drawing two vertical lines on the sides so as to prolong two white lines which are marked on the sides of the magnetometer.

The instrument as thus constructed admits of a very wide range of sensibility. By diminishing the distance of the magnetometer from the coil from the greatest to the least, the sensibility of the instrument can be increased fifty fold: and by removing the field magnet from the instrument and leaving the needle under the influence of the earth's force alone, a sensibility fifty times still greater can be given to it. For the practical purposes for which these instruments are designed the suspension of the needle by cap and point is the most convenient; but with this suspension there is always, with low directive forces, a slight error due to friction: and it is therefore not advisable to push the sensibility of the instrument further by diminishing the directive force of the earth's magnetism. An instrument of this kind, however, made for special purposes with a silk fibre suspension could be rendered more and more sensitive up to the limit of instability by so placing a magnet or magnets as, while not interfering with the uniformity of the field at the needles, to diminish more and more the earth's directive force. This method of increasing the sensibility of a galvanometer although quite commonly used by scientific electricians is not, I have reason to believe, at all well-known generally, and recourse is had, altogether unnecessarily in many cases, to troublesome astatic combinations in order to obtain sensibility.

An important feature of this instrument in connection with its use for the measurement of high potentials is the arrangement of terminals which has been adopted. In certain circumstances when the ends of the coil of a potential galvanometer are attached to terminals fitted with binding screws, it is convenient to connect the instrument with the circuit by wires attached to these screws; but in the case of a dynamo circuit giving between the terminals of the coil a potential difference of eighty or a hundred volts and upwards, this plan of connections has been found highly dangerous. If the wires are twisted together and are ordinary gutta percha covered wires there is always a liability to accidents which may cause conduction from one wire to the other, and the destruction of the wires. Again the ends of the wires are almost sure when removed from the instrument to be left dangling either in contact, or so as to be easily brought into contact inadvertently by a passer by, with the certain result if the dynamo is running, of the immediate fusing of the wires. To prevent the possibility of such an accident Sir William Thomson has used as terminals for the coil two strong strips of copper about 1½ cms broad which stand up vertically facing one another about a centimetre apart, within a vertical cavity in the wooden block behind the coil. To prevent any current from flowing through the coil except when a reading is being taken, the small spring contact key, shown behind the coil in Fig. 1, is inserted between one of these terminals and the coil. The leads for connecting the instrument with the circuit have their ends brought together so as to terminate in two parallel strips of stout copper kept apart by a piece of wood and held in position by a good serving of strong waxed cord. The two copper strips with the piece of wood between them have their ends turned down at right angles to their length, and when connection is to be made are pushed down into

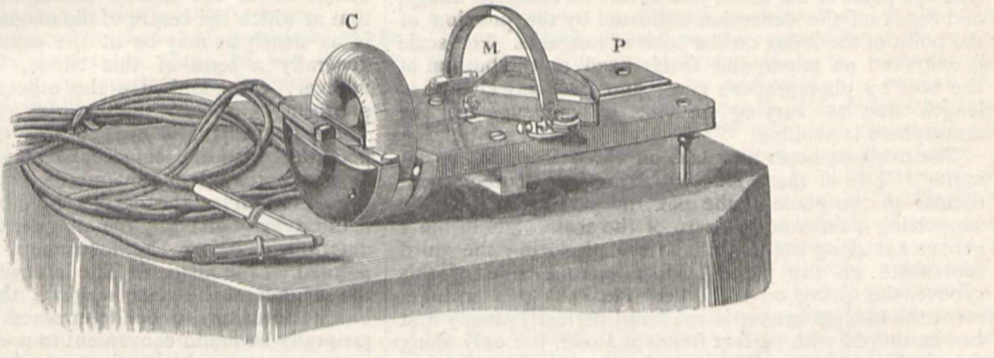


Fig. 1.

the cavity between the two bars to which the ends of the coil are attached. These bars are placed sufficiently near together to be forced a little apart by the contact piece, and thus give a secure spring contact. The leads are made of thin stranded copper wire, well protected by a thick woven covering of cotton, and are very flexible. They terminate in two spring clips (shown in Fig. 1) made each of a strip of stout copper held firmly against the flat side of a piece of wood, of semicircular section, by an india rubber

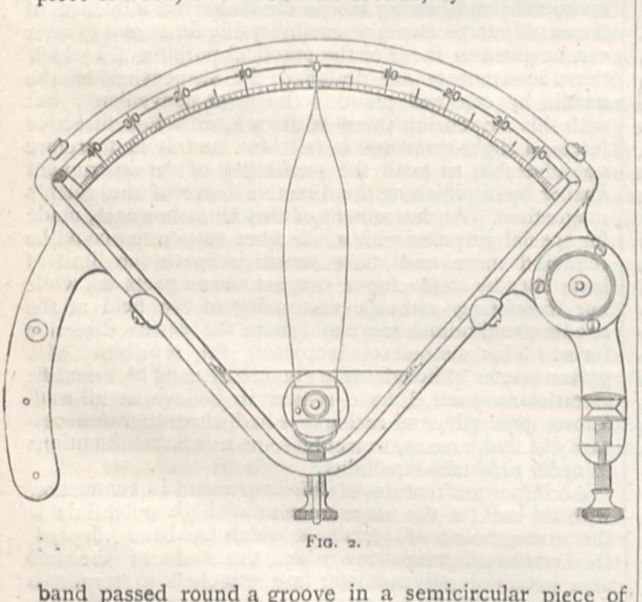


Fig. 2.

band passed round a groove in a semicircular piece of brass soldered to the copper strip, and round the back of the piece of wood. A groove carried along the piece of wood above the elastic band prevents the copper strips from turning round relatively to the wood, and thus a good and safe contact is made between the copper and anything on which it may be clipped. These clips are quite as efficient as binding screws and a great deal more convenient. They can in an instant be attached to or removed from a wire or lead of any size and in any position. For convenience in the use of the instrument the covering of one lead is coloured red, of the other blue.

II. *The Current Galvanometer.*

This instrument is shown in Fig. 3. It differs from the galvanometer above described only in the coil and arrangement of terminals. The coil is made of stout copper strip about 1·2 cm. broad and 1·5 mm. thick, wound in six turns, insulated by asbestos paper placed between. The outside diameter of the coil is about 10 cm., the inner diameter about 6 cm. It is covered like the other with silk ribbon, and attached in a similar manner to the platform P. A magnetometer exactly the same as that described above is used with the instrument, and all that has been said above with regard to the graduation of the potential galvanometer is applicable also in the present case, except that now amperes, not volts, are the subject of measurement.

This instrument is of course only suitable for the measurement of continuous currents, but owing to the small resistance of the coil, it can be left without risk of damage in a circuit with a current of upwards of 100 amperes flowing continually through it, while it is of sufficient sensibility to measure with accuracy, when the needle is acted on by the directive force of the earth alone, a current of from 1-10th to 1-100th of an ampere.

In special instruments for measuring very strong currents the coil is made of a single turn of massive copper strip, fitted with proper terminals to obviate undue heating at the contacts. With this mode of construction, an instrument can be made which shall measure with accuracy currents of from 1-10th of an ampere to 1000 amperes.

A pair of well-insulated leads several yards long, made of copper-wire cable containing 133 strands of wire of ·32 mm. diameter (No. 30 B.W.G.), and therefore very flexible and of inappreciable resistance, are sent out with each instrument to be used with it. These are shown coiled on the table beside the instrument in Fig. 3.

The terminals of the instrument and the mode of including it, by means of its leads, in any circuit in which it is to be used, are worthy of a little attention. In order that the galvanometer may be used to measure the currents in different circuits, it must be introduced into or withdrawn from each circuit with as little disturbance as possible to the current in that circuit. To do this without the complications of switches or arrangements of binding screws, the very simple plan of terminals, shown in Fig. 3, has been adopted. The ends of the copper strip forming the coil are brought out horizontally behind the instrument, one above the other, with a thin piece of wood between them for insulator. On one end of the leads for attachment to these terminals is a spring clip, formed of two stout strips of copper, one attached to each lead, kept apart for a short distance along their length by a thickish piece of wood, and held in their places by a serving of waxed cord at that place. The ends of the copper strips project beyond the separating piece of wood about two or three inches, and are bent round into similar curves, with their convexities turned towards one another. They have sufficient spring to bring their convex portions into contact, but they are held together at that place by a stout india-rubber band passed round a groove in the edges of the two semicircular pieces soldered on the backs of the strips. The points, however, of the strips are a little distance apart. If, now, the clip just described be pushed over the terminals of the coil, the jaws of the clip will be separated, but before separation takes place each of them has come into contact with a terminal of the coil. Hence if the leads form part of a galvanic circuit, the current, before the galvanometer is attached, passes from one lead to the other across the jaws of the clips, and after these have been separated, through the galvanometer

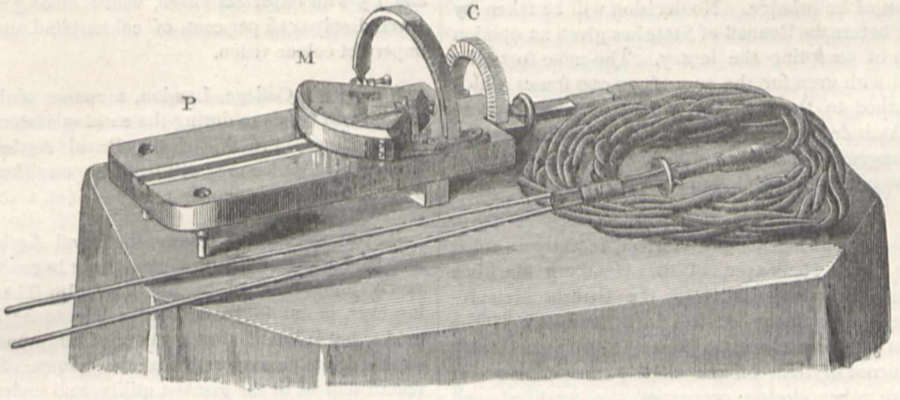


FIG. 3.

coil; and it is plain that no cessation of the current, and in practical cases only an infinitesimal disturbance can be caused by introducing the galvanometer. Sparks are thus altogether avoided, and the galvanometer is included in the circuit by a single simple and sure operation. When the leads are withdrawn from the coil-terminals the action is simply the reverse, the jaws of the clip have come together at their convexities before the terminals of the coil have lost contact with them.

In practice two stout wires which have one pair of ends attached to one of these spring clips are included in each circuit, the current in which is to be measured by the galvanometer. The instrument is placed with its leads attached to its terminals in a convenient position, so that the free end of the leads may reach easily the spring clips of all the circuits. The terminals at that end are similar to those of the galvanometer. They can therefore be pushed in between the jaws of each clip to allow the current to be read off, and withdrawn without disturbing the current in the circuit. The leads are shown attached at one end by their spring clip to the galvanometer, and at the other end to a spring clip supposed included by means of the two straight pieces of wire in a galvanic circuit.

This arrangement is exceedingly useful for a great number of purposes, as for example for measuring the currents charging secondary cells, or flowing through the various parts of an electric lighting circuit, or for measuring the whole current sent into the circuit by the dynamo or generator.

ANDREW GRAY

NOTES

THE German Association began its proceedings on Monday at Eisenach, when Prof. Haeckel delivered a lecture on the interpretation of nature by Darwin, Goethe, and Lamarck. The attendance at the meeting amounted to about 1000.

THE autumn meeting of the Iron and Steel Institute was opened on Tuesday at Vienna in the great hall of the Vienna Ingenieur und Architekten Verein. In the absence of the president, Mr. Josiah Smith, the vice-president of the Institute, Mr. I. Lowthian Bell, took the chair. The British and other foreign guests were then welcomed, in the name of the Government, by Baron Possinger, the Governor of the province of Lower Austria, and in the name of the city by the burgomaster. Mr. Bernhard Samuelson, M.P., of Banbury, was chosen president of the Institute for the next two years. The place of next year's Congress it was decided should be London. The Congress next proceeded with the reading of the papers set down for the day. After this work was concluded, the Members were conveyed by steamer down the Danube to inspect the works which have been commenced by the Vienna Corporation for improving the navigation of the river. Thence the guests were taken to Nussdorf, and proceeded to the top of the Kahlenberg, a hill in the vicinity. The first day was wound up by a banquet, at which the guests were entertained by the municipal authorities of Vienna. The present is the fourth meeting which the Institute has held upon the Continent, it having met at Liège in 1873, at Paris in 1878, and at Dusseldorf in 1880. The number of guests from abroad is nearly three hundred. They include not only Members of the English Institute, but visitors from America, Germany, France, Belgium, Spain, and Russia. The business portion of this autumn's Congress is expected to occupy three days, but fully a week will be spent in excursions and other festivities, and in visits to the chief ironworks and mines of Austria and Hungary.

M. BARTHELEMY ST. HILAIRE has completed the translation of Aristotle's "History of Animals," which will be published shortly by Baillière, and will extend to four volumes 8vo, with preface, notes, and commentary. The learned senator delivered last Saturday before the Academy of Moral and Political Science, of which he is a member, a lecture on his translation, showing that in this work, executed after numerous dissections of animals sent to him by Alexander, the great philosopher exhibited a penetration of mind which had been unsurpassed in his other treatises, and had been praised by Buffon and Cuvier. M. Barthelemy St. Hilaire contends that the descriptions were originally accompanied by illustrations, to which numerous allusions are made in the text.

THE inventory of the fortune left by the late M. Giffard has been completed. The whole amounts to about 7 million francs; 2 milions are devoted to legacies, and the other 5 are bequeathed to the French Government to be spent in foundations useful for the promotion of knowledge. No decision will be taken by the Government before the Council of State has given an opinion on the question of accepting the legacy. The same formality will be complied with even for the sum of 50,000 francs which has been bequeathed to the Academy of Science, as well as to the Société des Amis des Sciences, and Société d'Encouragement. But it has been suggested that the 5 millions should be employed in the foundation of a "Caisse Giffard" for the help of inventors in their discoveries.

THE Dutch Society of Sciences, at Harlem, recently awarded gold medals to Herr Neumayer, of the Hamburg Maritime Observatory, and Herr Buijs-Ballot, of the Utrecht Meteorological Institute, for eminent services in meteorology. The prize-subjects for the current year (to January 1, 1883) are briefly these:—(1) Influence of light on the electric conducting power of selenium; are other electric properties also modified, and other matters similarly influenced by light? (2) Chemical relations of the principal elements of the bile. (3) Chemical relations of terpenes. (4) Influence of structure and elasticity on the compound tone (the timbre) of sonorous bodies. (5) Examination of Clerk-Maxwell's theory of the electric medium, and its relations to the electro-magnetic theory of light. (6) Decomposition of organic matters in bare ground, and ground covered with vegetation. (7) Origin of the mesoderm in vertebrates. (8) Development of one or several species of annelids. (9) Ditto of echinoderms. For the following year (to January 1, 1884):—(1) Nature and composition of the *Terpen* of Friesland and Groningen, their animal and plant remains, &c. (2) Mariners' compasses and the means used to remedy the effects of oscillations and trepidations of the ship, also of the ship's iron. (3) Intensity of the light emitted in different directions from surfaces reflecting light by diffusion, and those emitting proper light; law of dependence of this intensity on the angle of emission and the nature of the luminous surface. (4) Change of refrangibility of light through motion of the luminous source or the refringent medium. (5) Structure of the kidneys of mammalia, specially as regards the epithelial lining in the different subdivisions of the renal tubes. (6) Condensations of different gases on the surface of solid bodies at different temperatures. (7) Study of the (probable) explanation of many physical and chemical phenomena by motions of particles of a system about a state of equilibrium. (8) Peripheric nervous system of various osseous fishes. (9) History of the development of one or several species of Lamellibranchs. (10) The phenomena of electric discharge in rarefied gases. The prize offered, in each case, is (at the author's option) either a gold medal or a sum of 150 florins; a supplementary premium of 150 florins may be given if the memoir be thought to deserve it. Memoirs to be written in Dutch, French, Latin, English, Italian, or German, and sent to the Secretary in the usual way.

A SERIES of researches having been undertaken by several Russian physicians as to colour-blindness, Dr. Kolbe has just published in the newspaper *Vrach* (*The Physician*) the results. Out of 10,828 railway servants examined, no less than 251 were colour-blind, and 32 proved to have an imperfect capacity for distinguishing colours. The average percentage of colour-blind would thus be 2·6; but the five doctors who have made these investigations arrived at very different percentages, namely, from 0·85 to 5 per cent. Three other doctors have made experiments on sailors and pupils in naval schools and have found a much higher percentage—6·08 per cent. of colour-blind, and 8·5 with imperfect vision. Among scholars of naval schools the percentage of colour-blind is however smaller, that is, 1·6 and 1·95. Women are subject to a far smaller extent to colour-blindness. Thus, Dr. Kolbe, who has experimented both on men and women, discovered among the men 2·5 per cent. of colour-blind and 7·5 with imperfect vision, whilst among women he has discovered only 0·16 per cent. of colour-blind and 3 per cent. with imperfect colour vision.

AT King's College, London, a course of lectures on Agriculture will be given during the ensuing winter by Mr. Frederick James Lloyd, F.C.S., of the Royal Agricultural Society of England. The lectures will be given on Thursday evenings at 6 p.m., beginning October 12.

UNDER the title of *Timehri* the Royal Agricultural and Commercial Society of British Guiana have begun the issue of a half-yearly journal edited by Mr. E. F. Im Thurn. The journal, however, is not to be devoted solely to agriculture and commerce, but is intended as a record of all important work bearing on the scientific exploration of the colony. Such a permanent record will be of the greatest utility, and under Mr. Im Thurm's care we may expect some valuable contributions to science. Among the articles in the first number are:—"Tame Animals among the Red Men of America," by the editor; and "Note on a Journey up the Cuyuni," by Mr. J. S. Blake. The term *Timehri*, we may say, is a Carib word, and denotes those curious hieroglyphics found so plentifully on the rocks of British Guiana.

IN the new number of the New Zealand *Journal of Science*, Mr. A. K. Newman advocates the formation of a New Zealand Association of Science similar to the British Association. We are glad to see any effort to promote science in our colonies, though we should have thought that the New Zealand Institute, combined with the *Journal of Science* itself, would render any such Association superfluous. But why not attempt the formation of an Australasian Association?

THE annual Conference of delegates from scientific societies was held at Southampton during the meeting of the British Association. Efforts have been made to enlist the co-operation of local societies all over the kingdom, and obtain their aid in carrying out the work of several of the British Association Committees, but so far, we regret to see, not with much success. Still the Conference is capable of doing good work, and we hope will continue its efforts.

AN International Electrical Exhibition has been opened at Munich.

MESSRS. CASSELL, PETTER, AND GALPIN have issued Part I. vol. ii. of the Encyclopædic Dictionary, extending from Cable to Conarum. It seems to us to be in all respects up to the standard of the first volume, noticed by us some time since.

UNDER the title of "Brehm's Zoological Atlas," Mr. T. R. Johnston of Edinburgh has brought together the leading illustrations to Brehm's well-known "Thierleben." As an aid to the teaching of the subject the Atlas will be found really serviceable, and will be especially interesting to children and useful in leading them to take an interest in science.

WE have received a further supply of University Calendars. That of University College, Liverpool, is pleasant reading in some parts; the list of donations and subscriptions to the young college is quite worthy of Liverpool, and might well excite the envy of more struggling institutions. Here we have 10,000*l.* for a Chair of Natural History, another 10,000*l.* for a Chair of Chemistry, and the like sums or nearly so, for Chairs of Philosophy, of Art, of Mathematics, for a chemical laboratory, and so on, besides thousand on thousand for other purposes. Liverpool College has had a good start, and much will be expected of her. The Calendar of Firth College, Sheffield, is small and business-like, and in the statement of the objects of the college, the governors show that they have a satisfactory idea of what such an institution should be and do. We have also the Calendar of University College, Wales, in whose curriculum science has a place.

Two interesting cases of explosion are described by Herr Pfaundler in a recent number of Wiedemann's *Annalen*. A closed glass tube two-thirds filled with liquid carbonic acid was inserted a few centimetres deep in a bath of carbonic acid and ether brought to a temperature of − 100° C., in order to get crystallised carbonic acid. Beautiful crystals were soon formed in the immersed part of the tube, and a layer of the liquid acid remained above. The tube was then raised by its upper part into the air, and in a few minutes it exploded violently. This tube had often before borne a rise of temperature to 31°. The explosion is attributed to thermal expansion of the solid carbonic acid (as a more likely cause, than vapour-pressure on glass rendered brittle by a low temperature). In the second case, a large sheet zinc bell-gasometer, used exclusively for keeping oxygen gas, was concerned. It had stood about six months unused, containing a little of the gas. When the issuing gas was being tested with a glowing match, an explosion occurred, shattering the apparatus. Any entrance of hydrogen or coal-gas is out of the question. It is supposed that the water had gradually absorbed acid vapours from the air of the laboratory, and that the zinc had been thus attacked, yielding hydrogen. The zinc was in fact somewhat corroded. It is recommended that the zinc in such cases be coated with a lac.

IN a recent communication to the *Rivista Scientifico-Industriale*, Prof. Palmieri concludes from experiments (1) that glycerine in contact with an ammoniacal nitrate of silver solution partially reduces the metal in the cold state, and with heat the reduction is more pronounced, and gives the appearance of a metallic mirror; (2) that with addition of a solution of caustic potash, either in the cold or hot state, complete reduction is produced, with a most brilliant metallic mirror; (3) that some substances accelerate the reduction, such as alcohol and ether; and (4) that, operating in the cold state and in darkness, the reduction is more brilliant and rapid that when operating in light. On the whole it appears that the reducing action referred to may be applied industrially with advantage to the silvering of mirrors, both on account of the facility of the process and its economy. The exact proportion of the components is important, and Prof. Palmieri promises particulars shortly.

A SIMPLE anemoscope and anemometer, designed by the Brothers Brassart of Rome, at the instance of Prof. Tacchini, especially for use in meteorological stations of small resource, is described in the *Riv. Sci. Ind.* (Nos 12-13). The chief peculiarity in both instruments is the system of free transmission, obviating prejudice to the indications from changes of temperature; the axis has several universal joints in its course, and in the case of the anemoscope passes down freely through a central hole in the plate bearing the compass card, a weight being hung at the end of it. It carries an index just over the card. In the anemometer the weighted axis has a perpetual screw acting on a toothed wheel, which, by means of a system of jointed rods, actuates three discs having peripheral numbers, in such a way as to present a numerical record of the wind's velocity in a given time. About forty of these anemoscopes and anemometers are now at work at various Italian stations.

EXPERIMENTS have been recently made in Rome by Signors Capranica and Colasanti regarding the action of oxygenated water on the system. Physiologically absorbed (according to Hueter's method) the substance acts as a poison, quickly killing animals, the fatal dose varying with the animal's size (about 25 cc., is enough for a dog weighing 3 kgms., 75 cc. for one weighing 13 kgms.). The poisonous action appears in all the great functions of the body, especially that of the spinal cord; the excito-motor power of that organ is over-excited, as shown by convulsive phenomena (tetanus, locomotor ataxy, &c.). The physico-chemical acts of nutrition are also profoundly disturbed, as is proved by the very pronounced glycosuria previous to death. All these disturbances are attributable to decomposition of the H_2O_2 in contact with the tissues. The consecutive phenomena in poison with oxygenated water are identical (the authors say) with those M. Bert has observed as resulting from the action of compressed oxygen.

THE additions to the Zoological Society's Gardens during the past week include a Chacma Baboon (*Cynocephalus porcarius* ♀) from South Africa, presented by Mr. H. Banfield; a Moustache Monkey (*Cercopithecus cephus*) from West Africa, presented by Mrs. Heath; two Macaque Monkeys (*Macacus cynomolgus* ♂ ♀) from India, presented by Mr. F. J. Newton; a Great Anteater (*Myrmecophaga jubata* ♀) from Parana, presented by Sir William Wiseman, R.N.; a Vulpine Phalanger (*Phalangista vulpina* ♂) from Australia, presented by Mr. W. Marston Clark; three Gold Pheasants (*Thaumalea picta* ♂ ♂ ♀), six Bamboo Partridges (*Bambusicola thoracia*), a Common Moorhen (*Gallinula chloropus*) from China, a Black Kite (*Milvus migrams*), captured in the Red Sea, presented by Mr. Theodore A. W. Hance; a Horned Lizard (*Phrynosoma cornutum*) from Texas, presented by Mr. W. Pilcher; a Squirrel Monkey (*Chrysothrix sciurea* ♂) from Brazil, a Ring-tailed Coati (*Nasua rufa*) from South America, deposited; a tiger (*Felis tigris* ♂) from India, two White-eared Conures (*Conurus leucotis*) from Brazil, two Dusky Parrots (*Pionus violaceus*) from Venezuela, a Horned Parrakeet (*Nymphicus cornutus* ♀) from New Caledonia, received in exchange; a Wapiti Deer (*Cervus canadensis* ♀), a Geoffroy's Dove (*Peristera geoffroii* ♀), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

COMETARY DISCOVERIES.—By telegram to the Earl of Crawford's Observatory at Dunecht, M. Cruls, director of the Observatory at Rio Janeiro, announces the presence of a bright comet in the morning sky, the position of which on September 11·718 M.T. at Rio, was in R.A. 9h. 48m., Decl. − 2° 1′; it was visible to the naked eye.

On Sunday last, Mr. A. Ainslie Common, of Ealing, while observing the sun with a special telescope (reflector with glass reflecting-surfaces only), found a fine comet near the sun: nucleus bright, tail about 4′ long, and apparently much brighter at each side, giving the appearance of two tails. Mr. Common compared it for position with the sun's limbs, and from his observations we find for the comet's place at Greenwich noon, on September 17, R.A. 11h. 33m. 58·3s., Decl. + 1° 42′ 16″; the hourly motion in R.A. appeared to be + 1m. 14s., and in Decl. + 4′·5.

M. Cruls thought his comet might be the expected one of 1812, but this is certainly an oversight. Were the comet of 1812 in his observed right ascension on September 12, its declination would be much further north than that observed if the comet were approaching perihelion, and much further south if it were receding therefrom. Whether the comet detected at Rio is identical with the remarkable one discovered by Mr.

Common, it would be premature to decide upon present data. The Brazilian Telegraph Company has cabled from Madeira two positions for September 12 and 13, obtained on H.M.S. *Triumph* by Capt. Markham, but taken in conjunction with the Rio message, they tend to throw a doubt upon the accuracy of some of the figures so far received.

Another comet discovered by Mr. Barnard is announced in a telegram from Boston, U.S., to Dunecht, it is described as circular, 2′ in diameter, with some central condensation. An observation at Harvard College gives the following position :—

Sept. 14·8162 G.M.T. : R.A. 7h. 19m. 17·8s, Decl. + 16° 3′ 51″.

Daily motion in R.A. : + 1m. 44s. ; in Decl. : + 43′.

There is no possibility of identity of this comet with that of 1812.

The Total Solar Eclipses of 1883 and 1885.—Observers of the total solar eclipse on May 6, 1883, will have but very limited observing-room, and in fact will be confined for stations to one or two of the smaller islands or islets of the Marquesan group, the Roberts Islands of the Admiralty Chart. Wide separation of the parties to secure better chances of favourable weather will therefore be impracticable. The same contingency will occur in the case of the total eclipse next following, viz. that of September 8, 1885, where the course of the central zone is again almost wholly a sea-track. In this case observers will be limited to the southern parts of the north island of New Zealand, and to the extreme northern point of the southern island.

The following figures will indicate the precise conditions :—

Long. E.	Latitude, N. limit of totality.	Latitude, Central Eclipse.	Latitude, S. limit of totality.
°	° ′	° ′	° ′
171 ...	− 39 31·4 ...	− 40 20·2 ...	− 41 10·2
173 ...	39 42·0 ...	40 31·0 ...	41 21·0
175 ...	39 55·0 ...	40 43·8 ...	41 34·4
177 ...	− 40 9·5 ...	− 40 58·8 ...	− 41 49·2

The duration of totality on the central line in longitude 175° will be 1m. 52s.

GEOGRAPHICAL NOTES

At the Southampton meeting of the British Association Mr. Joseph Thomson read a paper *On the Geographical Evolution of the Tanganyika Basin.* The keynote of this paper is struck by a reference to a recent lecture of Dr. Archibald Geikie. to the Royal Geographical Society, in which he points out that the days are now over in which the scientific geographer is content with the simple description of the superficial aspects of the various regions of the globe. He must also know how they came to be, and what they have been in the past. This line of inquiry is applied by Mr. Thomson to the lake regions of Central Africa, but more particularly to the Tanganyika Basin. In the first place he presented a bird's-eye view of the lake regions from the Indian to the Atlantic Ocean, bringing into relief only the most prominent features of the geography, but describing more in detail the aspect of the Tanganyika Basin, round which the chief interest centres. From a description of these purely superficial matters he proceeded to describe what these have been in the remote past, and the manner in which they have been evolved, being of course compelled to call in the assistance of the sister science geology. The conclusions he arrived at as to the primary origin of the region are, from purely hypothetical considerations, based on the theory of a shrinking nucleus, and the necessary effects on the earth's crust arising therefrom. At a later stage, however, he is on safer grounds when he is able to appeal to the rocks themselves as to the aboriginal conditions of the African continent south of the Equator. These, according to Dr. Thomson, prove the existence of an immense central sea cut off from the ocean by the elevation of the continent, and which was almost coterminous with the present drainage area of the Congo. An elevated ridge was upheaved along the eastern boundary of this sea, the origin of the trough of Tanganyika, by the collapse of the centre of this ridge and the central sea, subsequently drained away to the west, leaving Tanganyika isolated. Mr. Thomson then proceeded to describe how its secondary characters arose, and its scenery was moulded, by the action of sub-aërial denudation on rocks of different powers of resisting the decomposing and eroding agents, and explained the curious marine-like type of its shells, the origin of its outlet, the Lukuga, the freshening of the water of the lake, and finally the curious intermittency of the outflow. The various stages in the evolution of the Tanganyika Basin were summarised as follows :—The first appearance of the future continent, we have been led to believe from various theoretical considerations, was the appearance of a fold of the earth's crust bounded by two lines of weakness converging towards the south, which fold gradually rose till it appeared above the ocean, first along these two lines of weakness, in the form of a series of islands, which finally join, inclosing in their centre a large part of the ocean. This inclosed water area formed a great central sea, and the inclosing land along the lines of weakness is now indicated by the east and west coast ranges. In the second stage the continent of Africa south of 5° N. lat. presented the outline of the continent of to-day. The third stage shows the central plateau with the great central sea very much diminished in size, and almost coinciding with the present Congo Basin. There is as yet no evidence of the existence of Tanganyika. After an enormous period of undisturbed deposition of sand in the sea, the fourth stage is ushered in by a period of great continental covulsions. On the line of the future Tanganyika a huge boss of rock is intruded into the throbbing crust, and the surrounding region elevated to a considerable extent, followed by the subsequent collapse of the body of the elevated area originating the great abyss of Tanganyika. The fifth great stage is marked by the formation of a channel through the western coast mountain, causing the draining of the great central sea, which immediately becomes the inner drainage area of the Congo. The sixth stage then sees Tanganyika isolated as a lake by itself, from which time dates the moulding of its present scenery, the formation of an outlet, the freshening of its waters, and the lowering of its level, and finally we have seen that the intermittency of the lake's outflow is explained by the probable fact that the rainfall and evaporation nearly balance each other in ordinary seasons.

The Geneva correspondent of the *Times* sends some notes on an interesting paper recently read by Prof. Calladon :—"So far back as 1880 M. de Saussure suggested the probability of the level of Lake Leman being much lower than it had been a few centuries previously, and that there had been a time when the upper part of Geneva formed a peninsula, washed on every side except that of Champel, by the waters of the lake. This theory has lately been comfirmed by the observations of Prof. Calladon, who, at the recent meeting of the Association of Swiss Geographical Societies, read a paper on the subject that attracted much attention. It results from the Professor's investigations that the Plateau of the Tranchée, to the south-east of the city, and the hill once crowned by the temple of Diana, and now by the cathedral, are parts of the same lacustrine terrace, both being composed of regular beds of sand and gravel, having an inclination of 30 to 37 degrees, and dipping in a north-westerly direction. Superimposed on these beds is a horizontal layer of pebbles of an average thickness, much exceeding the thickness of the oblique layers underneath. The height of this layer, Prof. Calladon contends, corresponds with the former *maximum* level of the lake, which was 28 to 30 metres higher than the present level. The excavations for the foundation of the new theatre which were laid in 'drift,' had to be carried to a great depth, and included 3000 square metres of ground. It was quite evident from the nature of the deposits, which had not been previously disturbed, that hereabouts the Arve, once upon a time, joined the Rhone, and other excavations have indicated the old course of the former river to the point at which it now takes its departure. Underneath the inclined bed of pebbles and gravel comes glacial clay, identical in every respect with the glacial clay that now underlays the bed of the Rhone. It is from the depth of drift resting upon this platform of gravel clay that Prof. Calladon calculates his estimate of the lowering of the level of Lake Leman in modern times. He is confirmed in his conclusion by the fact that the deposits in the ancient bed of the Arve are not alone similar in kind to the deposits still brought down by the river, but identical with them in chemical composition. In the opinion of Prof. Calladon, Geneva, at a period not many centuries before the Christian era, occupied a strategic position analogous to that of many other cities of antiquity in being built upon a promontory almost surrounded by water. The uncovering of the platform of glacial clay enables Prof. Calladon further to ascertain the minimum level of the lake at the time when the superincumbent layers of Alpine sand and gravel were brought down by the Arve. It follows, from the geometric measurements which have been made, that the surface of the bed of glacial clay is only 85 centimetres below the present level of the lake, and 4 metres above its bottom at Geneva. Hence the level of the lake at the time in question must have been at least 3 metres above its present level, for otherwise the Lower Rhone could not have existed. As regards these estimates, it should be remembered that the difference in time between the maximum and minimum levels of the lake has to be reckoned by centuries, and that the volume of rivers and lakes fed by Alpine snows varies with the seasons."

M. LESSAR, who made last year an interesting journey to Saraks, has returned from a second journey in the same country, as far as Herat, and publishes an account of it in the *Golos*. All the route, from Askabad to Saraks, 185 miles, goes along the foot of mountains through a completely flat country, which is usually called Attek. This name, however, which signifies "the foot of the mountains," is unknown in Persia and Afghanistan. That part of this oasis, which was occupied by the Tekke-Turcomans, was usually known as Akhal, whilst the south-eastern part of the oasis was known as Arakadj. Only two places of the Attek, Luftabad and Shilghyan, are occupied by Persian Shiites, the remainder are Turcomans, having immigrated from Merv after a bloody struggle with the former inhabitants, at the beginning of this century. The population live mostly in clay-houses, the number of felt tents diminishing very rapidly, and the clay-houses which formerly were built within small earthen fortifications, are now mostly erected outside of them. Water is scarce in the Attek, the streams coming down from mountains being few, and in the hands of Persians, who often take the water for their fields. The population of the Attek, between Askabad and Saraks, is estimated by M. Lessar, at about 7000 Turcoman inhabitants. They carry on agriculture, and have good orchards, as well as good gardens in the neighbourhood of the Persian settlements. But altogether they are very poor.

A TELEGRAM, dated Isefjord, September 5, has been received in Stockholm, *viâ* Tromsö, from the Swedish Geological Expedition dispatched to Spitzbergen, according to which snow covered the island as early as August 30, and the members were thus compelled to discontinue their researches, and intended to sail for Beeren Island. The results of their labours are very important. All was well with the Meteorological Expedition at Smith's Observatory.

ANOTHER message, similarly conveyed, but dated August 24, has also been received from the Swedish Meteorological Expedition, from which it appears that observations commenced at Smith's Observatory on August 15, with the exception of the magnetical, which were delayed until the 21st, in consequence of the difficulty in firmly fixing the instruments. From August 15 to 21 the mean temperature and the readings of the barometer were respectively as follows:—15th, temp. +3·1° C., bar. 748; 16th, temp. +1·5° C., bar. 749; 17th, temp. +3·9° C., bar. 749; 18th, temp. +3·6° C., bar. 752; 19th, temp. +3·7° C., bar. 754; 20th, temp. +4·5° C., bar. 751; 21st, temp. +3·9° C., bar. 752. At mid-day of the 16th snow fell, while pools became covered with ice; the minimum temperature was +0·1° C. The weather had up to that date been dull with little rain. Wind being generally from west to east, with an average force of 1 (Beaufort's scale). There was little ice at sea, but the fact that four smacks had been frozen in in Storfjord caused the members some anxiety, as they were not quite prepared, as yet, to face the winter. As these four vessels have since got away, this will probably be the last message we shall obtain from the expedition this year.

OWING to the enormous quantities of drift-ice in the Kara Sea the steamer *A. E. Nordenskjöld*, bound for the Jenisei, has put back to Vardö. Capt. Johannesen states that he attempted four times—August 31, September 1, 7, 8—to penetrate Matoschkin Schar, and was compelled to turn back. He went up alongside Waigats Island into the Kara Strait, where he saw ice as far as 54° long., and would have been frozen in here, if the vessel had not possessed such powerful machinery.

HERR KARL PETTERSEN, of Tromsöe, has given the name of "Arktis" to a great land-mass which he maintains at one time extended between Norway, Novaya Zemlya, and Spitzbergen. His theory is based mainly on the existence of a submarine plateau which recent Norwegian expeditions have found in the region referred to. He also maintains that such a land-mass would account for the present geological and biological conditions of Norway and Spitzbergen, and that it extended to the conclusion of the Quaternary period.

PARTS 6 to 10 of the new edition of Balbi's "Allgemeine Erdbeschreibung" have been sent us by Hartleben of Vienna. The recasting of the work by Dr. Chavanne continues to be thoroughly carried out, and the illustrations and maps are very good.

DR. OTTO FINSCH, who for the last two and a half years has been travelling in Polynesia and Australia, under the auspices of the Berlin Academy of Sciences, may soon be expected home. A large part of his rich collections in all departments of natural science and ethnography, has already arrived in Berlin, and the rest is on the way. He has visited the Sandwich Islands, the Marshall group, where he stayed a long time, the Carolines and New Britain, New Zealand, Australia, and Tasmania. He stayed for a considerable time among the islands in Torres Straits, as well as on the south coast of New Guinea.

THE permanent Commission of the "Association Géodesque Europèene," the object of which is to promote the measurement of the earth by General Bayer's system, has been meeting at the Hague under the presidency of the Spanish General Hanez. Representatives of France, Austria, Germany, Italy, Spain, Switzerland, Norway, Roumania, and Holland attended the first meeting, and were welcomed by the Dutch Foreign Minister, Mr. Rochussen. Prof. Oppolzer (Austria), who is the secretary of the deputation, gave the annual report of the Association. Several other members presented communications upon the geodesic work in their respective countries.

AN edition for 1882 of the "Handbook of Jamaica," the first issue of which we noticed at length, has been published. Several important alterations and additions have been made. Stanford is the London agent.

THE new number of the *Deutsche Geographische Blätter* of the Bremen Geographical Society, contains some long communications from the Brothers Krause, who have been wintering at Chilkoot, in North-west America. They give details concerning journeys which they made during the past winter and spring, in which, among other things, they obtained much information concerning the Chilkoot Indians. The number also contains an interesting lecture by Prof. Karl Möbius, on the influence of food supplies on the spread and migration of animals. Dr. Fr. Hirth has two communications:—On the Walls of the Towns of Kwang-tung, and on the Chinese Coast from the boundary of Annan to Tien-pai, from Chinese sources.

IN consequence of the very hot and dry weather experienced in Russia during this summer, the water has become very shallow in all rivers, so that navigation meets with great difficulties on the Volga and Northern Dwina.

WE regret to learn from a telegram received at Copenhagen from Vardöe that it is feared the Danish North Polar Expedition under Lieut. Hovgaard is already ice-bound on the coast of Novaya Zemlya. The Kara Sea was closed by ice in the middle of August. It will be remembered that Lieut. Hovgaard intended to make for Cape Chelzuskin, from which he was to make an attempt to force his way northwards.

UNWRITTEN HISTORY, AND HOW TO READ IT[1]

IT has now for some years been the custom at the meetings of the British Association for the Advancement of Science, for one of its members to be deputed to deliver a lecture, not to his fellow-members, for whom in the ordinary programme an amply sufficient supply of mental food has been provided, but to the operative classes, in the town where the annual meeting happens to be held. Such a custom has much to commend it, for all alike—the rich and the poor, the worker with the head and the worker with the hand—are interested in the advancement of that science, or "natural knowledge," for the promotion of which this association, like its elder brother the Royal Society, was founded.

An occasion like the present, moreover, gives a good

[1] A lecture to the working classes, delivered at the meeting of the British Association for the advancement of science, held at Southampton, *August*, 1882, by John Evans, D.C.L., LL.D., F.R.S., &c. Revised by the Author.

opportunity of treating of some subject which lies within the range of all observers of what is going on in the world around them, which may even be of local interest, or to speculate on which may give an additional zest to an evening stroll or a day's relaxation from toil. It is not, however, easy to find a subject of this kind; and yet, perhaps, if I talk to you this evening of those who, in times more or less remote from the present day, have lived and laboured in this part of the globe, I shall at all events have a theme of some general human interest. And if, in addition to laying some particulars of their method of life before you, I can point out the methods by which our knowledge of the manners and customs of remote antiquity is obtained; if I show you the way in which the successive links in the chain of circumstantial evidence relating to human progress are forged, you will be able to appreciate the value of the application of scientific methods to the study of the past, and to feel that our present knowledge of antiquity rests upon something more secure than vague conjecture. It is fortunate for me that in and around this town of Southampton is what may be termed the home of some of the witnesses I propose to call, so that if I am able to interest you in what they have to reveal, many of you will have the opportunity of examining them and cross-examining them yourselves at your leisure. The subject of my lecture, "Unwritten History, and how to read it," is, as you may imagine, is one in which testimony of various kinds is admissible; and, as in the case of many of the most important trials, much may depend upon what, at first sight, would appear to be a trivial common matter.

The term which I have used, "Unwritten History," is so comprehensive that it might be made to embrace the whole series of events which have happened in this world from its first creation until the written annals of the historian begin. It might be expanded so as to comprise the whole of the geological record, as exhibited by the testimony of the rocks, and even to go back to a time when it seems probable that the elements composing our globe had not been consolidated, but existed in a gaseous condition. I propose, however, to limit the term this evening, so that it may not extend beyond the period during which the human race has dwelt upon the earth. I need hardly say that, compared with the time which geological facts prove that the world has existed. this period of human occupancy is relatively short, however vast it may appear when we come to compare it with the few centuries embraced in our ordinary chronology. But of this it will be time to speak when we have traced back our evidence as far as our present knowledge will enable us to go.

With regard to that evidence, or the means by which we must attempt to read unwritten history, one of the principal aids that can be called in is the written history of the past. The ancient writings of Greek and Roman authors carry us back some three thousand years; while the annals of Egypt and Assyria, and those preserved in the pages of our Bibles, make us to some extent acquainted with the habits and customs of still earlier times. And in the same way the accounts of recent travellers who have been brought in contact with races of men unacquainted with even the most simple appliances of modern civilisation, serve to throw a light on what must have been the condition of most of the occupants of other parts of the world before those appliances were known. But, after all, our best evidence is to be derived from the relics of the past which, from time to time, we find buried in the earth, and from the circumstances under which they are discovered. Such relics are often of much service even in illustrating that portion of past time which falls within the limits of written history, especially so far as relates to the habits and customs of everyday life, as to which, except incidentally, our chroniclers are usually silent. The "princes and kings" who "flourish or may fade," "the unsuccessful and successful wars" whose records make up the bulk of our histories no doubt possess an interest of their own; but all that relates to the infancy and childhood of the human family and the development of its mental and material resources has for many minds a far greater charm, and much that concerns it is only to be gathered from a study of unwritten history.

But before going back to any really prehistoric times, it will be well to consider briefly a few points in connection with the written history of the town in which we are assembled. It was not always called Southampton, but was in Saxon times known as Hamtune, and under that name appears upon coins struck at the local mint from the middle of the tenth until the middle of the twelfth century. In the same manner Northampton was at one time only known as Hamtune, and it was to distinguish these two towns that the one received the prefix of North- and the other of Southampton.

Curiously enough, the name of Hamtune, which appears to be compounded of two well known Saxon words—Ham, our English home, a farm or possession; and Tune, the modern town—is more probably, both at Northampton and at Southampton, connected with the old British name of the river which flows past the town. The Nene of Northamptonshire seems to be called the Antona or Anton by the Roman historian Tacitus; and the Test of "Suthamtescire," as the country of this town is called by the Venerable Bede, still retains in part of its course this same name of Anton. The old geographer Ptolemy calls Southampton Water the mouths of the river Tris-anton, or possibly the three mouths of the Anton; and the Roman town which stood near this place was known by the name of Clausentum, which Camden interprets as a Latinised form of the British Claudh-Anton, the port of Anton.

I shall not attempt to determine the claims of Bittern, or Old Hamtune, to represent the Roman town; but the fact that Roman remains still exist here may be cited as a proof that whatever may have been the encroachments of the sea since Roman times, they have not destroyed all traces of the Roman settlement on this site, nor can the relative positions of the sea and the land have materially altered within the last 1800 years. It will be well to remember this when we hereafter come to consider the antiquity of some of the earlier traces of the presence of man in this part of the world. When, once, in ascending the stream of time, we have passed the date of the Roman occupation of this country, we enter upon the domain of unwritten history, or at all events find ourselves within its border provinces.

Who were the people whom the Romans found here on their arrival, and what was their civilisation? Historians give us some information on this point, which is, however, to be supplemented from other sources. Cæsar, whose invasions of Britain date some ninety years earlier than the actual Roman conquest, tells us that the southern part of this island was occupied by Belgic tribes who had come over from the Continent, who for the most part retained their original names, and were often subject to the same chiefs as their brethren on the mainland. Those who occupied this part of Britain appear to have been the Belgæ, whose name at least has on the other side of the Channel survived in that of Belgium. The habits and customs of these southern Britons were the same as those of the Gauls. They were acquainted with iron, gold, silver, copper, tin, and bronze, and had, moreover, a coinage of their own. Our knowledge of this coinage is not, however, derived from any ancient historians, but from a study of the coins themselves. By a careful record of the spots where coins of the Ancient Britons have been found we have been able to show that particular forms belong to particular districts, and, in the case of some of the coins which bear inscriptions, to determine the names of British princes, and to fix the districts in which they reigned. Here in Hants, and in the neighbouring county of Sussex, we find coins struck by two Princes, Tincommius and Verica, as to whom written history is silent, but who appear from their coins to have been the sons of Commius, who probably is the Commius mentioned by Cæsar.

It has been supposed, from a passage in Cæsar's "Commentaries," that the Britons in his time were unacquainted with the use of coined money; but this passage may have been misread. At all events, the coins themselves prove that the supposition is erroneous, and, moreover, that long before Cæsar's time a native coinage existed in Britain. You may ask how this can be proved by coins which bear neither dates nor inscriptions. I will attempt to answer this question, and to show you in what manner this chapter of unwritten history has been read. Coins such as we now know them, struck of a certain weight and with some established device upon them, were unknown even among the most civilised nations of antiquity until about seven hundred years before Christ; and it was not until about three hundred and fifty years before Christ that any extensive coinage of gold was issued at any one place. About that time some mines were discovered in Macedonia which produced about £250,000 worth of gold annually. Most of this was converted into coins rather heavier than our sovereigns, by Philip II. of Macedon, the father of Alexander the Great. These coins bore on the one side a head with a laurel-wreath upon it, and on the other a Victory, in a two-horse chariot. The coins were so well known, and gold from other sources was comparatively so scarce, that the use of these pieces, which were known as *Philippi*, spread through the whole of Greece and her colonies along the shores of the Mediterranean. Whether as the result of raids upon Greek towns, or from more peaceful contact with Greek colonies in what is now the south of France, the Gauls became acquainted with them, recognised their usefulness, and proceeded to strike coins in imitation of them. As was to be expected, the art of these imitations was far inferior to that of the original coins. Each copy in its turn served as a model from which other copies were made, and as is often the case, the copies were in many instances larger than the originals; so that by the time the art of coining had reached the northern part of Gaul the size of the coin had much increased, and the devices upon it had degenerated into a widespread bust with a laurel-wreath, and with the hair arranged in rows of locks of even size behind, and in crescent-shaped curls in front, while additions had been made to the original head in the shape of a kind of band around it and an ornamental covering for the neck. Such coins have been found in considerable numbers in England, principally in our southern counties, and especially in Kent. Of their origin from the Macedonian *Philippus* there can be no doubt; but how are we to judge of their date, and of the length of time that coins were known in Britain before Cæsar's landing? It is in this manner:—There are some British princes whose names are recorded by Roman historians and by Roman inscriptions, and to whom therefore we can assign a fairly certain date; and of some of these princes coins are known. They have on them devices such as at first sight appear almost unintelligible, but which by a succession of intermediate forms occurring on coins without inscriptions upon them, can be traced back to the head with the laurel-wreath, while on the reverse side there is always a horse of more or less barbarous form. We have, therefore, evidence of an uninterrupted succession of coins copied the one from the other, beginning with the coins with the widespread head and ending with the inscribed coins. Now each of these successive copies must have been intended to pass current with the coins from which they were copied, and if they had all been of one weight and of one quality of gold it might have been possible for the whole series to have been struck within no very lengthened terms of years. But, as it happens, there is a great diversity in the weight and fineness of the coins, those with the widespread head being of fine gold, and often weighing nearly 120 grains, and the last of the series being of much baser metal and only weighing about 84 grains. In the process of successive copying only the most striking parts of the device, and those most easy to imitate, such as the wreath and locks of hair, survived, and the face, being more difficult to copy, was the first to disappear. Coins with merely a mis-shapen lump upon them in lieu of the face usually weigh about 96 grains, and the farther they get from the original the lighter the coins become. Now the original weight of the *Philippus* was 133 grains; and assuming that it was first imitated in B.C. 300, and that the weight had become reduced to 84 grains in B.C. 20, and also that the diminution in weight always went on at the same rate, we find by calculation that the date at which the weight would have become reduced to 120 grains—that of the earliest British coins—is B.C. 226. Probably, however, there was a less tendency to reduce the weight and quality at the beginning than towards the end of the series, but the coins justify us in saying that the inhabitants of southern Britain were sufficiently civilised to make use of a coinage about 150 years before Christ, or 100 years before the time of our first Roman visitor, Julius Cæsar, if not indeed at an earlier period.

Besides these gold, silver, and brass or copper coins, with devices upon them derived from Gaulish copies of a Macedonian original, there are other coins cast in tin, with devices in imitation of some coins of Marseilles, in the South of France, which also tell us the same story of a close intercourse with Gaul. Many of these were cast in wooden moulds, as is proved by the grain of the wood being visible in relief upon them. Such coins have been found with iron tools and weapons in the ancient encampment of Mount Caburn, near Lewes; but iron or steel must have been in use for some four or five centuries in this country before the time of Cæsar's invasion.

In graves which must belong to the first few centuries before Christ, we find swords of iron with ornamental bronze sheaths; and there are highly decorated shields with artistic scroll patterns upon them, and sometimes with ornaments of red enamel, which belong to the same period. The warriors of those times had horses and chariots, the latter with iron tires and linch-pins to the wheels, and the harness of the former provided with bronze and enamelled buckles. Of this Early Iron Age, however, we learn more from the remains of ancient dwellings and cemeteries on the Continent. In one of these cemeteries at Hallstatt, in the Austrian Tyrol, upwards of a thousand graves have been examined; and as it was the custom to bury with the dead a number of objects of an ornamental or useful kind—possibly with the view that they might be of service in a future state of existence—we are able to reconstitute the surrounding conditions of their life. Great care was bestowed upon their weapons, some of the swords having hilts of ivory inlaid with amber, both probably derived from foreign commerce; some daggers had golden sheaths; their helmets were of bronze, as were also their girdles, bracelets, and brooches, which present an infinity of different forms, Their pottery was of graceful shape, and some of it highly ornamented. Many of their vessels were made of bronze, sometimes artistically ornamented, with figures of animals—as, for instance, a milk-cup, the handle of which is in the form of a cow with a calf behind her.

But mixed with these graves containing iron weapons are others in which swords, spear-heads, and hatchets of bronze have been found; and it is a remarkable circumstance that the iron weapons appear to have been imitated from those of bronze. cannot go into the details of the matter, but I may observe that the forms, though readily cast in bronze, are exceedingly difficult to forge in iron; and the only inference that can be drawn from this fact is this, that the bronze weapons and tools must have been in use at the time when iron was introduced as a substitute for the softer metal.

But if iron or steel thus superseded bronze, there must have been a time when bronze was the only metal in use for weapons and tools, and to this period antiquaries have given the name of the Bronze Age. Such terms as Iron Age, Bronze Age, or Stone Age mean, however, only certain stages of civilisation, and not only chronological periods applicable to the whole of the world; for while the inhabitants of one country had acquired a knowledge of iron and had given up bronze for such weapons as swords, in other countries bronze may still have been in use, and in others again it may have been entirely unknown. Here in the South of Britain iron, as already remarked, is thought to have been in use some four or five centuries B.C., and before that time we have evidence of the prevalence of a Bronze Age in Britain probably for a period of not less than ten centuries. We can read this chapter in our history partly by the contents of ancient grave-mounds or barrows, and partly by means of the bronze objects found dispersed in the soil. Bronze, or, as we now generally call it, gun-metal, is a mixture of copper and tin, and the proportions which produce the toughest and most useful alloy are about nine of copper to one of tin. No doubt in some part of the world, probably Asia, native copper, such as is found in so many countries, was first in use; but at present the traces of this copper-using age are on this side of the Atlantic but faint. On the other side, in some parts of the United States, numerous instruments of pure copper have been found. These have been hammered out cold from native copper, and not cast. Where and when it was discovered that the admixture of a small proportion of the softer metal, tin, made copper harder and more fusible, is at present a mystery; but it is remarkable that the same discovery seems to have been made in the New World as in the Old, for some of the weapons and tools of Peru, made before there was any contact with Europeans, are manufactured from bronze of the ordinary composition. Here in Britain, our Bronze Period is well illustrated by relics, representations of some of which are shown upon the wall. The swords, spear-heads, daggers, and shields speak for themselves, snd exhibit marvellous skill in the art of casting and hammering out. The various tools may also be recognised, and many, such as the chisels and gouges, do not differ materially from those of the present day. The hatchets or axes are either flat blades, sometimes with wings or flanges at the sides, or are cast with a socket to receive a crooked haft. In this country they are never provided with an eye for the helve like our modern axes. The way in which the socketed form was developed from the flat blade is susceptible of being traced, and we can learn from the hatchets themselves that the art of producing them with a socket was a foreign invention, and not originally discovered in this country. Let me dwell on this for a minute, The flat blade, which was cast in a single open mould and hammered into shape, was no doubt the earliest form. It, moreover, closely resembles some of the earlier hatchets made of another material, to which I shall presently have to call your attention. But these flat blades, it was found, could be rendered stronger by being hammered at the sides so as to form flanges upon them, much like those on modern rails. The blades were next cast with these flanges upon them, and it was then found advantageous to make them expand in the middle of the blade, so as to allow them to embrace the two sides of the split haft in which they were mounted. Eventually these projecting wings were hammered over so as to produce a kind of semicircular pocket for the haft on each side of the blade. At this stage a brilliant idea occurred to some ancient founder, and by means of a clay core he produced a single socket in the body of the blade itself, and thus did away with the labour of hammering out the wings on the flat blade and turning them over, and also with the trouble involved in making a deep notch in the haft, so that it might run down each side of the blade. But these semicircular wings had become a recognised feature in this class of hatchets, and out of regard to this fashion the earliest of the socketed blades were cast with the two wings on each face, in imitation of those of the older form. As has so often been the case in such developments, what was at one time of essential service survives at another as a useless ornament. And now comes in this little bit of history which these hatchets enable us to read. It is evident that the first socketed blades must have been cast in a country where the prevailing type of hatchet had the semicircular wings on each face; but this kind of hatchet, though abundant in some parts of the Continent, is very rare in Britain, and we are therefore justified in concluding that the art of casting hatchets with a socket was introduced into this country from abroad. Not but what our native founders cast plenty of hatchets of this socketed pattern when once they were acquainted with it, for the moulds for producing them have been found with lumps of metal and various bronze objects in different parts of the Kingdom.

Not only were the bronze-using people skilful as founders, but they understood how to work ornaments in amber and jet as well as in gold, and some few specimens of their ornamental inlaying are such as would do credit to any modern workman. The wooden handle of a bronze dagger found in the grave of a warrior in Wiltshire was inlaid with thousands of minute gold pins, arranged in regular patterns, and the amber pommel of a dagger found in Devonshire was as delicately inlaid with gold as any tortoise-shell patch-box of the last century.

The history of man in the bronze-using stage is, however, better read on the Continent than here. On the shores of many of the lakes of Switzerland, Italy, and the South of France the remains of settlements belonging to the Bronze Age have been discovered. As a safeguard against enemies and wild beasts, it was a custom in those times to construct artificial islands, or platforms carried on piles above the water, on which to erect their dwellings. The same custom also prevailed within the historic period both in Europe and Asia, and something of the same kind was practised in Ireland until comparatively recent times. A similar custom has been observed in other parts of the world by modern travellers. In such buildings, from time to time, disastrous fires occurred, and what was thus lost to the original occupants has been preserved beneath the waters for the instruction of long subsequent ages. Their houses seem to have been formed of interlaced boughs smeared over with mud, after the manner we now term "wattle and daub." They understood the art of spinning and weaving both woollen and linen cloth. Of domesticated animals they possessed the dog, ox, sheep, goat, pig, and finally the horse. In this country they hunted the red deer, the roe, the wild boar, the hare, and some other animals. But they also were to some extent agriculturists, and reaped their corn with bronze sickles. They made vessels of various shapes in burnt clay, but were unacquainted with the potter's wheel, though some cups of amber and a soft kind of jet were apparently turned in a lathe. Though using so many and such well-made tools and weapons of bronze, a certain number of appliances for both peaceful and warlike purposes were made of stone. The skins which they prepared as leather were scraped by means of flint scrapers. Their arrow points were made of flint, and their battle-axes and war maces were in this country carefully wrought out of stone. From the number and varieties of the bronze instruments found in Britain, it has been inferred that their use must have extended over several centuries, and it seems probable that the beginning of our Bronze Period dates back to at least some 1,200 or 1,400 years B.C. Such a date also seems to agree fairly well with what we learn from history as to the trading visits of the Phœnicians to this country in search of tin.

(*To be continued.*)

RECENT PROGRESS IN TELEPHONY[1]

THE Telephone was first introduced to the British public at the meetings of the British Association. In 1876, at Glasgow, Sir William Thomson startled his hearers by announcing that he had heard, in Philadelphia, Shakespeare quoted though an electric wire, by the aid of the invention of Mr. Graham Bell, which he then pronounced to be "the greatest by far of all the marvels of the electric telegraph," In 1877, at Plymouth, I had the pleasure of showing in actual operation the finally developed instrument now known as the Bell Telephone, which I had just brought over from America; and conversation was actually maintained between Plymouth and Exeter. Five years have elapsed since then, and it is fitting that the British Association should hear of the progress of this astonishing apparatus.

In 1877, it was a scientific toy; it has now grown to be a practical instrument. 1,550,000*l*. capital is already embarked in its extension in England, and it is earning a revenue of 109,000*l*. Hitherto it has been practically a monopoly in the hands of a private company, who hold the controlling patents, and of the Post Office, who possess the controlling power, but this monopoly has been broken, and we are about to witness severe competition. It is often said that competition in any business will have the effect of reducing the rates charged to the public, but the experience of the past in railways and telegraphs scarcely teaches this lesson. Undue competition tends to lower the rates for a time, but it eventually leads to amalgamation—to the absorption of the weak by the strong—to swollen and watered capital, aud, finally in many instances to higher rates to a too-confiding public. Competition, however, induces better service, and ultimately, in this respect, the public gain.

The free traffic in patents, however, leads to jobbery and speculation of the worst type. We have recently seen a mania for electric speculations that almost rivals the South Sea Bubble period. The public have wildly rushed into ill-matured schemes that have swollen the purses of gambling promoters, have turned the heads of inventors, have retarded the true progress of the beneficial application of this new science to the wants of man, and have thrown away millions upon imperfect schemes. Much has been said against the monopoly of the Post Office in telegraphic business, but at any rate it has the merit that it has checked the rapacity of company promoters and patent-mongers in that branch of the practical application of electricity, while no one can assert that it has checked the progress of telegraphy. During the first week that the telegraphs in this country were transferred to the State, the total number of messages transmitted was 26,000, while in the week ending August 11th it amounted to 724,000. There is no inventor who can assert that his scheme has not received proper consideration, nor show a real improvement that has not been adopted and remunerated; while the improvements of the Post Office itself are freely adopted by other countries, and America itself—the home of the inventor—has found the advanced system of England worthy of acceptance.

Receivers.—The original telephone receiver of Bell has scarcely been improved upon; it remains in form and construction very nearly the same as that which I exhibited in 1877. The perfection of its working depends upon the truth and perfection of its manufacture. It is now more solid and substantial than it was at first, more powerful magnets are used; but still it is the same simple, marvellous, and beautiful instrument that I brought over from America. Mr. Gower has increased its loudness by varying the form of its various parts, and using very powerful horse-shoe magnets of peculiar form; but experience shows that loudness is always obtained at the expense of clearness of articulation; and, although for many purposes the Gower-Bell iustrument, which is adopted by the Post Office and is now in use to connect together all the sections of the British Association scattered through the town of Southampton, is more practical, nothing for delicate articulation surpasses the original Bell.

The Paris Exhibition of last year, so fruitful in electrical novelties, did not bring forth any marked improvement in telephonic apparatus. It was noticeable chiefly for its practical applications of the telephone, and particularly to the transmission of singing and music to a distance. M. Ader's modification of Bell's receiver is that almost universally used in Paris. It is a

[1] Paper read at the Southampton meeting of the British Association. Revised by the author.

very handy, pretty, and convenient form. He utilises a principle which he calls "surrexcitation." A thick ring of soft iron is inserted between the ear-piece and the diaphragm, and this is said to increase the attractive power of the little horse-shoe magnet upon the vibrating iron diaphragm. A simple experimental apparatus of M. Ader's shows that there is some foundaton for this fact: when a thin steel spring is adjusted close to the poles of a magnet without being attracted by them, the near approach of a mass of iron to the spring will cause it to be attracted by the magnet.

D'Arsonval has also modified the Bell receiver. He has placed the coil in a powerful magnetic field of annular form, and has thereby concentrated the lines of force upon the induced coil. He brings the whole coil within the influence of the field. The effects are said to be magnified, and the increased loudness is not accompanied by the usual loss of articulation. Speech is reproduced without any change of *timbre*.

Telephone receivers of the Bell type are all based upon the magnetic effects of currents of electricity flowing around magnets or bars of soft iron.

The rapid and rhythmic magnetisation and demagnetisation of a bar of iron or the increment and decrement of the magnetism of a magnet, will produce molecular disturbances, in its own mass and in the matter about it, that lead to the oscillatory motions of the whole which produce sonorous vibrations that can be made manifest by various devices, and particularly by that patented by Graham Bell.

Other principles of electricity have also been utilised for telephonic receivers.

For instance, Mr. Edison used the electro-chemical effect. The decomposition of a chemical solution in paper or on chalk by the passage of currents through it, produces a modification of the friction of two moving surfaces, which can reproduce sonorous vibrations, and the result is a very loud-sounding apparatus. I myself had the pleasure, in 1880, of submitting to the Royal Society a receiver based on the electro-thermal effects of the current. The passage of a current through wires always heats them and therefore produces expansion. If the wire be made fine enough, the heat is generated and dissipated so rapidly, the expansion and contraction are so quick, that sonorous vibrations are the result. Although I was able to speak through it very clearly, I have not as yet developed this instrument into a practical form. Professor Dolbear has recently utilised the electro-static effects of currents. His receiver is even more simple than that of Bell. Two flat circular discs of metal are rigidly fixed very close to each other in an insulated case of ebonite. When one disc is electrified positively by a charge of electricity, the other is electrified negatively by induction. These two opposite states produce attractions varying in force with the strength of the signals sent, and the result is that, when telephonic currents are transmitted, we obtain sonorous vibrations, and, consequently, the reproduction of speech.

Many other forms of telephone receivers have been devised and exhibited, in fact I have recently seen quite a crop of them; but as they involve no new principle, and introduce no particular improvement, having been brought out chiefly to try to avoid existing patents, I pass them over, and proceed to the next branch of my subject.

Our present Patent Law is, unfortunately, in so disorganised and chaotic a condition, that evasion is often possible, and hence the questionable morality of doing a thing in another way, in order to avoid the incidence of a royalty, is practically encouraged. The possession of a patent is now no guarantee of property: it is granted without any discrimination, and cannot be upheld without tedious litigation and wasteful expenditure before a non-technical and scientifically incompetent tribunal. We therefore cannot hope for any virtue in English inventors or security for real improvements until our law is thoroughly revised. The question is before the House of Commons, and, when wordy agitators have fully exhausted the patience of our legislators, we may hope for some attention to so real and pressing a want.

Transmitters.—The great novelty and peculiarity of Bell's telephone was that the receiver and transmitter were similar and reversible. Sonorous vibrations of air impinging on an iron disc caused it to vibrate in front of a magnet around one pole of which a portion of an electric circuit was wound. These vibrations of a magnetic substance in a magnetic field produced currents of electricity in the coil of wire on the magnet, varying in strength and direction with the sonorous vibrations, which, proceeding along a wire to a distant station, there varied the magnetic strength of a similar magnet so as to vary its attractive force on a similar disc, by which it reproduced the motions of the first disc, and thus, reproducing the sonorous vibrations of the air, repeated speech. The currents, however, were very feeble; much energy was lost *en route*, and the effect scarcely attained a practical standard. Mr. Edison showed how to strengthen these currents. Taking advantage of a peculiar property of carbon which was supposed to vary in electrical resistance with the amount of pressure brought to bear upon it, he caused the vibrating disc which was spoken against to press upon a button of carbon, and so to vary the strength of a current of electricity passing through it. This varying current, passing through the primary wire of an induction coil, set up in the secondary coil more powerful currents than the Bell instrument produced, and caused louder and more marked effects at the receiving station. Professor Hughes went a step further. He found a combination of materials that were directly affected by sonorous vibrations, which he called a "microphone," and he proved that the effect of the carbon transmitter of Edison was not due to any influence of varying pressure on the mass of the carbon, but was a phenomenon of loose contact. He found a new fact in nature, and he startled the scientific world by introducing an instrument which did for minute sounds what the microscope had already done for minute objects. By the light thrown on the theory of the instrument by Hughes, Edison's carbon transmitter has been so improved by Blake, Hunnings, Moseley, Anders, and others, that little apparently remains to be done. The telephone as a speaking instrument is now well nigh perfect. It is quite possible to swear to a friend's voice at 100 miles distance. The difficulty of making the telephone a practical instrument under all circumstances is not due to any defects in the instrument itself, but to disturbing influences external to it, and consequent on its surroundings. The very pefection and sensitiveness of the apparatus itself are its chief enemies.

The true action of the microphone, or carbon-transmitter, is very little understood: it introduces into a closed electric circuit, through which a current is flowing, a resistance which, varying exactly with the sonorous vibrations impinging upon it, causes the current to undulate in a way exactly analogous to the varying sound waves. This effect is generally assumed to be due to a greater or less intimacy of electrical contact between two semi-conducting surfaces abutting upon each other; but there is now little doubt that it is due to effects of heat generated by the passage of electricity between two points in imperfect contact, whose relative distance is variable. Carbon is the best material for the purpose—first, because it is inoxidisable and infusible; secondly, because it is a poor conductor; and, thirdly, because it has the remarable property of having its resistance lowered when it is heated—the reverse of metals. This observation is due to Mr. Shelford Bidwell.

The resistance of microphones is very variable: some give 10^{ω}, while others give 25^{ω}, and some even 125^{ω}. The best transmitters that I have worked with (Moseley's) give an average of 20^{ω}.

Attempts have been made to apply mathematical analysis to the determination of the best form and arrangement of microphones, but at present the microphone defies mathematics.

Theory would lead to the conclusion that a carbon-transmitter should have the lowest possible resistance, but practice does not confirm that idea.

Theory again asserts that the resistance of the secondary coil of the induction coil should be equal to that of the line it works, but practice proves the very reverse. On a line giving nearly $1,800^{\omega}$ resistance, the best effects were produced with a secondary wire of only 30^{ω} resistance. The fact is, that the conditions due to heat in the microphone, and to self-induction in the induction coil, are very complicated, and are not yet sufficiently understood to bring the phenomena they affect within the region of mathematical analysis.

Accessories.—I do not intend to speak here of the bells, calls, switches, etc., used in carrying out telephonic operations: there has been nothing that is particularly novel introduced, or that was not previously used in telegraphy. In fact, the whole operations carried on in connection with the so-called "exchange" working are simply telegraphic, and are still in a somewhat tentative condition.

Long-distance Speaking.—I have said that the difficulty in speaking is chiefly due to the environment of the wires employed. Were we to erect a wire from Land's End to John o' Groats, upon lofty separate poles and away from all other wires, there would be no difficulty whatever in speaking between those two places. Conversation has been held in America over 410 miles; in Persia it has been effected between Tabreez and Tiflis, 390 miles apart; in India, over a distance of nearly 500 miles; in Australia, of 300 miles; but in all these cases it was done either at night or under exceptional circumstances, and in all cases the wires were over-ground. Had they been underground or submarine, the case would have been very different. Conversations have been held between Dover and Calais, between Dartmouth and Guernsey, and between Holyhead and Dublin, but I know of no case where any persons have spoken through more than 100 miles of submerged cable. The reason of this diminution of speaking distance is due to the electrostatic capacity of the telegraph line, which absorbs the minute quantity of electricity that makes up the currents employed for telephonic purposes.

In every submarine cable, before a signal can be made at the receiving end, the whole cable must be charged up with electricity, and if there be not sufficient electricity sent in to effect this purpose, practically no signal appears at the distant end. With telephone currents on long cables the whole of the electricity is, as it were, swallowed up—that is, none appears at the distant end, or, if it does appear, it is rolled up in one continuous wave, bereft of those rapid variations that reproduce sonorous vibrations. The newspapers said that the sound of the bombardment of Alexandria was heard at Malta; but, in the first place, the experiment was not tried, and, even if it had been tried, it could not have succeeded. The use of underground wires very seriously impedes telephonic extensions, and with our present apparatus and present knowledge we cannot readily speak over greater distances than 20 miles.

Disturbances.—But there are other disturbing influences at work of more serious import.

When two or more telephone wires run side by side, what is said on one can be overheard on all the others; and when a telephone wire extends alongside telegraph wires, every current on the telegraph circuit is repeated in the telephone, leading to a hissing, frying, bubbling sound that is not only very irritating, but which on busy lines entirely drowns speech. When music is transmitted on one wire, it can be heard equally well on all wires running parallel and contiguous. This is due to induction and to leakage.

(A.) *Induction.*—Induction is a term employed to designate the peculiar influence which electrified and magnetised bodies exert upon conducting and magnetic masses in their neighbourhood. If two wires run side by side for some distance, every current of electricity sent upon one wire will produce two currents in the contiguous wire, the one at the commencement and the other at the end of the primary current of electricity. The greater the intensity, and the more sudden and abrupt the commencement and the ending of the inducing current, the greater effect it has on the induced wire. Those instruments, consequently, which reverse their currents the most rapidly and suddenly, produce the greatest disturbance. The powerful alternative and intermittent currents used for certain electric light systems are death to telephones: they cause an incessant roar that renders speech an impossibility. There are some apparatus in telegraphy that require very powerful currents to work them, which are equally detrimental. Many attempts have been made to cure this evil.

1. The sensitiveness of the receiver has been reduced to lessen the influence of the disturbing currents, and the strength of the telephonic transmitting currents has been increased so as to overpower the induced currents.

2. The influence of one wire on the other has been screened off by inserting metal coverings in connection with the earth between them.

3. The suddenness of the rise and fall of the inducing currents has been modified by the insertion of condensers or electromagnets.

4. Counterbalancing or neutralising effects have been set up by counter-induction apparatus.

But all these plans, and many others, have been proved either only partially successful or wholly abortive; the only effective mode of curing the evil at present practically used is to employ a complete metallic circuit so contrived that the two wires are in very close proximity to each other, or that they twist round each other, so as to maintain a mean average equality of distance between themselves and the disturbing wires. When we have the two wires of a circuit kept at the same mean distance from the disturbing causes, however near they may be, the influence on each must be identically the same, and as the one is used for going and the other for returning, the similar influences must be opposite in direction, and they must therefore neutralise each other. This plan, which was originally devised for underground wires by Mr. Brooks, of Philadelphia, was found to be absolutely true in practice, and the Post Office, having laid down many hundred of miles on this system with perfect success, invariably constructs its circuits both underground or overground in this way. It is, of course, more expensive than a single wire, but the great gain—the absolute freedom from overhearing, the privacy and the absence of crackling—is well worth the extra cost. Wires in submarine cables are invariably laid up with a twist, so that no special contrivance is needed on such wires, and in underground wires not laid up together as cables, they are as a rule, so close to each other that twisting is unnecessary; but for overground purposes twisting is essential, and special arrangements have to be carried out. Professor Hughes showed how this was to be done, and Messrs. Moseley carried it out practically in the neighbourhood of Manchester. The plan adopted by the Post Office for *two* and for *four* wires is shown by the diagram. It is simply and easily carried out, and entails no practical difficulty whatever.

In the neighbourhood of Manchester there are over 400 miles of overground double wire twisted on this plan, working efficiently and thoroughly. I have spoken to a friend 76 miles off, through wires that were erected on poles carring busily-occepied telegraphic currents, without disturbance or difficulty.

(B.) *Leakage.*—The double-wire system is only absolutely effective so long as the insulation is good. The moment insulation fails, connection with the earth is made, and then we have disturbing causes due to currents flowing through the ground, which are increased in proportion to the deterioration of the insulation. Hence, good insulation is essential to telephone working.

The discovery of the telephone has made us acquainted with another phenomenon. It has enabled us to establish beyond doubt the fact that currents of electricty actually traverse the earth's crust. The theory that the earth acts as a great reservoir for electricity may be placed in the physicist's waste-paper basket, with phlogiston, the materiality of light, and other hypotheses. Telephones have been fixed upon a wire passing from the ground floor to the top floor of a large building, the gas pipes being used as a return, and the Morse signals sent from a telegraph office 250 yards away have been distinctly read; in fact, if the gas and water systems be used, it is impossible to exclude telegraphic signals from the telephone circuit. There are several cases on record of telephone circuits miles away from any telegraph wires, but in a line with the earth terminals, picking up telegraphic signals. When an electric light system uses the earth, it is stoppage to all telephonic communication in its neighbourhood. The whole telephonic communication of Manchester was one day broken down from this cause, and in the City of London the effect was at one time so strong as not only to destroy telephonic communication, but to ring the bells. A telephone circuit using the earth for return acts as a shunt to the earth, picking up the currents that are passing, in proportion to the relative resistances of the earth and the wire. The earth offers resistance, and consequently obeys the law of Ohm; hence it is not only essential for a telephonic system that the earth should not be used on any electric light system, but it is also desirable that the earth should be eschewed for telephonic purposes. Thus, the double-wire system adopted by the Post Office and by the Société Génerale des Telephones of Paris, not only cures the ill effects of induction, but it materially diminishes the disturbing influences of earth conduction. The four-wire system of the Post Office effectually checks leakage from one wire to the other—cross contact, as we call it in England—for each wire of the same current is always on a different supporting arm.

A telephone circuit when in connection with the earth gives distinct evidence of every visible flash of lightning, however far off the thunderstorm may be. No difference in time has been observed between seeing the flash and hearing the crash.

It is said that, if a telephone be connected between the gas and water systems of a house, distinct evidence of every flash can be heard. There have been several cases of persons being knocked down while experimenting during a thunderstorm, but no personal injury has been sustained, although the apparatus itself is frequently damaged. In England, at present, we have not found the damage done sufficient to justify the employment of lightning protectors. The use of double wires diminishes the danger to a minimum. On the Continent and in America, however, telephones are invariably protected by lightning arresters where one wire only is used.

There are certain natural currents flowing through the crust of the earth. They are called "earth" currents, and at times acquire such considerable energy, that, with a telephone pressed to each ear, I have been told, although I have not experienced it, that the noise made is as though "your brains were boiling." This is due to the intermittent currents produced by the polarisation of the earth plates.

M. Van Rysslberghe has recently spoken between Paris and Brussels upon a wire nearly 200 miles long, which was used at the same time for ordinary telegraphy, but the experiment was made early in the morning (4 a.m.), and was effected by retarding the telegraphic currents, so as to modify the suddenness of their rise and fall, by means of condensers and electro-magnets. I am unable to understand the advantage of any gain in speaking on a wire which is detrimental to telegraphic communication. Speed is of more importance than speech, and we can telegraph much faster than we can speak. In England speed is everything and we eliminate every influence that retards speed—condensers and electro-magnets in telegraphy circuits are out of the question. M. Van Rysselberghe has endeavoured to extend the idea to cure the effects of induction by destroying the main cause of the disturbance—that is, by reducing the sudden rise and fall of the prime telegraphic currents; but to do this means to retard telegraphy, and we cannot afford in England to cripple the one system in order to benefit the other.

I have recently tried an extremely interesting experiment between this place (Southampton) and the Isle of Wight, namely *to communicate across seas and channels without the aid of wires at all.* Large metal plates were immersed in the sea at opposite ends of the Solent, namely, at Porthsmouth and Ryde, six miles apart, and at Hurst Castle and Sconce Point, one mile apart. The Portsmouth and Hurst Castle plates were connected by a wire passing through Southampton, and the Ryde and Sconce Point plates by a wire passing through Newport; the circuit was completed by the sea, and signals were passed easily so as to read by the Morse system, but speech was not practical.

The telephone is very rapidly gaining ground, and, as improvements are effected in its accessories, in its installation, and in its mode of working, its use will still further extend. In Germany it is nsed very extensively for telegraphic business, there being 1,280 stations worked entirely by telephones, but in England it is not possible in the numerous open and public shops employed as Post Offices to secure that privacy which the telephone requires nor have we yet got over our early prejudices, resulting from the errors made through the inability of the instrument in its earlier form to repeat the sibilant sounds. The instruments of the present day (thanks to the improved transmitters), however, transmit "s's" perfectly.

William Henry Preece

SCIENTIFIC SERIALS

Journal of the Franklin Institute, September.—On a newly discovered absolute limit to economical expansion in the steam-engine and in other heat-motors, by R. H. Thurston.—Observations with the platinum-water pyrometer, with heat-carriers of platinum and of iron encased with platinum, by J. C. Noadley.—The microscope in engineering work, by R. Grimshaw.—Tests of double raw hide belts, by J. E. Hilleary.—Greatest ringing bells, by J. W. Nystrom.—Report on European sewage-systems, with special reference to the needs of the City of Philadelphia, by R. Hering.—Emerson's power scales, or dynamometer, by J. H. Lord.—Mechanical modifications of the Bessemer plant necessary to adapt it to the economical working of the basic process, by W. M. Henderson.—Prevention of fires in theatres (continued), by C. J. Hexamer.

Bulletin de l'Academie Royale des Sciences de Belgique, No. 7.—On the seat of thunderstorms and their origin, by W. Spring.—On the compound ethers of hyposulphurous acid, and on some organic bisulphides, by W. Spring and E. Legros.—On the brominated derivatives of camphor, by M. Swarts.—Note concerning the priority of the discovery of a relation existing between dilatability and fusibility, by P. De Heen.

Journal de Physique, July.—On the condition of achromatism in the phenomena of interference, by A. Cornu.—On the same, by A. Hurion.—On the actinic transparence of some media, and in particular on the actinic transparence of Foucault mirrors and their application in photography, by J. de Chardonnet.—On methods for determination of the ohm, by G. Lippmann.—Apparatus for regulating the flow of a gas at any pressure, by J. Ville.

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti. Fasc. xii.-xiii.—New method for determining the relative internal conductivity of metals for heat, by G. Poloni.—On the theory of systems of electrified conductors, by E. Beltrami.—On the pseudofocus of the paraboloid and on the magnetic centre, by G. Jung.—Contribution to the experimental study of hypnotism in hysterics, by A. Tanburini and G. Seppilli.

Fasc. xvi.—New microtelephonic system, by C. Fornioni.—The crystalline group of Albigna and Disgrazia; stratigraphical and chemico-lithological studies, by E. Bonardi.—On syphilitic reinfection, by A. Scarenzio.—Luni-solar influence on earthquakes, by A. Serpieri.—Contribution to the general physiology of smooth muscles, by E. Sertoli.—The plague of Milan in 1576 and Cardinal Borromeo, by A. Corradi.

Atti della l'Accademia dei Lincei; Transunti. Fasc. xiv.—On the circulation of blood in the human brain, by S. Mosso.—On the microscopical fauna of the Zanclean limestone of Palo, by S. Terrigi.—Internal equilibrium of metallic piles according to the laws of elastic deformations, by S. Allievi.—On the graduation of galvanometers, by Signor Canestrelli.—On the influence of hygroscopic condensation on glass in determination of the density of aqueous vapour, by Signors Macaluso and Grimaldi.—The action of oxygenated water on the system, by Signors Capranico and Colasanti.—On two isomeric acids, santonosic and isantonosic, by Signor Cannizzaro.—On some products of transformation of glutaric or normal pyrotartaric acid, by Signor Bernheimer.—Action of nascent hydrogen on pyrrol, by Signors Ciamician and Dennstedt.—On some derivatives of hexahydronaphthaline, by Signor Agrestini.—On two volumes of autograph drawings of the two brothers Cherubino and Giovanni Alberti, by Signor Cannizaro.—New Carthagenic inscription to Fanith and Baal-Hammon.—Ephemerides and hydrometric statistics of the River Tiber during 1881, by Signor Betocchi.—On the anatomy of leaves (continued), by Signor Briosi.—On the first phenomena of development of *salpa*, by Signor Todaro.—Statistics of the popular banks existing in Italy in the end of 1880, by Signor Bodio.—First outlines of a statistic of the conditions of life of operatives, by the same.—The diminution of illiterates in Italy, by the some.—On the Comet Wells, by Signor Respighi.—On the total eclipse of May 7, 1882, by the same.

SOCIETIES AND ACADEMIES

Sydney

Linnean Society of New South Wales, June 28.—Dr. James C. Cox, president, in the chair.—The following papers were read:—Half century of plants new to South Queensland, by the Rev. B. Scortechini. This paper was to some extent a continuation of a previous paper by the same author, and contained the results of further researches on the flora of that part of the country. Among the plants enumerated were many hitherto regarded as strictly tropical, while others had not previously been observed in such warm latitudes.—Contribution to a knowledge of the fishes of New Guinea, by the Hon. William Macleay, F.L.S., &c. This paper gives a list of 120 species of Percoid Fishes collected by Mr. Andrew Goldie at Port Moresby and Cuppa-Cuppa, in New Guinea. They are, with few exceptions, species which have been described by Dr. Bleeker as being found on the northern shores of that island and throughout the Netherlands India Archipelago generally. The new species described are *Serranus Goldiei*, *Serranus magnificus*, *Genyoroge bidens*, *Mesoprion rubens*, *M. parvidens*, *M. Goldiei*, *Diagramma Papuense*, *Lethrinus aurolineatus.* The remainder of Mr. Goldie's collection is to form the subject of a future paper.—A monograph of the Australian Aphroditacean annelids, by Mr. W. A. Haswell.—Two papers were read by Mr. E. P. Ramsay, F.L.S., Curator of the Australian Museum, one containing a description of a new species of *Phlogœnas* (*P. Salamonis*) and of a new species of *Dicrurus* (proposed to be called *D. longirostris*) from the Solomon Islands; the other containing a description of a new species of *Coris* from Lord Howes' Island.—Prof. W. J. Stephens exhibited a few specimens of a lost *Euca-*

lyptus which had been lately re-discovered by his brother, Mr. T. Stephens, in the immediate neighbourhood of Hobart. He stated that the plant (*Eucalyptus cordata*) had only once been seen by botanists since the expedition of d'Entrecasteaux, and then only in two isolated and remote spots.

PARIS

Academy of Sciences, September 4.—M. Blanchard in the chair.—The following papers were read:—Solution, in finite and simple terms, of the problem of longitudinal shock, by any body, of an elastic bar fixed at the unstruck extremity, by M. de Saint Venant.—On the figure of comets, by M. Faye. In this whole question, apparently so complicated, there is merely (he says), the play of solar attraction tending to decompose bodies of very small mass and large volume, and that of solar repulsion (due to incandescence) which begins to act on the evaporable part of those materials, when, freed from all pressure and subject to increasing heat, they commence to form nebulosities of excessive rarity.—On *trombes* observed on the sea at Etretat, by M. Lalanne. The phenomena described, comprising *eleven* trombes, occurred in September, 1851. M. Faye explains them on his theory.—On the distribution of heat in the dark regions of solar spectra, by M. Desains. He gives here his observations with prisms of crown-glass and flint (the previous were with rock-salt). The spectrum is prolonged much further on the side of the rays of great wave-length, than with rock-salt. M. Desains describes an apparatus, for determining, conveniently and surely, the angular distance of any line of the luminous spectrum from one of the cold bands of the dark spectrum.—M. Alph. Milne-Edwards announced that the *Travailleur* had returned from its cruise in the Bay of Biscay, to the west of Spain and Morocco, to Madeira and the Canaries.—Typhoid fever in Paris; period of 1875 to 1882, by M. de Pietra-Santa. In the first half of this year the deaths from typhoid fever in Paris were 4·60 per cent. of the total deaths (in 1865–7 they were only 1·90 per cent., in 1875, 2·30 per cent.). The fever has most victims in April and in November. Its distribution is unequal in the several arrondissements. There is no direct and constant relation between the number of deaths from it, and the number of the population in the arrondissement, the surface, the density of population, and the general mortality. Medical statistics, with clinical observation, prove the impossibility of referring typhoid fever to a single cause, the fecal origin assigned by the English school.—Theoretical and practical consideration on the phenomena of electro-magnetic induction; application to the more common types of machines, by M. de Tromelin.—Action of helenine on the bacillus of tuberculosis, by M. de Korab. Helenine seems adverse to the development of the organism.—On the syphilitic bacterium; syphilitic development in the pig, by MM. Martineau and Hamonie.—On the problem of Kepler, by M. de Gasparis.—Oscillation-balance employed for calculation of moments of inertia, by M. Brassinne.—Researches on the absorption-spectrum of the terrestrial atmosphere, by M. Egoroff. These were carried out at the Paris Observatory with M. Thollon, the electric and other light being sent from Mont Valerien, Montsouris, &c. Details of the spectra are given.—Experimental study of the reflection of actinic rays; influence of specular polish, by M. de Chardonnet. Every surface reflects in variable proportions each of the spectral radiations. The reflecting power of a liquid is independent of the substances it holds in solution or suspension. Specular polish increases the total quantity of radiations reflected, while the relative intensity of different regions of the spectrum depends on the matter employed.—On the law of cooling, by M. Rivière. He observed the cooling of a platinum wire heated by an electric current in dry air, within a glass cylinder, on which flowed a current of cold water. The wire's temperature was deduced from the variations of its conductivity, and the quantity of heat lost (equal to that developed by the current), calculated by Joule's law. The results are compared with those got from the formulæ of Dulong and Petit and of Rossetti. (The formula of the former is shown, as by other physicists, to give too rapid increase.)—On the law of thermal constants of substitution, by M. Tommasi.—On some combinations belonging to the group of creatinines, by M. Duvillier.—Researches on the circulatory apparatus of regular sea-urchins, by M. Kœhler.—On the innervation of the mantle of some lamellibranch molluscs, by M. Vialleton.—On the intestinal parasites of the oyster, by M. Certes.

September 11.—M. Blanchard in the chair.—Reference was made to the death of M. Liouville, Member, and M. Plantamour, Correspondent. (Funeral discourses on the former, by MM. Faye and Laboulaye, are printed in *Comptes Rendus*).—On the mean temperature of the northern and southern hemispheres of the earth, by Mr. Hennessy. There is reason to believe that the idea of a superiority of temperature of the northern hemisphere over that of the southern must be given up. Mr. Henel considers the southern hemisphere, with its greater mass of water, to have (if anything) the higher temperature, or about 15°·4 C. Herr Hann considers that 15°·2 C. represents the temperature of both hemispheres. Mr. Hennessey views with satisfaction the removal of a difficulty in his theory of climates put forth many years ago.—On the extension of the phylloxera at Béziers in vineyards not submitted to treatment, by M. Henneguy.—Means of combating the disease of the vine, by M. Maistre. He has had good results from applications of greasy water (from washing of sheep's wool) every fifteen days, besides sulphocarbonate of potassium.—Conditions for two linear differential equations without second member to have p common solutions; equations giving the solutions, by M. Lemonnier.—Natural definition of differential parameters of functions, and especially of that of the second order Δ_2, by M. Boussinesq.—Observations of the solar spectrum, by Mr. Langley. This relates to the resnlts of the Mount Whitney expedition. *Inter alia*, it is estimated, that, our atmosphere apart. the solar rays would raise about 3 deg. C. 1 gr. of water in one minute, for each square centimetre of the earth's surface exposed normally to them. Of the total energy which vivifies the world, only a quarter occurs in the visible spectrum and the ultra-violet; the other three quarters exist in the great infra-red region, whose extension has been so erroneously conceived. The general telluric absorption, at least in dry climates, diminishes to the extreme infra-red. In general, in both atmospheres (the earth's and the sun's), the absorption increases (except in interruptions noted) as the wave-length diminishes. The absolute colour of the photosphere is blue. The maximum energy in the visible spectrum is in the orange.—On the various causes of etiolation of plants, by M. Mer. He inquires into these by a comparison of the phenomena of aquatic plants with those of aërial plants grown in the dark or in moist air.—On a new amputation of an upper limb, by M. Després. For disease of the omoplate this bone was removed, with the arm and part of the clavicle.—Signor Govi presented a small work giving six unpublished letters of Galileo; also a memoir describing experiments in transformation of electricity of tension into voltaic currents. The latter were made in ignorance of the previous experiments of M. Bichat. With a small Holtz machine Signor Govi decomposed water, getting in three minutes 1 cc. of explosive mixture; with the same current he vibrated a Froment siren, produced magnetic spectra, obtained very bright sparks by interruption with a steel file, lit an arc between carbons, and actuated a Rhumkorff coil.

CONTENTS