THURSDAY, JUNE 11, 1885

THE DARWIN MEMORIAL

IT is not often that the unveiling of a statue is attended with an interest at all comparable with that which characterised this ceremony as performed last Tuesday in the Great Hall of the Natural History Museum. If the greatness of a man is to be estimated by the measure in which he has influenced the thoughts of men it is scarcely open to question that the greatest man of our century is Charles Darwin. As Prof. Huxley remarked in the course of his singularly judicious and well-balanced address, Mr. Darwin's work has not only reconstructed the science of biology, but has spread with an organising influence through almost every department of philosophical thought. Yet it was not merely the greatness of the naturalist which invested the proceedings in the Natural History Museum with an interest so unique. It was known to the whole assembly that the man whom they delighted to honour was one whose moral nature had been cast in the same lines of simple grandeur as those which belonged to his intellectual nature. It therefore only needed a passing allusion from Prof. Huxley to enable the whole assembly to reflect that it was due as much to massiveness of character as to massiveness of work that within three years of his death Mr. Darwin's name should constitute a new centre of gravity in every system of thought. And it was this reflection which gave to the ceremony so unusual a measure of interest. Around the statue were congregated the most representative men of every branch of culture, from the Prince of Wales and the Archbishop of Canterbury, to the opposite extremes of Radicalism and freethought. Indeed, it is not too much to say that there can scarcely ever have been an occasion on which so many illustrious men of opposite ways of thinking have met to express a common agreement upon a man to whom they have felt that honour is due. The international memorial could not in any nation have found a more worthy site than the one in which it has been placed; but if anything could have added to the "solemn gladness" with which the personal friends of Mr. Darwin witnessed the presentation of this memorial, it must have been the evidence which the assembly yielded that among the innumerable differences of opinion which it represented, his memory must henceforth be always and universally regarded as a changeless monument of all that is greatest in human nature, as well as of all that is greatest in human achievement.

Concerning the statue itself, we have only to speak in terms of almost unqualified praise. It is, in the truest sense of the phrase, a noble work of art. The attitude is not only easy and dignified, but also natural and characteristic; the modelling of the head and face is unexceptionable; and the portrait is admirable. The only criticism we have to advance has reference to the hands, which not only do not bear the smallest resemblance to those of Mr. Darwin, but are of a kind which, had they been possessed by him, would have rendered impossible the accomplishment of much of his work. Although this misrepresentation is a matter to be deplored, it is not one for which the artist can be justly held responsible. Never having had the advantage of seeing Mr. Darwin, Mr. Boehm has only to be congratulated upon the wonderful success which has attended his portraiture of the face and figure; the hands were no doubt supplied by guess-work, and therefore we have only to regret that the guess did not happen to have been more fortunate.

The following is the address made by Prof. Huxley, in the name of the Darwin Memorial Committee, on handing over the statue to H.R.H. the Prince of Wales, as representative of the Trustees of the British Museum:—

YOUR ROYAL HIGHNESS,—It is now three years since the announcement of the death of our famous countryman, Charles Darwin, gave rise to a manifestation of public feeling, not only in these realms, but throughout the civilised world, which, if I mistake not, is without precedent in the modest annals of scientific biography.

The causes of this deep and wide outburst of emotion are not far to seek. We had lost one of those rare ministers and interpreters of Nature whose names mark epochs in the advance of natural knowledge. For, whatever be the ultimate verdict of posterity upon this or that opinion which Mr. Darwin has propounded; whatever adumbrations or anticipations of his doctrines may be found in the writings of his predecessors; the broad fact remains that since the publication, and by reason of the publication, of the "Origin of Species" the fundamental conceptions and the aims of the students of living Nature have been completely changed. From that work has sprung a great renewal, a true "instauratio magna" of the zoological and botanical sciences.

But the impulse thus given to scientific thought rapidly spread beyond the ordinarily recognised limits of biology. Psychology, Ethics, Cosmology were stirred to their foundations, and the "Origin of Species" proved itself to be the fixed point which the general doctrine of evolution needed in order to move the world. "Darwinism," in one form or another, sometimes strangely distorted and mutilated, became an everyday topic of men's speech, the object of an abundance both of vituperation and of praise, more often than of serious study.

It is curious now to remember how largely, at first, the objectors predominated; but, considering the usual fate of new views, it is still more curious to consider for how short a time the phase of vehement opposition lasted. Before twenty years had passed, not only had the importance of Mr. Darwin's work been fully recognised, but the world had discerned the simple, earnest, generous character of the man that shone through every page of his writings.

I imagine that reflections such as these swept through the minds alike of loving friends and of honourable antagonists when Mr. Darwin died; and that they were at one in the desire to honour the memory of the man who, without fear and without reproach, had successfully fought the hardest intellectual battle of these days.

It was in satisfaction of these just and generous impulses that our great naturalist's remains were deposited in Westminster Abbey; and that, immediately afterwards, a public meeting, presided over by my lamented predecessor Mr. Spottiswoode, was held in the rooms of the

Royal Society, for the purpose of considering what further steps should be taken towards the same end.

It was resolved to invite subscriptions, with the view of erecting a statue of Mr. Darwin in some suitable locality; and to devote any surplus to the advancement of the biological sciences.

Contributions at once flowed in from Austria, Belgium, Brazil, Denmark, France, Germany, Holland, Italy, Norway, Portugal, Russia, Spain, Sweden, Switzerland, the United States, and the British Colonies, no less than from all parts of the three kingdoms; and they came from all classes of the community. To mention one interesting case, Sweden sent in 2296 subscriptions "from all sorts of people," as the distinguished man of science who transmitted them wrote, "from the bishop to the seamstress, and in sums from five pounds to two pence."

The Executive Committee has thus been enabled to carry out the objects proposed. A "Darwin Fund" has been created, which is to be held in trust by the Royal Society, and is to be employed in the promotion of biological research.

The execution of the statue was entrusted to Mr. Boehm; and I think that those who had the good fortune to know Mr. Darwin personally will admire the power of artistic divination which has enabled the sculptor to place before us so very characteristic a likeness of one whom he had not seen.

It appeared to the Committee that, whether they regarded Mr. Darwin's career or the requirements of a work of art, no site could be so appropriate as this great hall, and they applied to the Trustees of the British Museum for permission to erect it in its present position.

That permission was most cordially granted, and I am desired to tender the best thanks of the Committee to the Trustees for their willingness to accede to our wishes.

I also beg leave to offer the expression of our gratitude to your Royal Highness for kindly consenting to represent the Trustees to-day.

It only remains for me, your Royal Highness, my Lords and Gentlemen, Trustees of the British Museum, in the name of the Darwin Memorial Committee, to request you to accept this statue of Charles Darwin.

We do not make this request for the mere sake of perpetuating a memory; for so long as men occupy themselves with the pursuit of truth, the name of Darwin runs no more risk of oblivion than does that of Copernicus or that of Harvey.

Nor, most assuredly, do we ask you to preserve the statue in its cynosural position in this entrance-hall of our National Museum of Natural History as evidence that Mr. Darwin's views have received your official sanction; for science does not recognise such sanctions, and commits suicide when it adopts a creed.

No; we beg you to cherish this Memorial as a symbol by which, as generation after generation of students of Nature enter yonder door, they shall be reminded of the ideal according to which they must shape their lives, if they would turn to the best account the opportunities offered by the great institution under your charge.

The following reply was made by H.R.H. the Prince of Wales:—

PROF. HUXLEY AND GENTLEMEN,—I consider it to be a high privilege to have been deputed by the unanimous wish of my colleagues, the Trustees of the British Museum, to accept, in their name, the gift which you have offered us on behalf of the Committee of the Darwin Memorial. The Committee and subscribers may rest assured that we have most willingly assigned this honourable place to the statue of the great Englishman who has exerted so vast an influence upon the progress of those branches of natural knowledge the advancement of which is the object of the vast collections gathered here. It has given me much pleasure to learn that the memorial has received so much support in foreign countries that it may be regarded as cosmopolitan rather than as simply national; while the fact that persons of every condition of life have contributed to it affords remarkable evidence of the popular interest in the discussion of scientific problems. A memorial to which all nations and all classes of society have contributed cannot be more fitly lodged than in our Museum, which, though national, is open to all the world, and the resources of which are at the disposal of every student of nature, whatever his condition or his country, who enters our doors.

CLAUS'S "ELEMENTARY TEXT-BOOK OF ZOOLOGY"

Elementary Text-Book of Zoology. Special Part: Mollusca to Man. By Dr. C. Claus. Translated and edited by Adam Sedgwick, M.A., Fellow and Lecturer of Trinity College, Cambridge, with the assistance of F. G. Heathcote, B.A., Trinity College, Cambridge. (London: W. Swan Sonnenschein and Co., 1885.)

THE first 109 pages of this volume are devoted to the Mollusca and Tunicata, and the remarks offered in NATURE (vol. xxxi. p. 191) in criticism upon Vol. I. apply equally well here.

The information imparted is fully up to date, and the Tunicate section may be taken, on the whole, as a type of that well-balanced and succinct writing indispensable in a work of this order.

The unqualified statement on p. 9 that the mollusca are "*bilaterally symmetrical*" is unfortunate, and typical of a general insufficiency and sketchiness, evident throughout the entire work, in the diagnoses given of the great groups. No better instance of this can be quoted than those relating to the birds and mammals, where characters so vitally important as the modes of articulation of the jaw-apparatus upon the skull are omitted, and, although mentioned elsewhere, are inserted without that emphasis demanded of *primâ facie* characters applicable to both the living and extinct forms.

It is disappointing to find the invertebrate digestive-gland still spoken of as a "liver," no mention being made of the researches of Weber, Barfurth, and others, into its structure and functions. It is highly desirable in a book of this kind that any statements made concerning animals, such as are likely to fall into the hands of the average student, should be absolutely reliable. It cannot be said (p. 52) that the shell of Aplysia is "covered by two lobes of the foot," and the beginner would soon find that Limax and Arion are not the only common Gasteropods in which the pedal gland is present, while, from the statements made on p. 27 he would never infer that the common Anodon shell is destitute of teeth. The Argonauta, although somewhat less commonplace than the aforenamed, is to be found in our museums, and no mention is made in this volume of the exceptional characters of its shell—in fact, the beginner would rather infer from the descriptions given that it is a normal Cephalopod shell. Less pardonable are the inadequate remarks devoted to the rest of the Cephalopod group, which are especially unfortunate in their reference to connecting-links with the extinct forms. The anomalous but characteristic Aptychi go without a mention.

Viewed in the light of Prof. Moseley's recent discoveries, the reasons adduced on p. 44 for the absence of the cerebral ganglia in Chiton are of some interest, as a caution against making too sweeping generalisations.

Under the head of Molluscoidea there is a bare mention of the genus Rhabdopleura, and we are at a loss to conceive why the reference to this important form printed in the original index should have been omitted in the translation.

Turning now to that portion of the work which follows, the fact that but 231 pages are devoted to the Vertebrata, exclusive of Tunicates, is sufficient in itself to raise suspicion, especially when we reflect that 115 pages of Vol. I. are given up to Tracheates alone. When Mr. Sedgwick published the first volume of this work it was patent to any one familiar with the original that nothing short of a complete revision of the Vertebrate section could justify that claim set up by him in his translator's preface. Having admitted his willingness to supplement the original where he "thought it necessary"—thereby, we presume, countenancing the weakness of the volume now before us—it is surprising to find how little he has carried that resolve into execution, the more so as he acknowledges the assistance and advice of others, some of whom are authorities. That this defect is not due to any want of intention on the translator's part is clear from insertions such as that on p. 167; but we look in vain for dozens of other similar modifications, connected with matters of infinitely greater importance than that just referred to. Similarly, why should the recent discovery of the meroblastic segmentation of the Monotreme's egg be inserted by the translators and referred to some two or three times when there is no mention whatever of the far more weighty characters of the skull of that group? Even were defects such as the above-named rectified, the book would still remain wholly insufficient and incompetent. The exclusive use of the old classification of birds—the dogmatic statements made concerning many of the most involved fields of Vertebrate morphology; for example, that of the auditory ossicles, where Reichert's views are alone given—the entire omission of any description of such a characteristic structure as the lizard's hind-limb and ankle-joint—the feeble and confused descriptions of the vertebrate skull, obvious throughout the entire work and ushered in on p. 118 by the barbarous "*os linguale*" and "*copulæ*"—the ambiguous statements made on p. 124 concerning the vertebrate diaphragm, which still (p. 250) finds its place among the respiratory organs of birds, are, to say nothing of other similar defects, sufficient in themselves to stamp the vertebrate portion of the Text-book as little short of a failure. That that section of the work falls short of the needs of the English-speaking student is certain, especially as it is so far behind other manuals current in the tongue. Errors, the bare enumeration of which would be superfluous, are predominant on all hands, and the retention of the "Cetacea Carnivora" and "Cetacea Herbivora or Sirenia" (*sic*) of the ancients, is, leaving the Hydrosauria with its sub-classes aside, certainly not creditable to any one concerned. We heartily recommend the invertebrate portion of the work to the student. He may find that which follows useful, but he need be no specialist to see that it is insufficient on all points, and absolutely inaccurate and misleading on many of vital importance. It but remains to enumerate certain of the more conspicuous defects, respecting which at least, should a second edition of the work be demanded, it is to be hoped that the translators will see fit to effect an alteration.

The cumbrous and fanciful method of accounting (p. 113) for the characters of the thoracic region of the vertebrate body is to be regretted, leading the beginner, as it does to suppose this to be the most modified region of the trunk—a conception the precise reverse of that which the properly-trained student will soon form for himself. The exclusion of the teeth from the list (p. 119) of dermal derivatives and the complete confusion between scutes and scales evident throughout, are but slight faults compared with such as we have already enumerated. On p. 127 we are introduced to a thorough mixing up of the urinary receptacle of fishes with the allantoic bladder of Amniotes—a serious error, and one which the translator ought to have been expected to rectify.

The above remarks apply more especially to the general part of the vertebrate section of the work; but, on passing to that treating of the special groups, we find a general feebleness nowhere more evident than in that portion devoted to fishes. The diagnoses of that group are meagre in the extreme, and descriptions of even their tails such as are given on p. 164 are wanting in accuracy. No wonder, then, that the "jugular" pelvic fin should be once more to the front, that there is a disregard of characters so important as are those of the maxillary apparatus of Teleostei, and that such genera as Albula, Cheirocentrus, Megalops, &c., go unnoticed. The treatment of the Sauropsida is no less unfortunate than the above. Reference has already been made to some of the more conspicuous defects of this section, barely less pardonable than which are the bad descriptions of the bird's manus (p. 237) and the bare mention of the structure of the avian lung.

We are told on p. 243 that birds possess a rudimentary "corpus callosum," no mention being made of that tract which may probably answer to it in Amphibia. The treatment of the Sauropsidian pelvis and of the bird's shoulder-girdle are miserably poor, and the student is informed on p. 196 that Crocodiles possess an "*abdominal* sternum," which is "composed of a number of ventral ribs (without dorsal part)"; he will learn a valuable lesson who—Prof. Claus's manual in hand—discovers for himself that the ventral sternal ribs and these abdominal splints coexist in Hatteria, skeletons of which are now to be found in our museums. Considering the above facts, it is not surprising that nearly all reference to important matters of affinity between living birds and reptiles should be overlooked. The characters of the mesotarsal joint and of the tarso-metatarsus are imperfectly defined, and those of the pelvis of Apteryx ignored; while among the extinct forms, the Dinosauria—several of whose features we are told on p. 220 "recall mammals, especially the Pachydermata"—the Ornithoscelida, and the Odontornithes, are all dismissed in a few lines. Little would the student, taking his text from this work, dream of the noble array of direct affinities to be found among even living birds and reptiles.

The translators have evidently realised that the statements reproduced on pp. 198 and 215, concerning the lizard's quadrato-jugal arcade are contradictory, and a supplemental paragraph of their own on p. 198 only serves to increase the perplexity. Chapter IX. is devoted to the Mammalia, but 69 pages of it starting with the assertion (p. 282) that the Monotremes' hemispheres are "still smooth," is poor fare. The cutting down of every group of mammals to a minimum would be in a sense pardonable, if only concise diagnoses were given such as should cover the broad lines of modification; but when, bearing in mind certain of the more glaring defects of this chapter referred to at the outset, we read (p. 306) that the Whales approach the Ungulates "through the Sirenia," and that the "Sirenia are intermediate, so far as their form is concerned, between the whales and seals" (p. 309), our faith is shaken in that which remains. There is the usual confusion concerning the position and movements of the hind-limbs of the Pinnipedia, the condition of the parts in the eared seals being entirely overlooked. In diagnosing a group of animals for purposes such as are here required, where the living and the extinct are both under consideration, it is but fair to assume that special attention should be paid to the hard parts, the teeth not excepted; but we look in vain for statements such as shall embody the extremes of modification of these parts in any one group of living mammals—for example, in dealing with the Rodents the utmost sketchiness prevails, the modifications of even the fibula are not hinted at, and while Hydromys is placed among the mice with grinders $\frac{3}{3}$, Heliophobius is not mentioned. No wonder, then, that Hyœmoschus should go unnoticed, that Hyrax should here be found under the order Proboscidea (with a caution, it is true), and that the Carnivora, Cheiroptera, Lemurs, and Primates should be treated with disrespect. We are told (p. 301) that the epipubes support the marsupial pouch, and there is no reference at all to the most important facts concerning the marsupial dentition. There is something so specifically English about gross vertebrate anatomy that we search in vain for bare mention, not to say recognition, of discoveries bearing upon the above, and many similar matters of first importance.

From what has been said it will be obvious to English students that the vertebrate section of Prof. Claus's manual is weakest where works on the subject already current in our language are strong; and, with all respect to our Continental cousins, we are of opinion that the market is becoming overstocked with translations such as that before us. Their period is past; the English student in earnest must sooner or later fit himself for access to the originals, and the repeated production of English versions serves only to prolong the fatal day. We cannot but regret, though reluctantly, the publication of this work in its present form, the more so as it threatens to encourage the growing tendency to under-estimate the value of gross vertebrate anatomy, a field of labour essentially English, but still the very backbone of zoological science.

Mr. Sedgwick has performed the task of translation with a thoroughness and skill deserving the thanks of his countrymen. Some few passages in the original, at best clumsy, might have been better rendered than they are; and settings such as the "above together," on p. 16, might be advantageously modified. The translators give in Vol. I. a list of English synonyms for the geological terms employed in the original, but these are not always adopted in Vol. II.; thus we find the Jurassic beds referred to again and again as the "Jura," a rendering certainly not that of English geologists. The original illustrations are for the most part excellent, and those which remain are admirably selected. That on p. 284, however, certainly does not illustrate the anatomy of the human ear, and the figures selected from the classic of Johannes Müller, in illustration of the anatomy of the lamprey's skull (p. 154) do scant justice to the work of a great genius, and he a German. G. B. H.

CLIFFORD'S EXACT SCIENCES

The Common Sense of the Exact Sciences. By the late W. K. Clifford. (London: Kegan Paul, Trench, and Co., 1885.)

ONCE more a characteristic record of the work of a most remarkable, but too brief, life lies before us. In rapidity of accurate thinking, even on abstruse matters, Clifford had few equals; in clearness of exposition, on subjects which suited the peculiar bent of his genius and on which he could be persuaded to bestow sufficient attention, still fewer. But the ease with which he mastered the more prominent features of a subject often led him to dispense with important steps which had been taken by some of his less agile concurrents. These steps, however, he was obliged to take when he was engaged in exposition; and he consequently gave them (of course in perfect good faith) without indicating that they were not his own. Thus, especially in matters connected with the development of recent mathematical and kinematical methods, his statements were by no means satisfactory (from the historical point of view) to those who recognised, as their own, some of the best "nuggets" that shine here and there in his pages. His *Kinematic* was, throughout, specially open to this objection:—and it applies, though by no means to the same extent, to the present work. On the other hand, the specially important and distinctive features of this work, viz. the homely, yet apt and often complete, illustrations of matters intrinsically difficult, are entirely due to the Author himself.

The Editor, in his *Preface*, tells us the whole story of the difficulties he had to face in completing the volume for press. All will sympathise with him when they find that he had to furnish one entire chapter, and large portions of two others, in addition to thorough revisal of the whole. For Clifford's style is here entirely *sui generis*. The track to his homely yet hardy expositions often lay in regions where but a single careless step would have led to the Inconsequent or the Ridiculous. And one who tries to imitate him successfully must possess not only his nerve, but also his wonderful agility and resource of every kind. We shall therefore say no more on the subject of the Editor's additions to the volume, than that his daring has met with comparative immunity from the more obvious dangers of his course.

The original title of the work was, we are told, *The First Principles of the Mathematical Sciences Explained to the Non-Mathematical.* There can be no doubt that the new title is much to be preferred. We do *not* believe that the Mathematical Sciences, even in their first principles, can be explained to the Non-Mathematical. Whosoever understands the explanation has, to that extent at least, *become* Mathematical in the very act of understanding. But this observation is made on the assumption that Non-Mathematical means "uninstructed in mathematics." There is another sense which the term may bear:—viz. "incapable of understanding mathematics." Among mankind there are none who more persistently claim the almost exclusive possession of the highest grade of human intelligence than do the (so-called) Metaphysicians. How many of these self-accredited possessors of all but superhuman acuteness have been able to cross the *Pons Asinorum?* How many have been able to understand even the *objects* (not the *processes*) of mathematical investigation? When the answer comes (it probably will not come, as it *can not* come in a favourable form) it will be time to comment on it.

The chief good of this book, and in many respects it is very good, lies in the fact that the versatility of its gifted author has enabled him to present to his readers many trite things, simple as well as complex, from so novel a point of view that they acquire a perfectly fresh and unexpected interest in the eyes of those to whom they had become commonplace. Surely this was an object worthy of attainment! But it is altogether thrown away on the non-mathematical, to whom neither new nor old points of view are accessible.

Considering the circumstances under which the book has been produced, it would be unfair to comment on the smaller errors. But there are a few very awkward statements, and one or two grave errors, which ought not to have escaped correction. We give an example of each class. Thus, p. 16, the following statement is quite unnecessarily puzzling:—

"If we can fill a box with cubes whose height, length, and breadth are all equal to one another, the shape of the box will be itself a cube."

This out-germans German itself in the displacement of the words from their natural position in English; and, at first sight, seems to be nonsense. Read it, however, thus:—

"If we can fill with cubes a box whose height, &c. . . . the shape of the box itself will be a cube,"

and the absurdity, suggested by the collocation, disappears.

Again, p. 66, what are we to make of the following, standing, as it does, without comment or explanation of any kind?—

"The statement that a thing can be moved about without altering its shape may be shown to amount only to this, that two angles which fit in one place will fit also in another, no matter how they have been brought from the one place to the other."

Several most serious qualifications must be imposed upon this statement before it can possibly be accepted as true.

The chapter on *Motion* properly forms a part of this work, so far at least as kinematics is concerned. But it seems to be a mistake to conclude it with a few editorial sentences on the *Laws of Motion.* For here we have a perfectly new subject, and one which would require at least a full chapter to itself. It is probable enough that, at some period of his life, Clifford imagined that it might be possible to get rid of the idea of matter as well as of that of force, and so to reduce Dynamics to mere Kinematics. He never so expressed himself to me. But purely physical subjects were, properly speaking, beyond his sphere; his ideas about them were always more or less vague, because always of a somewhat transitional character, and were much modified at times by the momentary turn of his philosophical speculations. We are told in a foot-note to the first page of the *Preface* that Clifford left his *Kinetic* (a companion volume to his Kinematic) *in a completed state.* Surely, keeping this in view, the introduction of Laws of Motion into the present work was superfluous.

This foot-note unfortunately strikes a jarring chord at the very first opening of the book. We are told that "more serious delay seems likely to attend the publication" of Clifford's *completed* MS.; this is followed by a mysterious species of protest or remonstrance. Clifford could never have written in this vein. He would either have kept silence, or have blurted out the whole truth. Mystery and insinuation were not weapons of his, and should not be employed in connection with his name.[1]

P. G. TAIT

OUR BOOK SHELF

New Commercial Plants and Drugs. No. 8. By Thos. Christy, F.L.S., &c. (London: Christy and Co., 155, Fenchurch Street, 1885.)

THE eighth number of Mr. Thos. Christy's "New Commercial Plants and Drugs" has recently appeared, and the contents are of a similar character to those that have preceded it, the most recently introduced commercial products derived from the vegetable kingdom being enumerated and what has been written about them brought together. The first plant referred to in the book is of course the Kola nut (*Cola acuminata*), as being one of the most important, or at least one that has attracted a very large share of attention during the past year. This article is illustrated by a coloured plate of the fruit and seeds of this species, as well as of the Guttiferous plant known as the Bitter Kola. Besides having the property of cleansing or purifying and thus rendering wholesome stagnant or foul water, it has also been used for clarifying beer and spirits. One of its most remarkable properties is in restoring the senses after partaking to excess of intoxicating drinks. The most recent application of the Kola nut, however, is in the preparation of a paste for mixing with cocoa or chocolate, which it is said to improve "both in strength and flavour to an astonishing degree." It is considerably more nutritious and strengthening; so much so indeed "that a workman can, on a single cup taken at breakfast time, go on with his work through the day without feeling fatigued."

In consequence of this and many other medicinal

[1] In NATURE, vol. xxxii. p. 4, Mr. Tucker intimated that Messrs. Macmillan and Co. would publish the remaining mathematical papers of the late Prof. Clifford.—ED.

virtues the Kola nut is considered to have a great future before it in European commerce, and is consequently strongly recommended to the notice of planters in our colonies for extensive cultivation. With regard to the preservation of the germinating properties of the seeds, Mr. Christy says he has received them in good condition, both in baskets and barrels lined with the leathery leaves of a tree known as the "bal tree." Some received in dry loam arrived as fresh as when they were gathered, and of some that arrived eighteen months since, the bulk is stated to be perfectly fresh and retaining still their beautiful red colour.

From a list of fifteen species of *Myristica*, the fruits or seeds of which are described, the value of the nutmeg genus is shown, especially as oil seeds. Seeds new to commerce are frequently arriving in the Liverpool and London markets, intended for the expression of oil and for the preparation of oil cake. Such seeds are of a very varied character and belong to widely different natural orders, and not long since those of *Myristica surinamensis* came into Liverpool under the name of African nuts. Upon analysis they were found to contain a large quantity of solid oil or fat with an agreeable taste, and but little, if any, odour, and when fairly pure it is said to resemble cocoa butter.

Amongst other important economic plants or drugs mentioned are the Coca (*Erythroxylon coca*), the medical effects of which have attracted so much attention of late; the Jamaica Chewstick (*Gouania domingensis*), which, it is stated, "has recently been introduced into this country by one of our leading London dentists for use in tooth powder and mouth wash," and also in the form of a fluid extract as a gargle for relaxed throat.

Of Papaine, the active principle of the Papaw (*Carica papaya*), some interesting records are given regarding its effects in treatment of diphtheria, croup, indigestion, dyspepsia, &c.

LETTERS TO THE EDITOR

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

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

Ocular After-Images and Lightning

In reply to Mr. Shelford Bidwell's query whether the quiver of the lightning flash is a purely subjective phenomenon or not, I send the following extract from my note-book, made October, 1873:—"A flash of lightning consists of several separate flashes all occurring within a fraction of a second of each other. There was a very severe thunder storm at night, the thunder almost continuous. Drawing the curtain across the window so as to expose only a narrow slit of skylight, I observed this slit in the looking-glass which I kept moving rapidly backwards and forwards on its axis. Whenever a flash occurred, several images of the slit appeared, showing that there were several successive illuminations of the slit."

This was not the result I had expected, the experiment having been suggested to my mind in consequence of some experiments I had been making on the phenomenon of recurrent vision. The results of these experiments were published in the *Phil. Mag.*, December (supplement), 1872. One object of my experiments was to determine in what way the colour of the recurrent image depends upon the colour of the light producing it. By using a sliding shutter and a small window covered with different coloured glasses, I found that the colour of the recurrent image tends to be of a tint complementary to that of the light causing it, being, however, in all cases bluer than the complementary tint. I add the following extract from my paper:—"A recurrent image of an object may be produced without any apparatus whatever. To do this, place the right hand over the eyes so that the palm of the hand covers the right eye, and the fingers the left eye. If the middle finger be then raised for a moment, so as to admit light for as short a time as possible into the eye, a recurrent image of any light-coloured object held against a dark background may be seen. The effect is much better seen by twilight or gaslight than in full daylight. This method of producing a recurrent image is, however, much inferior to that in which a sliding shutter is used, owing probably to the illumination of the retina not being sufficiently instantaneous.

Cheltenham College, June 6 A. S. DAVIS

A Quinquefoliate Strawberry

In your issue for April 30 (vol. xxxi. p. 601) is an account of a quinquefoliate strawberry. In the garden of the New York Agricultural Experiment Station at Geneva we have some second year seedling strawberries, some of which are bearing three, four, and five leaflets on the same plant, the leaves all large and perfect. We have other plants in which the two extra leaves are borne half way down the petiole, and which attain fair size, and yet others where these stipulary-like appendages are reduced to hair-like bracts. The variety of strawberry introduced under the name "Mrs. Garfield" frequently has these bract-like appendages. While speaking of the strawberry, I would remark that seedling strawberries very frequently are unifoliate during their early growth, and it appears as if Duchesne's *Fragaria monophylla* may be regarded as an instance of arrested development in one of these one-leaved younglings.

E. LEWIS STURTEVANT

New York Agricultural Experiment Station,
Geneva, N.Y., May 28

OBSERVATIONS OF THE TEMPERATURE OF THE SEA AND AIR, MADE DURING A VOYAGE FROM ENGLAND TO THE RIVER PLATE IN THE S.S. "LEIBNITZ"

BEING obliged to proceed to South America at the beginning of this year, I took with me a thermometer and a hydrometer in order, if circumstances were favourable, to provide myself with occupation during the somewhat long and monotonous voyage. Thanks to the kindness and courtesy of Capt. Brown, of the s.s. *Leibnitz*, who took a lively interest, and assisted me greatly in carrying out my observations, the voyage was neither long nor tedious.

The *Leibnitz* sailed from Southampton on January 16, 1885, and made the passage direct, without touching at intermediate ports, to Monte Video, where she arrived on February 8, after a very favourable voyage. The route lay through the most interesting meteorological districts of the Atlantic, and my principal object at starting was to make as many observations of the temperature and the density of the surface-water along the route as possible. With these I combined observations of the temperature of the air, and frequently also of the wet-bulb thermometer. Observations were begun on January 21 in lat. 34° N., and continued up to the morning of arrival in the River Plate.

I have put together the simultaneous observations of the temperature of the air and the water with those of the wet-bulb thermometer, as they possess some interest of their own; the observations of density are kept for a future opportunity, as the reductions in connection with them are not quite finished.

The *thermometer* used for all the observations was divided into simple degrees of the Centigrade scale, and was of the ordinary form of German manufacture, with a paper scale. The degrees were 1·6 mm. apart, so that there was no difficulty in estimating tenths of a degree. Its zero was verified on board by immersing it in pounded ice, and found correct. The ice was well pounded in a clean towel, and a soda-water tumbler filled with it; the thermometer was then thrust into it and allowed to remain till sufficient ice had melted to fill up the interstices, producing a perfect magma of ice and water down to the bottom. The mercury remained constant on the zero line. The temperature of the air was 25° C.[1]

Temperature of the Water.—The water was collected in a small bucket, well clear of the side of the ship, and on the opposite side from that through which the condensing water of the engine is discharged. Its temperature was determined as soon as the sample was brought on board.

As the ship left the Channel in the middle of winter, and proceeded nearly due south, the temperature of the water rose rapidly at first. Observations were begun on January 21, in lat. 34° N., and between this latitude and lat. 10° N. the rate of rise was very steady, averaging 0·36° C. per degree of latitude. From lat. 5° N. to 15° S. the temperature is very uniform and high, averaging 26·86° C. After passing lat. 15° S. the temperature falls, and begins to show greater variations, as the shallow water on the Abrothes Bank is approached. The average temperature of the water over this bank was 25·56° C. After passing Cape Frio, and between the parallels of 25° and 30° of south latitude, the variations of temperature are considerable and often abrupt; the maximum observed in this part was 26°·7 C., and the minimum 24°·3 C. As the higher temperature generally accompanies a greater salinity, it is probable that these variations are due, not to any terrestrial source, such as large rivers, but to an oceanic cause, the less salt and colder water of the deeper ocean strata being thrown up against the coast, and mixing imperfectly with the hot and dense surface-water. In lat 30° S. the influence of the River Plate makes itself distinctly felt by a general rapid fall of temperature. As the ship got into soundings, with the change in colour and other properties of the water, the temperature fell rapidly to between 23° and 24° C., and to 22° C. in six fathoms off Flores Island close to Monte Video. The minimum temperature observed in this part was 20° C. at 2 a.m. between Lobos Island and Maldonado Point.

Excluding the latter part of the voyage between the River Plate and lat. 15° S., where the conditions are a good deal affected by purely local causes, the surface-water shows well-marked diurnal maxima and minima of temperature. From lat. 9° N. to lat. 2° N. the ship passed through the equatorial belt of calms and rains, which separates the regions of the north-east and the south-east trade-winds from each other. It is characterised by a calm sea, a cloudy sky, and heavy rains. Here the temperature was subject to very little diurnal variation (0°·3 C.) On approaching St. Paul's Rocks, a few miles north of the equator, the clouds cleared away completely, and there was a calm sea, a clear sky, and a very powerful sun. The result was a comparatively great rise of temperature in the afternoon; and yet the greatest difference between any neighbouring maximum and minimum in this region was only 1°·1 C.

The maximum temperature of the sea-surface observed during the voyage was 27°·4 C. (81°·3 F.) at 2 p.m. on January 31, in lat. 7° 35′ S., the Brazilian coast being about 100 miles distant. The temperature of the water will be further considered in connection with its density; at present its connection with the temperature of the air will be more particularly considered.

Temperature of the Air.—Along with the temperature of the water, that of the air during daylight was determined. It is probably very rare, in any part of the ocean, to find the mean temperature of the air agreeing accurately with that of the surface water, and in many places the differences are considerable. In order to be able to compare the temperature of the air with that of the water, it is necessary that both should be determined with equal accuracy. The temperature of the water is easily and accurately determined by agitating the thermometer in a bucket of it freshly collected. With the air it is somewhat different. Having only one thermometer with me, I was obliged to use it for all purposes, and I could not hang it up in a thermometer-box, even if I had had one, and had deemed it advisable to do so. On board ship, however, I am convinced that it is quite impossible to fix a thermometer-box in such a position as always to secure such an air-pressure as to justify the assumption that the indications of the thermometer may be taken as the true temperature of the air. Even on shore and under the most advantageous circumstances, the temperature of the thermometer in the atmosphere of the best constructed box is too much dependent on the temperature and capacity for heat of the material of the box for it to be assumed always to be identical with that of the air outside, at the moment of reading. I was obliged, therefore, to adopt the method of whirling the thermometer, at the end of a short string, in the air, in whatever part of the ship happened at the moment to afford the most favourable conditions, and reading it when it had assumed a constant temperature. The temperature of the air is thus determined in mostly the same way as that of the water, namely, by agitating a thermometer in it, and the comparison of the two is therefore likely to lead to trustworthy conclusions.

Temperature of Wet-bulb Thermometer.—The series of observations with this instrument is not so complete as that with the dry thermometer, but they possess some interest. The method of observation was the following:—The temperature of the air having been determined by whirling the thermometer in it, a bucket of sea-water was fetched and its temperature taken; the thermometer was then exposed, with its bulb still wet with sea-water, to the breeze in a proper part of the ship, and its temperature observed when it became constant. The exposure of the instrument requires some care. The bulb must be quite free from grease, which can be readily secured by washing it with soap and water. It is then dipped into the water and allowed to drip for a second. It is then held somewhat inclined to the direction of the wind and to the horizon, and rotated gently on its axis so that the bulb be kept covered with a continuous film of water which is locally thickened by gravity, which tends to form a drop on the lower side of the bulb. The reading of the thermometer is observed while it is being rotated. Had I intended from the beginning to make a series of wet and dry bulb observations, I should probably have used fresh water from the first. I began to expose the thermometer, merely in order to have an indication whether the atmosphere were saturated or not, and I expected, in the damp equatorial regions, to find the atmosphere so heavily saturated as to be incapable of producing any sensible lowering of the thermometer with damped bulb. For this purpose it seemed to be quite sufficient to expose the thermometer wet with sea-water. Having begun with

[1] Having plenty of pounded ice at my disposal, I poured off the water which had formed by melting, and replaced it by sea-water, containing 35·65 grammes salt per kilogramme, and then immersed the thermometer; it fell rapidly below zero, and remained constant at −1°·0. I then strained away the sea water from the ice and replaced it by a mixture of equal volumes sea-water and distilled water: the thermometer fell to −0·45, and remained constant for some time at that temperature. When the ice was mixed with distilled water alone, the thermometer again stood at 0° C. These experiments were made to verify some observations of Pettersson, quoted in his investigations into the nature of ice formed from waters of different degrees of salinity, in connection with the voyage of the *Vega*. He there says, referring to the melting temperature of different kinds of ice, that pure fresh-water ice, when immersed in sea water, melts at a temperature considerably below 0° C. Writing from memory, I think he puts the melting-point at from −1° to −2° C. Having both the ice and the sea-water ready at hand, I repeated this remarkable experiment. The result showed that Pettersson's observation is quite correct, and that the lowering of the melting-point is roughly proportional to the salt held in solution. When equal volumes of the sea-water and distilled water of the same temperature were mixed, there was no change of temperature. I do not remember if Dr. Pettersson furnished an explanation of this remarkable phenomenon, and I am unable to supply one myself, but it must necessarily affect the validity of conclusions as to the composition of sea-water ice drawn from its melting-point. When the *Challenger* was in Antarctic waters I made a number of observations on the melting-point of ice collected from broken pieces of the pack, and found it begin to melt a little below −1° C. I concluded that either it was one solid substance or a mixture of several solids. But if pure ice melts at a different temperature according to the medium in which it is placed, then this reasoning is faulty, for inclosed brine would have much the same effect as inclosed salt or crystalline hydrate.

sea-water the observations were continued with it. A few comparative observations were made in order to determine the effect of replacing the sea-water by fresh water. On February 2, after a shower, the temperature of the air was 25°·0 C. When wet with sea-water the temperature of the thermometer was 23°·5 C., and with rain-water 23°·1 C. Similarly, at noon on the same day, the following temperatures were observed: dry bulb, 26°·1 C.; wet bulb (sea), 24°5 C.; wet bulb (rain), 24°·2 C. The air, at this time, appeared, to the sensation, to be damper than at any other time, and yet, when suitably exposed, there was a difference of nearly 2° C. between the wet and dry thermometers.

There is an advantage in having the bulb of the thermometer wet with a continuous film of water, instead of being surrounded with damp muslin, namely, that it more nearly resembles the surface of the sea, which is exposed to the influence of the atmosphere. Observations with the wet thermometer were not made as regularly as those with the dry instrument, and no observations were made with either of them after dark, owing to the difficulty of securing proper exposure and reading the instrument with a lantern, without heating it.

The temperature of the air and of the water were taken generally every two hours from 6 a.m. to 6 p.m., but the intervals between the observations were not always the same. These observations showed that only on two days, January 31 and February 1, between lat. 6° S. and 12° S., did the mean *day* temperature of the air exceed that of the surface-water. On these days the temperatures were taken every two hours from 6 a.m. to 6 p.m., and the means of the groups of seven observations gave, on January 31: air, 27°·13 C.; sea, 26°·90 C.; difference, 0°·23 C.; and on February 1, air, 27°·26 C.; sea, 26°·96 C.; difference, 0°·30 C. These differences would have been reduced in amount if the observations had been carried on through the night, though, from the very high temperature of the air just before sunrise on February 1 and 2, they would not have been reduced to zero.

In the table (p. 129) all the simultaneous observations of temperature of air and water made during the voyage, except those of the last day, when approaching the mouth of the River Plate, are collected in small tables for each day. The time of day is given in hours, from 0 to 24; the temperatures are in Centigrade degrees; t denotes the temperature of the sea-surface, $t-T$ the difference between that of the temperature of the air, and $T-T$ the difference between the readings of the thermometer in air with its bulb dry and when it is wet with sea-water. At the head of each table is given the meteorological district of the ocean through which the ship was passing, as "north-east trade-winds," "equatorial calms," and the like; also the day of the month (1885) and the latitude and longitude at noon of the day. The means at the foot of each table are simply the arithmetical means of the numbers in each column; and their meaning and value are at once apparent on inspecting the column.

With the two exceptions above-named, the temperature of the sea was always found higher than that of the air, over the day, and only very seldom was it exceeded by that of the air at the hottest time of the day. Had the observations been carried on through the night, the contrast between the two temperatures would have been much greater. On January 31 and February 1 the conditions were somewhat exceptional. On the former of these days the ship passed into the northerly monsoon, which prevails all down the Brazilian coast during the southern summer. Like the similar monsoons in the northern hemisphere, it is caused by the proximity of a large mass of land, which gets intensely heated by the vertical rays of the sun. On January 30 the wind had been light south-easterly; during the night it fell calm, and at sunrise a light easterly wind sprang up, which gradually drew around towards the north and blew all day, with just sufficient force to travel exactly at the same rate as the ship (11½ knots); consequently, during the whole of the day the atmosphere on the deck was motionless, with a very powerful sun beating on it and heating up every thing, so that it was impossible to find any place where the air could be got, coming fresh on board, without having been exposed to the influence of the highly-heated deck and fittings. It is therefore certain that the air-temperatures are somewhat above the water.

It is probable that, when the true temperature of the air can be ascertained, it will be found to be usually below that of the sea-surface. The cause of this is, I think, to be found in the relative dryness of the atmosphere over the ocean. If the observations with the wet-bulb thermometer be considered, it will be seen that the least difference of reading between the dry- and the wet-bulb thermometers was 1°·0 C. on January 28, when the ship was in the middle of the equatorial belt of calms and rains. In this region perfectly saturated air might be expected, and with instruments exposed in the usual form of box I have no doubt that here, and in the very oppressive weather of the northerly monsoon, the two instruments would have given identical readings. The readings of the air-temperature on January 28 were perfectly trustworthy, as the sky was thickly overcast with dense rain-clouds all day; there was thus no risk of overheating; the readings with the wetted bulb were equally satisfactory, so that the results of the observations on that day may be taken to represent fairly the normal state of things in the "Doldrums." The temperature of the sea varied from 26°·3 to 26°·6 C., the mean of five observations during the day being 26°·42 C. The mean temperature of the air during the day was 0°·92 lower than that of the sea, or 25°·5 C., and the temperature of the wet-bulb thermometer 1°·3 lower still, or 24°·2 C. It will be seen that, on the two exceptional days, January 31 and February 1, the difference between the wet- and the dry-bulb thermometer is greater than would be expected from the oppressive damp feeling of the air; it is therefore all the more likely that the dry-bulb readings are too high as indicated above. However, it is important to observe that in all the regions passed through, whether in the westerly winds of the North Atlantic or the equatorial calms, or the monsoon of the South Atlantic, the temperature of the wet-bulb thermometer is always very markedly below that of the dry-bulb thermometer. In fact, such is the mobility of the atmosphere that it rarely has the opportunity of saturating itself; and if the effect which must be produced when this air meets the surface of the water be considered, it will, I think, afford some explanation of why at sea the temperature of the air, even by day alone, is usually markedly below that of the sea-surface.

If we consider the film of water immediately at the surface of the sea, having the atmosphere on the one side of it and the bulk of the water on the other, it is strictly comparable with the film of water surrounding the bulb of the thermometer, when exposed to the atmosphere in the way described above; and the air playing upon it must produce exactly the same effect in the one case as in the other. The evaporation lowers the temperature of the aqueous film, which proceeds to extract heat from the neighbouring bodies—namely, in the one case the air and the bulb of the thermometer and in the other case the air and the layer of water immediately below the surface film. If we imagine for a moment the surface film separated from the bulk of the water below it by a diaphragm impervious to heat, then exposed to the atmosphere so as to suffer evaporation and lowering of temperature, then on the removal of the diaphragm it would immediately sink away from the surface and its place would be taken by warmer, and therefore less dense, water from below. In the case of sea-water this effect would be slightly intensified by the concentration produced by evaporation. But

TABLE GIVING THE TEMPERATURE OF THE SEA SURFACE (t), THE DIFFERENCE BETWEEN IT AND THE TEMPERATURE OF THE AIR ($t-T$), AND THE DIFFERENCE BETWEEN THE READINGS OF THE DRY BULB AND THE WET BULB THERMOMETERS IN AIR ($T-T'$), AT DIFFERENT HOURS OF THE DAY

N.W. WINDS — Jan. 23, Lat. 26° 24′ N., Long. 21° 21′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
8¼	18·9	2·1	
10	19·3	1·1	
12	19·2	0·7	
14	19·3	0·8	
16⅓	19·7	1·7	
17½	19·6	1·9	
Mean	19·33	1·38	

N.E. TRADE WIND — Jan. 24, Lat. 22° 5′ N., Long. 23° 6′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
8¼	20·5	1·5	
10½	20·7	1·0	
12	20·9	0·8	
14	21·1	1·1	
16	21·2	1·2	
17½	21·2	1·3	
Mean	20·93	1·15	

N.E. TRADE WIND — Jan. 25, Lat. 18° 6′ N., Long. 24° 39′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
8¼	22·0	1·4	1·6
10	22·0	0·8	
12	22·2	0·7	
14	22·2	1·0	
16	22·7	1·7	
17¼	22·3	1·2	
Mean	22·23	1·13	

N.E. TRADE WIND — Jan. 26, Lat. 13° 46′ N., Long. 26° 6′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
8	23·2	1·0	3·0
10	23·8	0·8	—
12	24·0	0·7	1·8
14	24·0	0·9	2·1
16	24·2	1·1	
17¼	24·2	1·0	
Mean	23·90	0·92	

N.E. TRADE WIND — Jan. 27, Lat. 9° 25′ N., Long. 27° 21′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
6	25·4	1·5	
8	25·6	0·9	2·7
10	25·7	0·9	
13	26·0	1·0	3·0
16	26·0	1·0	
17½	26·0	1·0	
Mean	25·79	1·05	

EQUATORIAL CALMS — Jan. 28, Lat. 5° 16′ N., Long. 28° 32′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
6	26·4	6·7	1·7
9	26·3	1·0	—
12	26·3	1·1	1·4
15	26·6	1·0	1·1
18	26·5	0·8	1·0
Mean	26·42	0·92	1·30

EQUATORIAL CALMS — Jan. 29, Lat. 1° 15′ N., Long. 29° 16′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
6	26·5	0·6	1·4
9	26·7	0·8	—
12	27·0	0·3	1·8
15	27·0	0·0	2·5
18	26·8	0·2	2·3
Mean	26·80	0·38	2·00

S.E. TRADE WIND — Jan. 30, Lat. 2° 53′ S., Long. 31° 5′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
6	26·3	0·3	1·6
9	26·4	−0·2	1·9
12	26·8	0·0	2·4
15	27·0	+0·4	2·2
18	26·8	0·7	1·8
Mean	26·67	0·24	1·98

NORTHERLY MONSOON — Jan. 31, Lat. 7° 5′ S., Long. 33° 2′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
6	26·5	0·5	1·7
8	26·5	−0·2	2·3
10	26·8	−0·6	2·6
12	27·1	−0·7	2·8
14	27·4	−0·3	2·6
16	27·1	−0·3	—
18	26·9	0·0	2·3
Mean	26·90	−0·23	2·38

NORTHERLY MONSOON — Feb. 1, Lat. 11° 18′ S., Long. 34° 53′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
6	26·8	0·1	2·4
8	26·9	−0·1	2·2
10	27·0	−0·3	2·7
12	27·0	−0·8	—
14	27·0	−0·7	2·8
16	27·0	−0·3	2·3
18	27·0	0·0	2·0
Mean	26·96	−0·30	2·40

NORTHERLY MONSOON — Feb. 2, Lat. 15° 30′ S., Long. 36° 53′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
6	26·9	−0·1	2·3
8	26·9	−0·1	2·0
10½	26·7	+1·7	1·5
12	26·9	0·8	1·6
16¼	26·3	0·3	
18	25·5	−0·2	
Mean	26·54	0·40	1·85

NORTHERLY MONSOON — Feb. 3, Lat. 19° 48′ S., Long. 38° 42′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
6	24·3	0·1	1·8
8	25·7	0·8	2·1
9	25·4	0·6	—
12	25·2	1·2	—
14	25·9	1·3	1·8
16	26·0	0·1	1·6
18	25·9	0·0	—
Mean	25·48	0·60	1·82

S.E. TRADE WIND — Feb. 4, Lat. 24° 0′ S., Long. 40° 33′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
5½	25·5	1·5	—
8	26·0	1·1	2·9
10	25·8	0·2	—
12	25·7	0·5	2·9
14	25·8	0·8	2·8
16	26·0	1·0	—
Mean	25·80	0·85	2·87

S.E. TRADE WIND — Feb. 5, Lat. 27° 8′ S., Long. 44° 1′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
5½	24·4	0·6	—
8	24·5	0·2	2·8
10	24·5	−0·3	3·7
12	25·2	−0·1	3·3
14	26·4	+1·4	4·7
16¼	26·7	2·0	3·5
18	26·3	2·0	4·3
Mean	25·43	0·97	3·72

S.E. TRADE WIND — Feb. 6, Lat. 30° 13′ S., Long. 47° 52′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
6	24·7	0·6	2·8
8	25·0	0·7	2·7
10	24·8	1·1	2·7
14	25·2	0·9	3·0
16	24·7	0·7	2·9
18	24·8	1·1	3·7
Mean	24·87	0·85	2·97

while the water below supplies some of the heat rendered latent by the evaporation of the water, the air above it supplies its share, and is cooled. In both cases the heat thus lost is made good by the direct radiation from the sun. Through a moderately dry atmosphere the rays pass with comparatively little heating effect, but are largely absorbed on entering the water. Consequently the loss of heat which the water suffers by evaporation at the surface of separation is made good more abundantly than that sustained by the air; and the difference in power of absorption of radiant heat exhibited by these two substances is thus sufficient to keep up a permanent difference of temperature between the water and the air immediately above it.

Starting with air and water at the same temperature, we may imagine the process taking place in three acts. First, the water at the surface evaporates, and the air on the one side, and the water on the other, are cooled; second, in order to make up for the heat thus rendered latent and lost, the sun shines upon both alike, but the water absorbs a larger proportion of the heat of its rays than the air does; and finally, a portion of this excess is then removed from the water by the simple contact of the air at its surface. The nett effect of these causes is to produce a permanent excess of temperature of the surface-water of the sea over that of the air above it, provided that that air is not completely saturated with moisture.

From what I have seen and experienced in the regions visited by the south-west monsoon in the east, I cannot doubt that there are often cases where the most carefully exposed wet- and dry-bulb thermometers would show identical readings, and the atmosphere is completely saturated with vapour of water. Thus it is probable that the temperature of the air would not be inferior to that of the water. Further, when, on the eastern coasts of Asia, the south-west monsoon blows out of the China Sea and penetrates far into the North Pacific, off the coasts of Japan it attains a latitude of naturally lower temperature than that from which it proceeded, so that much of the water with which it was laden, and which is held diffused through it as a mere gas, is condensed and remains suspended in it, producing a visible haze, which obscures the horizon and condenses on all solid objects exposed to it. Here the conditions are reversed, and instead of the air losing heat to evaporate the water, it receives the heat liberated by the condensation of the steam removed from waters of lower latitudes. Such conditions are, however, certainly exceptional, and there can be little doubt that, as a rule, the temperature of the surface-water of the sea is higher than that of the air. The temperature of the air depends on that of the water which tends to warm it and the degree of its own dryness, by virtue of which the water has a tendency to evaporate into it and, by extracting heat from it for this purpose, to cool it.

It is obvious that local circumstances such as currents may produce differences between the temperature of the air and the water, but such cases are not here under consideration.

J. Y. BUCHANAN

Mendoza, March 18

THE REV. T. W. WEBB

BY the death of the Rev. Thomas William Webb, M.A., F.R.A.S., English astronomy has lost one of its most assiduous and accomplished votaries. Mr. Webb, who had reached the age of 79 years, passed a long life as the incumbent of two obscure Welsh livings, held by him in succession. At Tretire he may be said to have laid the foundations of those astronomical tastes which took their finished and best-known shape during the later years of his life whilst he was incumbent of Hardwick, in Breconshire. He was a genial and right-thinking parish priest, whose highest aim was the performance of his duty. For the sake of astronomy it was well perhaps that he obtained so little ecclesiastical advancement; for had things been otherwise it is probable that he would never have developed those scientific tastes which have made his name almost a household word. It was my privilege to make his acquaintance upwards of twenty years ago, and I look back with extreme pleasure to the many letters which have passed between us on practical matters connected with observational astronomy and the use of instruments. Whilst Mr. Webb in bygone years used to write a good deal in the current scientific magazines of the day, especially the *Intellectual Observer* and the *Student*, it was by his "Celestial Objects for Common Telescopes" that he became chiefly known in the astronomical world. This work, published in the year 1859, was designed to be a cheap popular abridgment in a modified form of Admiral Smyth's "Celestial Cycle," which had done right good service in providing English amateurs with information as to what to look for and how to find. By 1859 Smyth's work had become both out of print and somewhat out of date, and Mr. Webb's unpretending abridgment filled at once an undoubted void. It is indeed not wholly correct to speak of Webb's "Celestial Objects" as an abridgment of Smyth's older, larger, and more expensive volume. It was this; but it was also a good deal more, for whilst it offered to the possessors of small telescopes convenient lists of objects deserving of their attention, it also supplied an enormous amount of original information connected with the sun, moon, and planets, and the use of telescopes. This information, though no doubt suggested by Admiral Smyth's style, was no mere *rechauffé* of other people's work, but represented the personal experience of an intensely industrious and persevering man working under great difficulties through lack of instrumental means.

I shall never forget the feeling of blank astonishment which crept over my mind one day when (in, I think, the year 1864) Mr. Webb told me that the first edition of his book, and all his magazine articles up to that date describing double stars and clusters, were founded on studies pursued by means of a telescope set up in his garden and not equatorially mounted. This, I well remember, was not said in any spirit of boasting in the garb of mock modesty, but was the casual utterance of a simple truth disclosed without effort or intention. I do not think I ever came in the way of any student of nature of whom it could be so truly said that he was "without guile."

Mr. Webb was every inch a gentleman, and a philosopher in the highest sense of the word. Every line that he wrote contained either the record of some fact noticed by himself, or a sensible deduction from some other facts. When his facts had come to an end his pen ceased to pass over paper, and the result was that no one ever read a sentence written by him without learning something useful, set forth in the fewest possible words, often, indeed, in a form of concentration which erred on the side of inconvenient brevity; but in these days of penny-a-lining (and it may even be admitted that there is even such a thing as science penny-a-lining) Mr. Webb's habitual terseness cannot be described as a vice. His private letters show that, where necessary for the instruction of a young astronomer, he never grudged time and trouble for going into details. The highest praise that can be awarded him is that he not only did many useful things himself, but that he set an example of patient and industrious research which resulted in many young men all over the British Empire seeking to imitate his cheery and sensible style of work and thought.

G. F. CHAMBERS

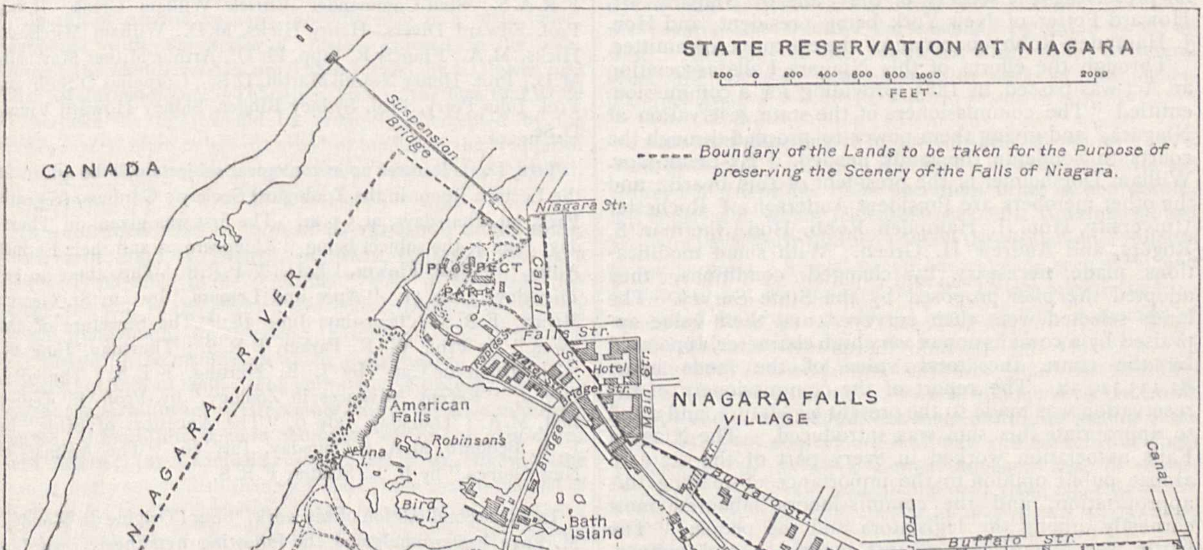
THE PRESERVATION OF NIAGARA[1]

NEARLY seven years ago Lord Dufferin, then governor-general of Canada, suggested to Gov. Robinson of New York that the governments of the province of Ontario and the state of New York should purchase such lands about Niagara Falls as would be required to give free access to the principal points of view, and serve to restore and preserve the natural scenery of the great cataract, beside securing to visitors freedom from those vexatious annoyances which now abound. Subsequently the governor-general called the attention of the government of Ontario to the matter, and recommended co-operation with the state of New York in accomplishing this purpose.

Later, in January, 1879, Gov. Robinson, in his annual message to the legislature of New York, presented this matter, and recommended the appointment of a commission to investigate the question, to confer with the Canadian authorities, to consider what measures were necessary, and to report the results to a succeeding legislature.

By resolution the commissioners of the State Survey were charged with the investigation. This commission included some of the most distinguished men of the state,—Ex-Gov. Horatio Seymour, Vice-President of the United States, W. A. Wheeler, Lieut.-Gov. Dorsheimer, President Barnard of Columbia College, and others.

With breadth of view worthy of such men, they state in their report that, "under this resolution, it became the duty of the commissioners to ascertain how far the private holding of land about Niagara Falls has worked to public



Stanford's Geogr. Establ.

disadvantage through defacements of the scenery; to estimate the tendency to greater injury; and, lastly, to consider whether the proposed action by the state is necessary to arrest the process of destruction, and restore to the scenery its natural character." In pursuance of these objects, the commissioners instructed Mr. James T. Gardiner, director of the State Survey, to make an examination of the premises, and prepare for their consideration a project. He was assisted in this work by Mr. Frederick Law Olmsted, the distinguished landscape-architect.

The examination showed that the destruction of the natural scenery which forms the framework of the Falls was rapidly progressing: unsightly structures and mills were taking the place of the beautiful woods that once overhung the rapids; the fine piece of primeval forest remaining on Goat Island was in jeopardy from projects looking to making a showground of the island; and every point from which the Falls could be seen on the American side was fenced in, and a fee charged for admission. It was found that, owing to the topography of the main shore, it was practicable to restore its natural aspect by clearing away the buildings from a narrow strip of land 100 to 800 feet broad and a mile long, and planting it with trees which would screen out from view the buildings of the village. When these trees should be grown, and the mills removed from Bath Island, and trees planted there, the falls and rapids would be again seen in the setting of natural foliage which formed so important an element in their original beauty. Every point from which the Falls could be seen would also become free of access by the plan proposed. A map was made showing just what lands should be taken to carry out these purposes. The commissioners adopted the plan of Mr. Gardiner

[1] From *Science*.

and Mr. Olmsted, and recommended to the legislature of 1880 the passage of an Act to provide for acquiring title to the necessary lands by the exercise of the right of eminent domain, leaving it to a future legislature to consummate the purchase by appropriating the amount for the payment of the awards, if the sum should seem a reasonable price for the property. Such an Act passed the Assembly, but was defeated in the Senate, although the movement was supported by petitions signed by the most distinguished men of this and other countries. The report of the State Survey, with its complete descriptions, illustrations, and maps, then became the basis of a systematic effort on the part of a few determined friends of the Falls to educate and arouse public opinion to save the scenery of Niagara. Early in 1883 this movement ripened into the organisation of an association to promote legislation for preserving the scenery of the Falls of Niagara, Mr. Howard Potter of New York being president, and Hon. J. Hampden Robb, chairman of the executive committee.

Through the efforts of this Niagara Falls association an Act was passed, in 1883, providing for a commission, entitled "The commissioners of the state reservation at Niagara," and giving them power to proceed through the courts to condemn the lands needed. Ex-Lieut.-Gov. William Dorsheimer is the president of this board; and the other members are President Anderson of Rochester University, Hon. J. Hampden Robb, Hon. Sherman S. Rogers, and Andrew H. Green. With some modifications made necessary by changed conditions, they adopted the plan proposed by the State Survey. The lands selected were then surveyed, and their value appraised by a commission of very high character, appointed by the court, the total value of the lands being $1,433,429.50. The report of the commissioners of the reservation was made to the present legislature, and a Bill to appropriate this sum was introduced. The Niagara Falls association worked in every part of the state to arouse public opinion to the importance of making this appropriation, and the commissioners laboured most earnestly among the legislators and the people. The battle was a hard one against ignorance and narrow-minded selfishness; but the victory is complete. The legislature, by more than a two-thirds majority, has appropriated the $1,433,429.50, and the governor has approved the Act.

After six years of almost continuous effort on the part of the active friends of this enlightened project, it is secured by a law which declares that the lands are purchased by the state in order that they may be "restored to, and preserved in, a *state of nature*," and that every part of them shall be for ever free of access to all mankind.

NOTES

We understand that on the receipt by the Science and Art Department from the Foreign Office of a despatch from Her Majesty's Minister at Washington forwarding communications concerning the proposed change in the time for beginning the astronomical day, as recommended by the recent International Meridian Conference at Washington, the Lords of the Committee of Council on Education requested the following Committee to advise them as to what steps should be taken in the matter. Prof. J. C. Adams, F.R.S., the Astronomer-Royal, Capt. Sir F. Evans, K.C.B., R.N., the Hydrographer of the Navy, Gen. Strachey, R.E., C.S.I., F.R.S., Dr. Hind, F.R.S., and Col. Donnelly, R.E. In accordance with their recommendations copies of the Report of the Delegates to the International Prime Meridian Conference at Washington, together with the resolutions adopted by that body, have been sent to various departments of the State, and to the following Societies, &c.: Society of Telegraphic Engineers, Royal Astronomical Society, Royal Society, Submarine Telegraph Company, Eastern Telegraph Company (Limited), Eastern and South African Telegraph Company (Limited), Eastern Extension, Australasia and China Telegraph Company (Limited), Railway Clearing House. They have been informed that these resolutions of the Prime Meridian Conference appear to my Lords of the Committee of Council to be such as commend themselves for adoption. But before informing the American Government to that effect their Lordships would be glad to receive the opinion of the various societies on the subject.

The annual meeting for the election of Fellows of the Royal Society was held at Burlington House on Thursday, June 4, the President in the chair. The following were elected:—Major A. W. Baird, R.E., Philip Herbert Carpenter, D.Sc., Sir Andrew Clark, Bart., M.D., Andrew Ainslie Common, F.R.A.S., Staff-Commander Ettrick William Creak, R.N., Prof. Edward Divers, Henry Hicks, M.D., William Mitchison Hicks, M.A., Francis R. Japp, Ph D., Arthur Milnes Marshall, M.D., Prof. Henry Newell Martin, D.Sc., Cornelius O'Sullivan, Prof. John Perry, Prof. Sydney Ringer, Sidney Howard Vines, D.Sc.

The Davis lectures upon zoological subjects will be given in the Lecture Room in the Zoological Society's Gardens, Regent's Park, on Thursdays, at 5 p.m. The first was given on Thursday, June 4, the subject being "Rhinoceroses and their Extinct Allies," by Prof. Flower, LL.D., V.P.R.S. The others are:—Thursday, June 11, "Apes and Lemurs," by Dr. St. George Mivart, F.R.S.; Thursday, June 18, "The Structure of the Swan," by Prof. W. K. Parker, F.R.S.; Thursday, June 25, "The Domestic Cat," by J. E. Harting, F.L.S.; Thursday, July 2, "Recent Advances in Zoology," by Prof. F. Jeffrey Bell, M.A.; Thursday, July 9, "The Ancestors of Birds," by F. E. Beddard, M.A.; Thursday, July 16, "The Animals of New Guinea," by P. L. Sclater, F.R.S.

In the second edition of his work, "Sur l'Origine du Monde," M. Faye has promulgated the following hypothesis regarding the relations between the geological epochs and the stages of the terrestrial cosmogony. The history of the earth he divides into six stadia. The first is that in which the earth was a glowing ball. The second he calls the *Antezoic period*, in which total darkness supervened on the extinction of the earth's glow. The third is the *Primary period*, during which there was a feeble illumination from the sun, which was then just coming into existence. During the *Secondary period* the sunlight went on increasing as the sun itself grew larger and assumed its proper shape. In the fifth stadium, which is that of the *Tertiary period*, there was complete solar illumination, and the sun soon attained the maximum of its activity; while in the last stadium, that of the *Quaternary period*, there has been a slight diminution of the solar activity (rather surmised than demonstrated), accompanied by the diappearance of every cosmogonic influence and the establishment of perfect stability in almost all directions. Oscillations in the earth's crust and feeble volcanic manifestations are almost the only instances of cosmogonic change still observable.

We have received from MM. Fol et Sarasin a copy of a paper by them on the depth to which the light of the sun will penetrate into the sea. It will be remembered that in November last they recounted the results of their experiments on the same subject in the Lake of Geneva. The present paper describes similar experiments made in the Mediterranean off the zoological station and harbour of Villefranche. By means of photographic plates they have proved that in the month of March, in the middle of a sunny day, the rays of the sun do not penetrate beyond 400 metres below the surface of the Mediterranean. This is established by seven separate experiments, at varying depths and different hours of the morning. At 380 metres, shortly before 11 a.m., the impression on the plate was less than that which would have been left on exposure to the air on a clear night, without a moon. Between 1.20 and 1.30 p.m., at a depth of 405 to 420 metres, there was no trace of any impression whatever on the plate. Light clouds do not appear to cause any notable diminution in the depth to which the light penetrates. In the Lake of Geneva the writers also undertook a new series of investigations to determine the effect of the season on the penetration of light. They give 200 metres as the extreme limit for winter in the lake; but they found that there is as much light at 380 metres in the Mediterranean as at 192 metres in the Lake of Geneva; and by a comparison of these with previous experiments, it appears the light penetrates from 20 to 30 metres deeper in March than in September; in the month of August, perhaps the difference is a little more. Compared with the series of plates exposed in the lake, those of the Mediterranean are characterised by a slower and more regular gradation. This gives rise to the idea that while in the lake the light would be promptly intercepted by the deeper layers, more or less disturbed or muddy, in the Mediterranean the absorption proper to pure water would be the principal, if not the sole factor in arresting the luminous rays.

In a communication to *Ausland* on the causes of the Andalusian earthquakes, A. Rzehak, of Brünn, maintains that they are clearly referable to the "tectonic" class of terrestrial disturbances—that is, those which are connected with the process by which mountains are elevated. Evidence of this connection is furnished by the manner in which the disturbed areas are influenced by lines of fault. The entire area of disturbance in the case of the earthquakes of December last is divisible into three zones: (1) the littoral zone in the south, where the shock was most severe; (2) Andalusia proper, which was likewise the seat of pretty severe disturbances; and (3) the central plateau of Spain as far as the Carpetena chain (a section of the Sierra Guadarrama), where, as already pointed out by M. Noguès (NATURE, xxxi. p. 417), the shocks completely died out. These three zones are separated by lines of fault. A great fault can be traced not only along the northern slopes of the Serrania de Ronda, but also further eastwards to the district lying north of Malaga. To the north of this line scarcely any places suffered greatly from the earthquake—except those which, like Antequera, Loja, and Archedona, lie close to or immediately beside transverse faults. Elsewhere the degree of shock was tolerably uniform as far as the fault of the Guadalquivir, which bounds the central plateau on the south. A third great fault passes along the south of the Sierra Guadarrama, and there the disturbance seems to have ended.

The honour of C.I.E. has been conferred upon Mr. Francis Day, Deputy-Surgeon-General (Retired), Medical Department, Madras, and on Mr. J. B. N. Hennessey, late Deputy-Superintendent, Indian Survey Department.

The Meteorological Society of Vienna has resolved to erect a meteorological station on Mount Sonnenblick, near Tauern, in the central range of the Tyrolese Alps, 3100 metres above sea-level, and thus the highest station of the kind in Europe.

The Royal Institute of British Architects, on Monday evening, presented to Dr. Henry Schliemann, F.S.A., their Royal Gold Medal. In acknowledging the medal Dr. Schliemann said that our knowledge of prehistoric architecture was very deficient, for our sole informant was Homer, whose scanty information as to the construction and arrangement of the heroic palaces we did not even understand.

The latest official report of the earthquake in Cashmere states that much damage was occasioned in the north western portion of the valley. The ground opened, and the villages of Dubgaon, Jamalapar, and Ovan were swallowed up, while sulphurous dust and hot water issued from the cracks. The fort at Gurais and the grain store-houses were buried. A telegram sent from Serinagur on Friday last says:—"The shocks continue every three hours, with much preliminary noise, but a comparatively slight motion." The great shock appears to have travelled in a southerly direction, and to have been felt at several places in Northern India, although it did no damage there.

The death is announced, at the age of fifty-two, of Robert von Schlagintweit, Professor of Geography and Ethnology at the University of Giessen. He was the youngest of the three brothers Schlagintweit who, on the recommendation of Alexander von Humboldt, and under the special care of Lieut.Col. Sykes, were sent by the British East India Company to explore that country, and especially the mountain regions in the north-west. The results of their researches, which lasted for several years, are recorded in comprehensive works of the highest scientific value.

Important experiments in aërial navigation are now being made by Mr. A. F. Gower, well known in connection with the Gower-Bell telephone. The operations being carried on are, it is understood, within the cognisance of the Government, and are more particularly directed towards the adaptation of balloons to war purposes. Several ascents have already been made, and in carrying out his arrangements Mr. Gower appears to have recognised the advantages offered by the position of the town of Hythe, which he has made the centre of his operations. On Sunday week the wind being favourable, one of the automatic pilot balloons invented by Mr. Gower, with appliances for giving out its own gas and ballast, one compensating for the loss of the other, was filled with 2300 feet of gas, and ascended at about 11 o'clock. In the car a written statement was, of course, placed, explaining the ownership of the machine and its object, with the result that it was next heard of at Dieppe, having made a rapid passage of about seventy-two miles in a straight direction and descended at 2.30 in the afternoon. On Monday, another pilot balloon, with a capacity of 4300 feet, was started, and immediately followed by Mr. Gower in his own balloon (containing 23,000 feet of gas). The object of Mr. Gower in ascending was to watch the action of the pilot; but the smaller machine made such rapid progress that it got out of his observation and came down in the vicinity of Paris. Meanwhile Mr. Gower, who ascended about noon, took the French coast at Boulogne at 2.15, and then taking a northerly curve travelled overland to Calais, where he made a smooth descent at 4 p.m. A still more important undertaking was, however, entered upon on Wednesday, when Mr. Gower, Capt. Lane, and Mr. Dale, the aëronaut, ascended in a balloon of 40,000 feet capacity. A good start was made, and the aërial voyagers sailed away in a northerly direction. After a journey of rather more than an hour, they were compelled to descend, owing to the wind taking a slight turn towards the North Sea, and with much difficulty landed on the Isle of Sheppey, having travelled twenty-three miles.

A very laudable effort at teaching the general public practical astronomy is being made in Christiania. An optician, Herr A. Olsen, has erected a great refractor in the Royal Park—in size said to be the fifth in the world—through which the celestial bodies can be observed by the public for a small fee, while explanations are given of their nature, &c. The interior of the pavilion in which it is mounted is hung with celestial charts and diagrams, as well as views of the planets, the sun, and the moon, for the purpose of facilitating the object in view. The cost of the instrument is very nearly 2000*l.*

Intelligence has been received at New York, June 9, stating that a waterspout has burst near Lagos, in Mexico. One hundred persons are reported to have perished, and it is feared that the loss of life will prove even greater.

A WATERSPOUT passed over a portion of the town of Hagenau (Alsace) on May 23 last, doing very great damage to houses and trees.

AT Stendal (Prussian Saxony) a Committee for the erection of a monument in memory of Dr. Gustav Nachtigal has been formed, and contributions towards this object are solicited.

THE Austrian Central Tourist Club has addressed a petition to the Assemblies of all Austrian alpine provinces to pass a law prohibiting the wholesale uprooting of *Edelweiss* now carried on. The petitioners point out that hundreds of thousands of the plants are dug up and sent abroad, even to America, so that there is a fear that the favourite plant of all lovers of the Alps will be totally exterminated, except in a few remote plac s. In Switzerland, it is stated, for several years past there have been stringent laws in the several cantons against uprooting and selling the *Edelweiss.*

THE *rôle* of wind in fertilising the ground is remarkably illustrated, according to M. Alluard, by the very fertile valley of Limagne, in Auvergne. The prevalent winds there are west and south-west, and traverse the chain of the Dômes, where are vast deposits of volcanic ashes. Much of this dust is thus carried to the Limagne valley, and settles there of itself, or is carried down by rain or snow. As it contains a large amount of phosphoric acid, potash, and lime, it is highly fertilising, and its very fine state favours rapid assimilation. From observations on the Puy de Dôme, M. Alluard estimates the annual deposit at 348 to 400 grammes per square metre.

WE have received the Calendar of the University of Virginia for the academical year 1884–85. The science department appears to be exceptionally strong and well organised.

ONE result of the recen visit of the Ameer of Afghanistan to India is that his palace at Cabul is to be lit by the electric light. He ordered the necessary apparatus when at Rawul Pindi, and three Cabulese have for some time past been studying its manipulation at Bombay.

WE have received a copy of a lecture by Mr. Thomas Fletcher, delivered before the Parkes Museum of Hygiene, on "Smokeless Houses and Manufactories." It deals mainly with the lecturer's personal experiences of the employment of gaseous fuel in his private residence and manufactory at Warrington, the appliances which he has used, a comparison of the cost with that of coal, the work done, &c. In reply to a question, Mr. Fletcher expressed the opinion that radiant heat is the only possible comfortable way of heating a living-room, and that it is therefore better to mix gas with air to prevent smoke, and heat as large a surface as possible to incandescence.

ACCORDING to a report by the Director of Public Instruction in Tunis, there are at the present moment twenty primary schools in the Regency—eight in Tunis, and twelve in other towns—Susa, Monastir, Sfax, Goletta, &c. In this number are included three schools of the Israelite alliance at Susa, Tunis, and Mehdia. The number of pupils is 3974, composed of 2291 boys and 1683 girls. The report states that there are in addition a certain number of primary schools in which the instruction is religious. Of these there are 113 in Tunis, and about 500 in the whole Regency. For secondary instruction there are three establishments, all in Tunis. These contain 23 classes with 38 masters, giving instruction to 416 pupils, of whom 78 are French, 27 Italian, 26 Anglo-Maltese, 74 Jews, 193 Arabs, and 18 of various nationalities.

A MEETING of the National Fish Culture Association was held on Thurday last to consider the question of instituting sea temperature observations with a view to gaining independent and fresh knowledge with respect to our marine food-fishes. The subject of marine stations was discussed together with other matters relative to log-books to be issued to suitable investigators.

THE additions to the Zoological Society's Gardens during the past week include a Squirrel Monkey (*Chrysothrix sciurea*) from Demerara, presented by Mr. T. C. Edwards-Moss; a Common Badger (*Meles taxus*) from Derbyshire, presented by His Grace the Duke of Devonshire, K.G., F.Z.S.; a Common Badger (*Meles taxus*) from North Wales, presented by Mr. T. W. Proger; two Common Hedgehogs (*Erinaceus europæus*), a Common Viper (*Vipera berus*) from Norfolk, presented by Mr. T. E. Gunn; a Chattering Lory (*Lorius garrulus*) from Moluccas, presented by Mr. H. D. Astley, F.Z.S.; a Red-crested Cardinal (*Paroaria cucullata*) from South America, presented by Miss Hyrzan; a White-tailed Eagle (*Haliaetus albicilla*) from Perthshire, presented by Mr. H. Tennent Tennent; a Manx Shearwater (*Puffinus anglorum*), a Puffin (*Fratercula arctica*), British, presented by Mr. W. Graham, F.Z.S.; an Egyptian Monitor (*Varanus niloticus*) from West Africa, presented by Mr. H. Denny; an African Lepidosiren (*Protopterus annectens*) from African Rivers, presented by Mr. Cornelius Alfred Malony, C.M.G.; two Slowworms (*Anguis fragilis*), British, presented by Mr. F. J. Guy; a Sharp-nosed Crocodile (*Crocodilus acutus*) from Jamaica, deposited; a Collared Fruit Bat (*Cynonycteris collaris*), an Axis Deer (*Cervus axis* ♀), a Hybrid Luhdorf's Deer (between *Cervus luehdorfi* and *Cervus canadensis* ♂), a Burrhel Wild Sheep (*Ovis burrhel*), two Triangular-spotted Pigeons (*Columba guinea*), a Variegated Sheldrake (*Tadorna variegata*), a Herring Gull (*Larus argentatus*), twenty Spotted Salamanders (*Salamandra maculosa*), thirty Pleurodele Newts (*Molge walti*), bred in the Gardens.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *JUNE* 14–20

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

At Greenwich on June 14

Sun rises, 3h. 44m.; souths, 11h. 59m. 59·9s.; sets, 20h. 16m.; decl. on meridian, 23° 18′ N.: Sidereal Time at Sunset, 13h. 49m.

Moon (at First Quarter on June 19, 14h.) rises, 5h. 46m.; souths, 13h. 38m.; sets, 21h. 25m.; decl. on meridian, 17° 37′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	2 58	10 56	18 54	20 45 N.
Venus	4 26	12 48	21 10	24 11 N.
Mars	2 18	10 7	17 56	19 17 N.
Jupiter	9 28	16 37	23 46	12 32 N.
Saturn	4 7	12 16	20 25	22 28 N.

Phenomena of Jupiter's Satellites

June	h. m.	
14	20 15	III. tr. ing.
	22 37	I. ecl. reap.
16	22 24	IV. ecl. disap.
18	23 17	II. occ. disap.
20	20 33	II. tr. egr.

The Eclipses of Jupiter's Satellites are such as are visible at Greenwich.

June	h.	
17	15	Jupiter in conjunction with and 3° 44′ north of the Moon.
18	23	Saturn in conjunction with the Sun.

GEOGRAPHICAL NOTES

AFTER having lost, in December last, their director, Prof. W. G. Erofeeff, and in January one of their most active members, W. A. Domzer, the Russian Geological Commission has again sustained a heavy loss in the death of the distinguished G. P. Helmersen. According to the notice in the last issue of the *Izvestia* of the Commission he began his scientific career more than sixty years ago, at the Dorpat University, and when less than twenty-two years of age. Throughout his life he has had the opportunity of exploring nearly all the surface of Russia in Europe, from Olonetz to the Crimea and from Poland to the Ural, penetrating also into the Kirghiz Steppes in the Asiatic dominions of the empire. The results of his varied explorations are embodied in 130 monographs, some of which are bulky works. His first work of importance, the "Exploration of Southern Ural," was published in 1831, in connection with Hofmann. Five years later it was followed by a description of the Kirghiz Steppes and by a short paper on the Ural and Altay Mountains. In 1838 he began to publish the results of his explorations of the Baltic provinces, which were thenceforth continued throughout his life. In 1840 he studied the lake region of North-west Russia and of the Valdai Hills, and next year made the first attempt to embody all that was known regarding the geological structure of Russia by publishing the first geological map of the country. The coal-fields of the Moscow basin then attracted his attention, and in 1845 he published the results of his researches into the structure of the Ust-Urt and its slopes towards the Sea of Aral. In 1850 he published an interesting sketch of the Devonian Rocks of Middle Russsa. In 1857 there appeared his notice as to the rising of the Baltic shore and the action of ice and water on it, being the first of a series which led him afterwards to investigate the subject of boulders. After having spent four years in the exploration of the Olonetz region, he embodied the results of his observations in a work published in 1860. His researches into the physical conditions of St. Petersburgh, the artesian well bored in that capital, and the Alexander monolith, made his name popular even among unscientific readers. A work on Lake Peipus and the Narova river appeared in 1864, and completed his researches in the lake region of North-west Russia. Next year a second revised edition of his geological map of Russia, including the Ural and Caucasus, and a map of the Russian coal-basins, were published by the indefatigable geologist. The supposed drying up of the Sea of Azov was the subject of several papers and reports presented by him to the Academy of Sciences, as also the extension of the coal-fields from the Don, through Tula and Kaluya, to Courland and Eastern Prussia. In 1870 he published his "Studies on Boulders," the second part of which appeared only three years ago. In 1879 he issued a geological and physico-geographical description of the Aralo-Caspian region. A paper, written together with M. Yakovleff on the same subject, in 1883, was his last contribution to the Memoirs of the Academy of Sciences. In all these works, Helmersen appeared as a follower of the school of geologists represented by Leopold von Buch and Alexander Humboldt. Instead of merely describing the fossils of a given formation, and minutely studying its various stratigraphical and palæontological horizons, he tried to discover the leading physical and geographical features of the country he explored, and devoted great attention to dynamical geology. His works are as valuable to the geographer as to the geologist. For twenty-five consecutive years Helmersen was Professor at the Mining Institute of St. Petersburg, and since 1844 he was one of the most active members of the Academy of Sciences. In 1851 he was elected a foreign member of the Geological Society of London—an honour well bestowed on one of the most industrious and distinguished geologists whom Russia has produced.

THE last issue of the *Izvestia* of the Russian Geographical Society contains a map showing M. Potanin's last journey in China, from Peking to Kookoo-koto and Lang-tcheou (73° 30' E. long.), to illustrate M. Potanin's letters dated Boro-balgasun and Lang-tcheou, September and November 13th, 1884. The Ordos, described with so dark features by Huc, looked more attractive than might have been expected. True, the whole of the country between the Yellow river and Boro-Balgasun is covered with sand; but moving sand is rare, the *barkhans* being usually fortified by vegetation. The *shiabyk*—a species of *Artemisia*—is the most frequent growth in the *barkhans*, the cavities between them being thickly covered with bushes of Caragana, *archa*, and *yashil*. Water is found wherever the subsoil appears from beneath the sand; numerous sweet water ponds make there their appearance, and they are surrounded with moist pasture-grounds. The dry grounds between the sands are covered with Steppe vegetation, the *Calimeris* colouring sometimes wide spaces in white. Sarrazin, millet, and hemp are cultivated on these dry grounds. Altogether, the eastern Ordos may be considered as a rich country for cattle breeding, if supported by some agriculture. Two old towns, now in ruins were passed on the borders of the Ordos. Boro-balgasun, too, was formerly a town, within the ruined walls of which there are now but a few Mongolian huts, and the house of the Belgian missionaries. In the Van principality M. Potanin visited the Edjen-khoro place, on the Tchamkhak river; it consists of two tents where the bones of Chengiz-khan are said to be preserved. On Sept. 22, the expedition left Boro-balgasun. They visited the salt lake Baga-shikyr, and for five days crossed a region covered with low hills and almost uninhabited, notwithstanding the good pasturage which spread between the *barkhans*, these last becoming more thinly spread than in the east. Ruins of Mussulman villages destroyed during the last insurrection are not uncommon. Lin-tcheou, on the Hoang-ho, is surrounded by fruit-gardens. South of it numerous villages extend for some fifty miles along a canal which runs parallel to the Hoang-ho and crosses on aqueducts its tributaries. Its banks offer an uninterrupted fruit garden, with a few rice-fields. All this richness is, however, of recent origin, the former gardens having been all destroyed by Chinese after the last insurrection. Altogether, the region bears traces of desolation; whole towns have been quite destroyed. The town Tsin-tsi-pou was the centre of the insurrection. South of this town, M. Potanin left the valley of the Hoang-ho, and crossed the series of flat ridges which reach towards the south, 6,000 feet to 7,000 feet above the sea-level. Still they have gentle slopes, owing to their covering of Loess which reaches a thickness of from 200 to 300 feet. The hills are formed of red sandstone, with some layers of pudding-stone north of the Tao-tsoui river, while south of Tsin-youang the ridge consists of silicious and clay-slate. The sandstone contains beds of salt, which impregnates also the soil and is worked to some extent; it is raised also from a number of small lakes. The Loess covers the whole of the country from Ping-yang-sia to Lang-tcheou, spreading also over the summits of the higher ridges. The population is of Turk origin, and though it has assumed Chinese customs it maintains its Mussulman religion. In the hilly tracts dwellings, and even inns, are dug out in the Loess. Lang-tcheou is a great city, picturesquely built on the right bank of the Hoang-ho at the foot of a high mountain ridge. A floating bridge crosses the great river. The plants collected for the herbarium by the expedition were but few, owing to the late season; but altogether in the whole region there are no trees excepting those which are cultivated; even the higher ridges are devoid of trees and but scarcely clothed with grass. From Lang-tcheou, where the astronomer, M. Skassy, remained with the scientific collection, M. Potanin went to the west to visit the Salors and Shorongols, who inhabit that region, while M. Berezovsky proposed to advance further south to Hoy-sian, situated on the water-divide between the Yellow and the Blue Rivers. The scientific results of the expedition promise to be very interesting. The astronomer, M. Skassy, has determined the position of fifteen places and mapped the route. M. Berezovsky has collected 140 samples of birds, and M. Potanin brings back collections of plants, insects, and reptiles, as also a geological collection.

A RECENT number of the *Japan Gazette* contains a series of notes on each of the islands forming the Kurile group, which stretches from Jeso northward to Kamtschatka, and which for the past ten years have belonged to Japan. The notes are arranged by Prof. Milne, from his own notes and those of Mr. Snow, who has spent many consecutive summers amongst the islands. They refer mainly to the numerous volcanoes among the Kuriles, but much information on other points relating to this little-known group is given. The name applied by the Japanese to the chain is "Chishima," or "the thousand islands," but there are really not more than thirty or forty. Of these, Iturup and Kunashiri, the most southern members of the group, are the largest. They "form the first links of the chain which volcanic agencies have built up whilst attempting to join Japan and Asia." Iturup is 113 miles long and 77 in greatest width; Kunashiri is 62 miles by 17. They are all very desolate, and sparsely populated in summer by Japanese and Ainos, who come to fish. In Iturup, between the coast and the mountains, there is a kind of jungle composed mainly of bamboo grass, which is impassable. The explorer has therefore to follow the bed of a stream or the bear tracks. Prof. Milne thinks it not unlikely that the Iturup bear may be a species new to science. From the specimens seen in cages it seems to resemble the grizzly bear of North America.

ANNIVERSARY OF THE ROYAL GEOGRAPHICAL SOCIETY

THE Anniversary Meeting of the Royal Geographical Society was held in the theatre of London University on Thursday, the Right Hon. Lord Aberdare, F.R.S., President, in the chair. In his address, Lord Aberdare referred to Mr. Keltie's report on the position of geographical education in England and on the Continent. The Report, Lord Aberdare stated, contains statements and recommendations of the highest interest and importance. Of the state of geographical education in Great Britain Mr. Keltie draws a very dismal picture. "There is no encouragement to give the subject a prominent place in the school curriculum; no provision, except at elementary normal schools, for the training of teachers in the facts and principles of the subject, and in the best methods of teaching it; no inducement to publishers to produce maps, globes, pictures, reliefs, or other apparatus of the quality and in the variety to be found on the Continent; while our ordinary text-books are, as a rule, unskilful compilations by men who have no special knowledge of their subject." This neglect is attributed to the "exigencies of examination." Geography, as a class-subject, "does not pay." It is not recognised at the Universities by either professorship or readership; it does not find a real place at any of their examinations; while in the Army and Navy examinations it is at a discount; and such geography as is given is of a very partial character, and is merely left to crammers. These unsatisfactory statements are justified by a large amount of evidence. In striking contrast to this picture is that which Mr. Keltie presents of the state of geographical education in Germany, France, Italy, Switzerland, and several other countries of Europe. Germany, as might be expected, takes the lead, and does its work most thoroughly. But the systematic study of geography is even there of recent creation. It prevails in twelve out of the twenty-one universities of Germany; and nearly all the twelve existing professorships of geography have been founded within the last twelve years. "The ideal aimed at, and being rapidly carried out, is to have one continuous course of geographical instruction from the youngest school-year up to the university." And Mr. Keltie deals with these ascending courses, showing in detail the teaching from the elementary to the higher schools, and in the universities. His examples of lessons he himself heard at some of these schools are most graphic, and suggest their high value in any course of intelligent education.

Lord Aberdare then briefly referred to the conclusions at which Mr. Keltie arrives. These, he stated, are clear, sensible, practical, but by no means encouraging. In all these European countries the curriculum is defined and imposed by the State, which, keeping the purse-strings, dictates the course of instruction. Except over our elementary schools, the State in this country exercises no such power, direct or indirect. We must be content to bring the force of public opinion to bear upon our schools and universities; for with them, and especially with our universities, rests the solution of this great question. Mr. Keltie's Report will be duly considered by the Council; it will doubtless be published; and means, Lord Aberdare ventured to prophesy, will be taken to bring home to our educational authorities, with fresh power and urgency, the necessity for not allowing Great Britain to lag behind our political and commercial rivals, our rivals in human culture, in the systematic study of geography. In the meantime, during the course of the autumn, an exhibition will be formed of the results of Mr. Keltie's labours in collecting specimens of the best text-books, maps, globes, diagrams, models, and other apparatus used in teaching the various branches of geography. This done, it remains for me, Lord Aberdare said, only to express the fervent hope that this latest effort of the Society to promote the studies which it was founded to extend, may meet with a large measure of success and tend to lay the basis of a sound and thoroughly national system of instruction in geography in all its branches, physical, political, and historical.

Lord Aberdare then gave a brief *résumé* of exploring work since his address in November last. He specially referred to the four years' explorations in Eastern Tibet of the Pundit Krishna, and to the geographical work done in connection with the Afghan Boundary Commission.

The preliminary map sent home by Major Holdich rectifies in many important points the erroneous topography in all pre-existing maps, and gives us a clear idea of the surface-configuration and physical condition of one of the most interesting districts in Central Asia.

Further east the indefatigable Colonel Prjevalsky has been recently again heard of from the centre of the continent, at Lob Nor.

In and around the Zhob valley, areas of about 5500 square miles of reconnaissance on the $\frac{1}{4}$-inch scale, and of 400 square miles of topography in the $\frac{1}{2}$-inch scale are reported to have been completed; thus going far to fill in a reproachful hiatus in our present maps of Afghanistan. The ascent of certain peaks in the Himalaya by a member of the Alpine Club, Mr. W. W. Graham, an account of which was read by him at one of the Society's meetings in June last, has attracted considerable attention in India. The classical lands of Asia Minor have again this year been the subject of topographical investigation. In the winter of 1882-3 a fund was raised by public subscription in order to effect explorations that might throw light on the antiquities and early history of the region. Mr. W. M. Ramsay was entrusted with the execution of this scheme, and travelled with this view, May to October, 1883. He invited a scholar of the American School of Athens, Mr. J. R. S. Sterrett, to accompany him during great part of the summer. During that year's work the conviction grew up that no adequate study of the history of Asia Minor was possible till the ancient topography was better known and that no advance in the study of the ancient topography could be made till a better map of the country had been compiled. It was therefore found necessary, week by week, to pay a growing attention to the natural features of the country, the natural routes of communication, and the natural boundaries separating district from district. Lord Aberdare referred to the work done in New Guinea by Mr. Van Braam Morris, Dutch Resident at Tidore, who has examined this part of the coast, and ascended the Amberno, which had always been reported by passing navigators, on account of its numerous supposed mouths, to be a large river with an extensive delta, and to the journeys into the interior of the Rev. James Chalmers. Mr. Chalmers has visited many parts of this coast along a line of about 500 miles, and penetrated, at various places further inland, by land, than any other European, and his descriptions of the country and the habits of the vivacious, excitable, and pugnacious race of savages with which it is peopled, merit careful attention at the present time. An attempt is about to be made by the experienced traveller Mr. H. O. Forbes to penetrate to the summit of the ranges, or plateaux, which extend along the centre of this part of the great island. Since he left England on this arduous mission some weeks ago we learn that the Sydney and Melbourne branches of the Geographical Society of Australasia have offered to contribute to the expenses of this expedition, which is supported by grants by our Society, the Scottish Geographical Society, and the British Association. In other parts of Australasia the chief additions to our knowledge have been a survey of a large tract of new country in Central Queensland by Mr. C. Winnecke, and the exploration of the King Country in the northern island of New Zealand by Mr. Kerry-Nicholls, of which the explorer himself gave us an account at one of our evening meetings.

In Africa Lord Aberdare referred to the work done by Mr. H. H. Johnston at Kilimanjaro. Since then the brothers Denhardt, who had previously done excellent work in surveying the course of the River Dana, which flows from the southern slopes of Mount Kenia, have left again for East Africa. They have been commissioned, as we are informed by the German African Society, to take up a line of exploration similar to that adopted with so much success by Mr. Joseph Thomson, but to follow it much further to the north than the point reached by our English traveller, namely, to the reported great lake Samburu, north of Lake Bahringo. Further north still the year has witnessed the accomplishment of what may be termed one of the most interesting and difficult feats of all recent African travel. This is the journey of Messrs. F. L. and W. D. James, the authors of the well-known book on the "Wild Tribes of the Soudan," who with three English companions, Messrs. G. P. V. Aylmer, E. Lort Phillips, and J. Godfrey Thrupp, organised an expedition and started last December to cross the north-eastern angle of Africa from Berbera to Mogadoxo. The hostile disposition and uncertain temper of the Somali tribes who inhabit this wide region have hitherto offered invincible obstacles to its exploration by Europeans. Mr. James and his party, however, succeeded in penetrating 400 miles to the south, as far as Barri on the River Webbe, a point about 215 miles distant from Mogadoxo. The interior was found to be a plateau of an average elevation of about 4000 feet.

With regard to the more southerly parts of Eastern Africa, and more especially the region between the Mozambique coast and Lake Nyassa, our knowledge has lately increased by leaps and bounds. The increase has been principally due to the systematic explorations of Mr. Consul O'Neill. The general remark may be permitted that, thanks chiefly to Mr. O'Neill, we now have for the first time a fairly satisfactory knowledge of a region varied in its physical configuration, well watered, and fertile, which has hitherto remained a blank on our maps, notwithstanding the occupation of the coast by the Portuguese for nearly four centuries.

M. Giraud has returned this spring from his exploration of Lake Bangweolo and its outlet, and his unsuccessful attempt to cross Africa by way of the Upper-Congo; Mr. Arnot has crossed from Natal to the Bihé plateau by way of the Upper Zambesi; Mr. Montagu Kerr has crossed Matabele-land and the Zambesi, and penetrated by a new route to the south-western shore of Lake Nyassa; and Mr. Richards has reached from Inhambane the southern districts of Umzila's kingdom. In Western Africa further additons have been made to our knowledge of the Congo, chiefly by the publication of Mr. Stanley's long-expected book and the maps which accompany it, and by Messrs. Grenfell and Comber's careful survey of the middle course of the Congo and the Bochini tributary to the junction of the great river Kwango.

The members of the French Expedition on the Ogowé and the northern tributaries of the Congo have also been doing good work in the survey of the territories newly acquired by France.

In South America a striking feat of exploration has been accomplished since my last address; the supposed inaccessible summit of Mount Roraima, on the confines of British Guiana and Brazil, was reached in December last by Mr. im Thurn and his companion, Mr. Perkins, accompanied by a small party of Indians.

In conclusion Lord Aberdare gave the following brief summary of the Admiralty surveys of the year 1884, for which he was indebted to the hydrographer, Capt. Wharton, R.N.: The continuous prosecutions of marine surveys in different quarters of the globe has been well maintained during the past year. The two home-surveying vessels have been employed, one on the west and the other on the east coast of Great Britain. On foreign surveys 60 officers and 500 men have been employed in four steam ships of war and five other smaller vessels. These ships have been at work in Newfoundland, the Bahama Islands, Magellan Straits, South Africa, Red Sea, Malay Peninsula, coasts of China and Korea, north-west coast of Australia, and amongst the Pacific islands. The most important additions to our hydrographical knowledge are as follows:—The survey of the Little Bahama Bank will be shortly finished, and the same may be said of the southern shore of Newfoundland. The survey of the main strait of Magellan, to which reference was made in the last address, was completed early in the year. Many useful additions have been made to ports and salient parts of the coast of south-east Africa. In the Red Sea the intricate approaches to Sawakin have been well laid down. On the west coast of the Malay Peninsula, Penang harbour has been re-surveyed and the positions of the islands lying to the north-west and forming the eastern boundary of the ordinary route of vessels to Malacca Strait have been accurately determined. The unknown western shores of Korea, south of the approach to Seoul, for two degrees of latitude have been explored, and the main features of this island-studded shore laid down. New rivers and harbours have been entered, notably, the large river Yeun-san-gang, at the entrance to which stands the considerable town of Mokfo. There appears, however, to be little chance of immediate trade with Korea, in consequence of the absence of any valuable products and the scanty needs of the population. The southern approach to Haitan Strait on the Chinese coast, much used by British trade, has been re-charted. On the difficult shores of Western Australia such progress has been made as the small means at the disposal of the surveyors has permitted. In the Solomon Islands the Bougainville Strait has been charted. This Channel will in the future be most probably a highway for traffic between Eastern Australia and Japan. Many additions have been also made to the charts of various groups of other Pacific islands. The survey of the coasts of India carried on by officers of the Royal Navy and India Marine has been actively progressing. Surveys of Rangoon, Cheduba, and other ports in the Bay of Bengal, as well as harbours on the west coast of Hindostan, have been made. A re-survey of the great Canadian lakes has been commenced in Georgian Bay, where trade by water is on the increase.

Lord Aberdare then intimated his resignation of the Presidency of the Society, the Marquis of Lorne having been elected to succeed him.

PROF. REYNOLDS ON THE STEAM INDICATOR[1]

THE object of this paper was to define the causes and extent of the disturbances in indicator diagrams. The theory, as given, had been taught for several years in Owens College; but the publication had been deferred to enable an extensive series of experiments to be made. These experiments had now been carried out by Mr. A. W. Brightmore, Stud. Inst. C.E., late Berkeley Fellow in Owens College. In the first place it was shown that there were five principal causes of disturbance, namely: the inertia of the piston of the indicator and its attached weights; the friction of the pencil on the paper, and its attached mechanism; varying action of the spring; inertia of the drum; friction of the drum.

The effect of the inertia of the pencil and its attached mechanism presented a mathematical problem, by the solution of which it was shown that there were two disturbances from this cause: one, a general enlargement of the mean indicated pressure, depending on the weight of the moving parts of the indicator, the stiffness of the spring, and the square of the speed. The other disturbance was a vibration of the pencil. Every indicator piston vibrated when disturbed, so that the period of vibration depended on the stiffness of the spring.

The error which these oscillations caused in the area of the diagram depended on their magnitude, and, to a greater extent, on the smallness of the number in a revolution. But the evil of these oscillations was not so much an effect on the area as in the disfigurement and the confusion they produced in the diagram. So long as there were thirty of these oscillations in a cycle, the necessary fluid friction of the indicator piston would so far reduce them as to render a fair diagram possible, but when the number was as low as ten it was all the pencil could do to prevent them upsetting the diagram.

The friction arising from the pressure of the pencil always acted to oppose the motion of the pencil, and therefore rendered it too large during expansion and exhaust and too small during compression and admission, and thus the general effect was to increase the size of the diagram. This friction consisted of that of the pencil on the paper; and that of the mechanism, caused by sustaining the pressure of the pencil. The effect of the friction of the pencil was greatly reduced by the motion of the paper. The magnitude of these effects taken together on the area of the diagram depended on the construction of the instrument and on pencil-pressure. From numerous experiments it would appear possible to make a difference of as much as five per cent. in a locomotive in mid-gear by pencil-friction.

The couclusions, as regarded the motion of the pencil, were that the general effect of inertia and friction were both to increase the size of the diagram; that so long as the speeds were such that the number of vibrations of the pencil during a revolution of the engine was not greater than fifteen, the effect of inertia was less than one per cent., but that, if the number was greater than thirty, oscillations would show themselves unless the pencil-friction was increased. They might, by this, be kept down till the number of vibrations was equal to fifteen, but not farther, and then the necessary friction would affect the area of the diagram about five per cent. For the diagrams to be sensibly accurate, and free from oscillation, the speeds must not be greater than would make the number of vibrations equal to thirty. These speeds were given in the paper for Richards' indicators.

The effect of the inertia of the drum with an elastic cord was shown to be a nearly uniform elongation of the diagram. The result of the varying stiffness of the drum spring was a nearly uniform contraction. With Richards' indicator these two latter disturbances neutralized each other at a speed of 150 revolutions per minute. At other speeds the effects were apparent in the length of the diagram; but, except when the expansion was great and the connecting rod short, they did not affect the indicated pressure. The friction of the drum with an elastic cord caused the cord to be longer during the forward stroke than during the

[1] A Paper read at the Institution of Civil Engineers, May 19, "On the Theory of the Indicator and the Errors in Indicator Diagrams," by Prof. Osborne Reynolds F.R.S.

backward stroke, so that the diagram was distorted and shortened, the drum being uniformly behind its proper position during the forward stroke, and before its position during the backward stroke. This distortion diminished the area of the diagram according to the rate of expansion and the length and elasticity of the cord used. This was definitely expressed by a formula. This disturbance, the influence of which was very great in cases of high expansion, large engines, and ordinary cords, appeared to have been unnoticed. The circumstances on which it depended were the elasticity of the cord and the friction of the drum, and the question was how far these existed in the ordinary indicators. It might be said that the diagrams which led to the discovery of this effect were taken with an indicator which had been in constant use for several years. It was in apparently perfect condition, and the diagrams did not differ essentially from those which had been previously taken. The cord was one which had been supplied by the maker. The manner of the discovery was described: For years the author had pursued in the class the method of testing the vibrations of the indicator pencil by projecting them on to the crank-circle, and he had noticed that the first oscillation fell short, and shorter in the back diagram than in the front. The cause of this was not obvious, and it was partly with a view to determine this cause that Mr. Brightmore's investigation was commenced. A slight error in the reducing rod, which had a fixed centre and a slot in which a stud in the slide-block worked, was altered. This, however, did not get rid of the effect. A new cord was substituted for the old one, and the effect was found to be much enhanced, the new cord being more elastic than the old one. This reduced it to the stretching of the cord, but it was only after carefully working out the effect of the inertia of the drum, and it was seen this was to lengthen the first oscillation at the back end that the friction was examined. The indicator was taken to pieces, cleaned and oiled; then the effect was much reduced. Several new wires and cords were used, and eventually steel wire was adopted as the best. The test supplied by the oscillations could only be applied to diagrams taken at high speeds, and the test furnished by the influence upon area was vague. What was wanted was an independent means of determining the simultaneous positions of the drum and the engine-piston. As the best method of meeting this, it was decided to arrange an electric circuit through the pencil to the drum, with sufficient electromotive force to prick the paper, making the engine-piston close this circuit at eleven definite equidistant points in the motion backwards and forwards. This was successfully carried out, and the stretching of the cord during the backward and forward strokes was definitely ascertained. Taking the smallest results obtained with a cord, it appeared from these experiments that the least difference of stretching was to make this difference in inches 5 per cent. of the length of the cord in feet. Examples of this effect in diminishing the mean indicated pressure were given. Thus, in a locomotive cutting off at one-quarter it was 8 per cent.; in a condensing engine having 3·5 feet stroke, cutting off at one-tenth, 20 per cent.; and the same compounded, 10 per cent.

These would seem to be the smallest results that could have occurred in ordinary practice. The conclusion, however, that hitherto the normal indicated power from engines had been from 10 to 20 per cent. too small must wait for verification. Yet there were not wanting independent evidences of such an effect. In diagrams taken from engines at high speeds the admission line would not but for this effect be vertical. It would show a certain amount of detail, and the first oscillation would not have a sharp top. Moreover, it was commonly found that the expansion line, allowing for clearance, was above the true expansion line for the steam. This apparent rise in the curve of expansion was exactly what would result if the apparent cut-off was too early, and this was the result of the effect that had been considered. The author had tried several diagrams, and found that after correction the expansion line came out very close to the true curve.

In making these comparisons the explanation of another feature of diagrams became apparent. When the two diagrams were traced on the same card, there was sometimes a want of symmetry about them, and in this case the cut-off was shorter on the back than on the front diagram. This the author attributed to the friction of the drum when the cord for the back diagram was longer than that for the front. When this was the case the relative lengths of the cord were about 1 to 1·8. These observations were illustrated in a diagram from "Richards' Indicator." To test this diagram a tracing was taken, and reversed so that the front diagram was superimposed on the back. It was observed that the diagrams were of different lengths, and the difference was about the same as the difference in cut-off; that notwithstanding the apparent cut-off in the back diagram was to that in the front in the ratio of 2 to 3, the expansion line of the back diagram was the same shape as that in the front; and that if the diagrams were restored, supposing the lengths of the cords used to have been 5 feet and 9 feet, the diagrams became exactly similar, and, allowing 2 per cent. clearance, the expansion line came to be the true expansion line for that cut-off. The mean pressure was 14 per cent. larger than from the original diagram.

Such instances as these seemed to sufficiently establish a case against the blind faith which appeared to be at present placed in the accuracy of the indicator diagrams. But, in conclusion, the author stated that he should be very disappointed if anything in this investigation should have the effect of diminishing reliance on the indicator itself. He would have the instrument treated fairly, and instead of being the object of unthinking worship he would have it the object of careful study and experimental investigation, so that the limits of its wonderful perfection might be known exactly, and that reliance placed on it which sprang from knowledge.

THE VISITATION OF THE ROYAL OBSERVATORY, GREENWICH

THE visitation of the Royal Observatory took place on Saturday last, when, in spite of bad weather, there was a numerous attendance. The following extracts (condensed in some cases) from the Report of the Astronomer-Royal to the Board of Visitors indicate the work of the past year. It will be gratifying to all to know that a considerable increase in the optical power of the Observatory is in contemplation.

Transit-Circle.—A reversion-prism made by Messrs. Troughton and Simms has been used since last June in observations with the collimators as well as with the transit-circle to reverse the apparent direction of measurement or of motion, a movement towards the left (as in transits of south stars) being converted into a movement towards the right, or upwards, or downwards, according to the position of the plane of reflection of the reversion-prism. The collimation-observations show no sensible personality depending on the apparent direction of measurement; it has, however, been considered well, in order to eliminate any possible effect of the kind, to take half the measures in each determination of collimation with the direction of movement of the wire reversed as regards right and left. In the transits the practice is to observe on each day two clock-stars and also circumpolar stars with the direction of motion reversed. A comparison of the results from the reversed and ordinary observations of clock-stars shows sensible differences in the case of some observers, who, however, have probably not yet settled down into a definite habit of observing stars which appear to move in the reverse direction.

In order to determine absolute personal equations in the observation of slow-moving as well as of quick-moving stars of various magnitudes (whether the motion be from right to left or the reverse) and of limbs of the sun, moon, or planets, the Astronomer Royal has arranged, in concert with Mr. Simms, a personal equation instrument to be used with the transit-circle. In this instrument, which is on the point of completion, and was seen at work on Saturday, a vertical plate with a circular aperture, 6 inches in diameter, to represent the sun or moon, and several small pinholes, to represent stars of different magnitudes, is placed in the focus of an object-glass of about 7 inches aperture and of about 50 feet focal length (which is attached to the dew-cap of the transit-circle, when horizontal and pointing north), and is carried smoothly by clockwork from east to west or west to east at a rate which may be varied at will from that of a very close circumpolar star to three or four times that of an equatorial star by an ingenious but simple mechanical contrivance devised by Mr. Simms. The apertures in the vertical plate are illuminated by direct sunlight or moonlight reflected by a plane mirror towards the object-glass, and the times of transit of the artificial sun, moon, or stars, which are to be observed over the wires of the transit-circle, are also registered automatically on the chronograph by means of insulated platinum studs, corresponding to the artificial objects, which make contact with other studs, corresponding to the wires in the field of view of the transit-circle.

Since last October transits of the close circumpolar stars have been taken at the middle wire set to successive revolutions of the R.A. micrometer, thus virtually introducing a system of very close equidistant wires for the slow-moving stars. It is thus found that a larger number of separate observations can be obtained in a moderate time, a point of special importance in changeable weather. The equality of successive intervals of the R.A. micrometer-screw was tested last January for each revolution through a range of twelve revolutions, and also for every tenth of the three middle revolutions, and the errors of the screw appear not to exceed the errors of observation. The determination was made by means of the south collimator, the eye-piece of the transit-circle having been turned through 90°. The observations of close circumpolar stars have also been discussed with a view of testing the equality of successive revolutions of the R.A. micrometer screw, the results being very satisfactory. The screws of the microscope-micrometers also were examined by means of the south collimator on March 27 and following days, successive intervals being measured for each revolution and third of a revolution from -1^r to 6^r. Though there is evidence of considerable wear in the individual screws, which have been in constant use since 1875, the method of using them (the action of the spring being in opposite directions for the micrometers of each pair) entirely eliminates this effect from the mean, and the resulting errors (which are probably casual errors of observations) do not exceed 0″·05 at any part of the screws.

The subjects of meridian observations in the past year have been as usual the sun, moon, planets, and fundamental stars, with other stars from a working catalogue, which now contains about 2,750 stars. About 380 stars have been lately added to the list from the "Harvard Photometry," with a view of making the forthcoming Greenwich Catalogue of stars down to the sixth magnitude as complete as possible. It is hoped that all of these stars will have been sufficiently observed by the end of 1886, when it is proposed to form a Ten-Year Catalogue, epoch 1882·0. The annual catalogue of stars observed in 1884 contains about 1,370 stars.

The following statement shows the number of observations with the transit-circle made in the twelve months ending 1885, May 20:

Transits, the separate limbs being counted at separate observations...	5523
Determination of collimation error	299
Determinations of level error ...	376
Circle observations	5321
Determinations of nadir point, including the number of circle-observations ...	294
Reflection-observations of stars (similarly included) ...	619

The discordance between the nadir observation and the mean of the results from reflection observations of stars north and south of the zenith has recently become very small, the correction deduced for the first four months of the present year being only −0″·07. The mean correction indicated by the observations of 1884 was −0″·36, whilst those of 1883 gave the value −0″·45. The steady increase of this discordance from 1878 to 1883 and its subsequent decrease remained unexplained, no change having been introduced into the method of observation of the nadir point or of stars by reflection during the last two years.

The apparent flexure of the transit-circle, as found by means of the collimators, has again changed sign. From six determinations made on 1884 June 3, Sept. 9, Sept. 29, Oct. 5, Oct. 20, and May 20 (the reversion-prism being used on each occasion except the first) the resulting values (found by four different observers) are −0″·47, + 1″·00, + 0″·03, + 0″·10, and +0″·08, the mean of which is +0″·17, agreeing closely with the value + 0″·13 found by nine accordant determinations in the period 1879 to 1882, whilst the mean of five determinations by three different observers in 1883 gave the value − 0″·49. No correction for flexure (as distinct from the R − D correction) has been applied to the observations since 1879.

The correction for R − D, the error of assumed colatitude, and the position of the ecliptic, have been investigated for 1884. The computation of the geocentric and heliocentric errors for the planetary results is not yet complete.

The correction for discordance between reflection and direct observations of stars, deduced from observations in 1884 which extend from Z.D. 69° north to Z.D. 70° south is − 0″·02 + 0″·66 sin Z.D. The assumed formula $a + b \sin z$ represents the observations of 1884 satisfactorily throughout the whole range of zenith distance.

The value found for the colatitude from the observations of 1884 is 38°. 31′.21″·91, differing only by 0″·01 from the assumed value; the correction to the tabular obliquity of the ecliptic is + 0″·57; and the discordance between the results from the summer and winter solstices is − 0″·99.

The mean error of the moon's tabular place (computed from Hansen's Lunar Tables with Prof. Newcomb's corrections) is +0s·02 in R.A. and + 0″·29 in longitude as deduced from 104 meridian observations in 1884.

Altazimuth.—The observations with this instrument have been restricted to the period from last quarter to first quarter in each lunation, the total number of observations of various kinds made in the 12 months ending 1885 May 20 being as follows:—

Azimuths of the moon and stars ...	321
Azimuths of the azimuth-mark ...	181
Azimuths of the collimating-mark ...	192
Zenith-distances of the moon ...	178
Zenith-distances of the collimating-mark ...	196

Since last December a "reversion prism" has been used to reverse the apparent direction of motion in the observation with lamp right and in that with lamp left on alternate nights.

Clocks.—On Jan. 1 the public clock at the Observatory entrance and the other mean solar clocks were put forward 12 hours so as to show Greenwich civil time, starting at midnight and reckoning from 0h. to 24h., which would correspond with the universal time recommended by the Washington Conference. The change from astronomical to civil reckoning has also been made in all the internal work of the Observatory, and has been carried out without any difficulty. Greenwich civil time is found to be more convenient on the whole for the purposes of this Observatory, but its introduction into the printed astronomical observations has been deferred to allow time for a general agreement amongst astronomers to be arrived at. It is proposed, however, to adopt the civil day without further delay in the printed magnetical results, thus reverting to the practice previous to 1848, and making the time-reckoning harmonise with that used in the meteorological results, the reckoning from 0h. to 24h. being for the future adopted in both cases.

Reflex Zenith Tube.—The observations of γ Draconis for determination of the temperature correction have been continued, and about 45 transits over the 30 wires have been observed at temperatures ranging from 46° to 72°. Seven transits of 9 Aurigæ were also observed last February at low temperatures ranging from 42° to 56°.

Equatorials.—The work on the Lassell equatoreal has occupied a great deal of attention during the past year, a number of repairs and alterations having been required in order to get the instrument into proper working order. The driving clock, which was found to drive the instrument at only three-fifths of the proper speed, has been altered, a slow motion in R.A. (to be worked from the observing stage) has been contrived, a new slide of improved construction has been made for gearing the driving-screw into the hour-circle, the teeth of the hour-circle have been re-cut, a firm declination clamp has been applied, an improved edge suspension for the large mirror (consisting of a steel band which encircles the mirror and is supported by brackets at six equidistant points of the circumference) has been contrived, a new and firmer mounting of the small mirror has been made, and the eye-piece has been mounted firmly on a plate which allows it to be tilted in any direction, for optical adjustment. The framed iron base which supports the instrument has been bricked up and filled with concrete, and this, with the other alterations, has greatly increased the stability of the telescope, which is now quite satisfactory. Difficulty is, however, still experienced from want of stability of the optical axis of the large mirror, which requires to be readjusted continually, as the telescope is moved. When the mirrors have been properly adjusted the definition appears to be very good, the companion to Vega being shown with remarkable distinctness without any trace of scattered light from the large star.

The south-east and Sheepshanks equatorials are in good order, as also is the Simms' six-inch equatorial mounted in the south ground.

With one or more of these equatorials, or with the altazimuth, 30 occultations of stars by the moon (19 disappearances and 11 reappearances, including 7 disappearances and 9 reappearances during the lunar eclipse of October 4), and 57 phenomena of

Jupiter's satellites, have been observed in the twelve months ending 1885 May 20, and the observations have all been completely reduced to the end of 1884. Comet (*c*) 1884 has been observed on four nights, the Lassell reflector or one of the other equatoreals being employed, and some measures of distances and position-angle of double stars, as well as a large number of observations for determining the value of 1^{rev}. of the screw in different parts of the field of view have been made with the Airy double-image micrometer mounted on the Sheepshanks' or Simms' equatorial.

Micrometer measures of some of the satellites of Saturn (including Enceladus) were made on seven nights with the Lassell equatorial.

Spectroscopic and Photographic Observations.—The solar prominences have been observed with the half-prism spectroscope on only two days, the photographic reductions having pressed very severely on the spectroscopic assistant during the long continued maximum of sun-spots.

For the determination of motions of stars in the line of sight, 569 measures have been made of the displacement of the F line in the spectra of 47 stars, and 72 measures of the *b* lines in 14 stars, besides measures of the displacements of the *b* and F lines in the spectra of the east and west limbs of Jupiter, and of the east and west ansæ of the rings of Saturn, and comparisons with lines in the spectrum of the moon, or of the sky, made in the course of each night's observations of star-motions, or on the following morning, as a check on the general accuracy of the results for star-motions. The observations of the last twelve months confirm the change in the motion of Sirius, which now appears to be approaching the sun at the rate of about 20 miles a second. As there is great difficulty in the use of a pointer or cross-wires for measuring both the broad dark line in the star's spectrum and the narrow bright comparison line, Mr. Maunder has suggested the use of a reversion spectroscope (on the double-image principle) for these observations, and Prof. Pritchard has kindly lent the reversion spectroscope of the Oxford University Observatory, in order that the suitability of that form of instrument may be tested. The spectroscopic observations of all kinds are completely reduced to the present time.

In the twelve months ending 1885 May 20 photographs of the sun have been taken on 173 days, and of these 431 have been selected for preservation, the record being not so complete as usual, owing partly to the loss of several days during the adjustment of the instrument after the adaptation of the secondary magnifier, and partly to a failure of the supply of dry plates in July last during the absence of Mr. Maunder. There were only two days on which the sun's disk was observed to be free from spots.

The mean spotted area of the sun was slightly less in 1884 than in 1883 and slightly greater than in 1882, whilst the faculæ in 1884 showed a slight increase as compared with 1883, and a slight falling off as compared with 1882. It would seem that the maximum both of sun-spots and faculæ occurred about the end of 1883 or beginning of 1884.

For the year 1884 Greenwich photographs are available for measurement on 152 dsys, and Indian photographs filling up the gaps in the series on 159 days, making a total of 311 days out of 366 on which photographs have been measured. In 1883 the total number of days was 340, viz., Greenwich series 215 days, supplemented by Indian photographs received from the Solar Physics Committee on 125 days.

Magnetic Instruments.—The following are the principal results for magnetic elements for 1884:—

Approximate mean westerly declination	18°.8′.
Mean horizontal force ...	3·931 (in English units). 1·812 (in Metric units.)
Mean dip	67°.29′. 8″ (by 9-inch needles). 67.29.32 (by 6-inch needles). 67.30. 9 (by 3-inch needles).

In the year 1884 there were only five days of great magnetic disturbance, but there were also about 20 days of lesser disturbance for which it appears desirable to publish tracings of the photographic curves. It may be interesting to add the tracings for a few quiet and nearly quiet days in order to exhibit the characteristics of the ordinary diurnal movement.

Commencing with 1883 the magnetic diurnal inequalities of declination, horizontal force, and vertical force have been discussed by the method of harmonic analysis, the harmonic expressions for these inequalities being obtained for each month and for the year with arguments expressed in apparent solar time as well as in mean solar time.

Meteorological Observations.—The mean temperature of the year 1884 was 50°·7, being 1°·4 higher than the average of the last 43 years. The highest air temperature (in the shade) was 94°·1 on Aug. 11, and the lowest 24°·5 on Nov. 25. The mean monthly temperature was above the average excepting in the months of April, June, Oct. and Nov.

The mean daily motion of the air in 1884 was 286 miles, being 3 miles greater than the average of the last 17 years. The greatest daily motion was 891 miles on Jan. 23, and the least 78 miles on Feb. 8. The only recorded pressure exceeding 20 lbs. on the square foot in 1884 was 22·7 lbs. on Jan. 23, after which the connecting chain of the pressure plate broke, as mentioned in the last report. It is probable that greater pressures occurred afterwards on the same day, and also in the gale of Jan. 26, at which date the chain had not been renewed.

During the year 1884 Osler's anemometer showed an excess of about 25 revolutions of the vane in the positive direction N, E, S, W, N, excluding the turnings which are evidently accidental.

The number of hours of bright sunshine recorded by Campbell's sunshine instrument during 1884 was 1115, which is about 100 hours less than the average of the seven preceding years. The aggregate number of hours during which the sun was above the horizon was 4465, so that the mean proportion of sunshine for the year was 0·250, constant suushine being represented by 1.

The rainfall in 1884 was 18·0 inches, being about 7 inches below the average of the last 40 years.

Chronometers and Time Signals.—The number of chronometers now being tested at the Observatory is 151, and of these 103 (79 box-chronometers, 13 pocket-chronometers, and 11 deck-watches) belong to the Navy, 40 are placed here for the annual competitive trial, and 8 are on trial for purchase by the Austrian Government.

The first six chronometers in the competitive trial of 1884 were rather above the average of the last ten years as inferred from the trial numbers. As much difficulty is experienced in maintaining the chronometer oven at a nearly constant temperature, an apparatus has been procured from Mr. Kullberg which is designed to effect this automatically, by the action of a compensation-bar, which, as the temperature rises, gradually closes a small hole through which the supply of gas to the gas burners passes. The apparatus has not yet been brought into use, as the chronometer oven has been constantly required for testing chronometers since it has been received.

The automatic drop of the Greenwich time-ball failed on 6 days through the clock-train stopping. The ball was not raised on 3 days on account of the violence of the wind.

As regards the Deal time-ball, which is now dropped by current passing through the chronopher of the Post Office telegraphs, there have been fourteen cases of failure owing to interruption of the telegraphic connections, and on one day the current was too weak to release the trigger without the assistance of the attendant.

In connection with the establishment of hourly time signals at the Start or Lizard, which was long advocated by Sir G. B. Airy, I have received from the Committee of Lloyds', in answer to my inquiry, an assurance that that corporation would be willing to undertake the maintenance of hourly time-signals at any of their signal-stations, provided the Government would supply the necessary apparatus. After consultation with Capt. Wharton, it has been thought better that, before taking further steps, some preliminary trials should be made of a collapsible cone as an hourly time-signal, facilities for doing which exist at Devonport. As regards ball-drop or other time-signal, I would propose that it should be made automatically by a local clock, to be corrected daily by the help of a time-signal from Greenwich at 10 a.m., which should automatically start an auxiliary seconds pendulum, suspended freely just behind the clock pendulum. The attendant would then accelerate or retard his clock pendulum (by electro-magnetic action as in the Greenwich mean solar clock) so as to make it pass through the middle of its vibration at the same time and in the same direction as the auxiliary pendulum, and thus to indicate accurately Greenwich mean time. A return signal to Greenwich sent by the local clock at the next hour (11 A.M.) would show that this clock had been properly corrected, and would be a guarantee for the general accuracy of the time-signals. Preliminary trials have shown that the observation of coincidence of vibration of two pendulums can be made with great certainty, and Messrs, E. Dent and Co. are now arranging for the mounting of an auxiliary pendulum on one of the transit of Venus clocks, and for adapting it to give hourly time-signals.

The errors of the Westminster clock have been under 1s. on 50 per cent. of the days of observation, between 1s. and 2s. on 29 per cent., between 2s. and 3s. on 10 per cent., between 3s. and 4s. on 7 per cent., and over 4s. on 4 per cent.

During the past year the Observatory has lost the valuable services of Mr. Dunkin, who retired on August 25, after an honourable service of forty-six years, which has been throughout characterised by remarkable zeal and ability, and has contributed largely to maintain the credit of the Observatory. Mr. Dunkin has been succeeded in the post of Chief Assistant by Mr. H. H. Turner, B.A., of Trinity College, Cambridge.

The report concludes as follows :—

During the past year the various classes of work carried on in this Observatory have been somewhat extended. The meridian observations are more numerous than usual, and various subsidiary investigations involving considerable labour have been undertaken with a view to increase their accuracy. A large number of spectroscopic determinations of star-motions have been obtained, and the long continued maximum of sun-spots has made the photographic measurements and computations much heavier than in any previous year. Extensions have also been made in the magnetic and meteorological branch, which appeared very desirable, but which have pressed rather severely on Mr. Ellis and his staff.

Turning to the future, I wish to invite the attention of the visitors to the circumstance that an increase in our optical means is required to enable us to carry out satisfactorily the determinations of proper motions of stars in the line of sight with the spectroscope, a work which peculiarly belongs to this Observatory, as supplementing the determinations of proper motions from meridian observations.

The aperture of our largest refractor (12¾ inches) is too small to allow of our observing successfully with the spectroscope any but the brightest stars, and though the Lassell reflector is somewhat more powerful, its mounting and clock-work are not adapted to carry a heavy spectroscope with the necessary steadiness and accuracy of motion. The firmness of the mounting of the south-east equatorial and the perfection of its clock-work would make it peculiarly suitable for this class of work if it carried a much larger object-glass.

After careful consideration of the conditions I have satisfied myself that an object-glass of 28 inches aperture and of 28 feet focal length could be mounted on the south-east equatorial, in place of the present object-glass of less than half that aperture; and I have ascertained that Mr. Grubb would be prepared to undertake the construction of such an object-glass with a tube suited to the special requirements of the case, so that the telescope would be equally available for eye-observation or for use with the spectroscope. With Mr. Grubb's assistance, I have prepared a model showing how this may be arranged.

While a large refractor is required specially for spectroscopic observations, it seems desirable also on other grounds that this Observatory should possess an equatorially mounted telescope comparable with those of other first-class observatories, so that we may no longer be prevented by deficient optical means from obtaining complete series of observations of comets and faint satellites.

VIVISECTION

A RETURN has been issued by the Home Office containing the reports of inspectors showing the number of experiments performed on living animals during the year 1884 under licences granted according to the Act 39 and 40 Victoria, c. 77, distinguishing painless from painful experiments.

The former of the two reports deals with England and Scotland, the latter with Ireland. They are as follows :—

"(1) The names of the 49 persons who held licences during any part of the year are given in the subjoined tables, in one of which are entered the names of those licensees who performed any experiments, 34 in number; and, in the other, the names of those who performed none.

"(2) The total number of experiments of all kinds performed during the year was about 441.

"Of these, 140 were done under the restrictions of the licence alone, 78 under the same restrictions, but under certificates in column 1 (lecture illustrations); 145 under certificates in column 2; 76 under those in column 3; and 2 under a certificate in column 4.

"(3) With regard to the infliction of pain, as in all the experiments, except those under special certificates in columns 2, 3, and 4, the animals are rendered insensible during the whole of the experiment, and are not allowed to recover consciousness, no appreciable suffering would be caused if the provisions of the Act are faithfully carried out, as there is not the least reason to doubt they were.

"With respect to experiments under certificates in columns 2, 3, and 4, which dispense either wholly or partially with the use of anæsthetics, it should be stated :—

"(*a*) That of the 145 experiments performed under certificates in column 2, 99 consisted in simple inoculation with a morbid virus, in which no operation beyond the prick of a needle was required, and for which the administration of an anæsthetic would only have entailed needless annoyance and distress to the animal. In these experiments any appreciable suffering would be felt only in those cases in which the inoculation took effect, involving about the same amount of pain as ensues on ordinary vaccination, before the brief period the animals were allowed to survive. Of such cases, according to the returns I have received, about 16 occurred. Of the remaining 46 experiments under these certificates, 24 were performed for the purpose of medico-legal inquiries in cases of suspected poisoning, resulting in the death by tetanus of three frogs and six mice, which survived, however, only a few minutes; 10 other cases under the same head were experiments on the infection of fish with a species of fungus, very destructive in certain rivers and streams; and five on the effects of immersion of fish in distilled water, which proved fatal to about thirty minnows and sticklebacks. In none of these cases could it be said that any appreciable suffering was inflicted. In seven cases, in which salts of ammonia were hypodermically injected, two are returned as having suffered pain, but of a very trifling character.

"(*b*) Of the 76 experiments under certificates in column 3, 47 required a simple operation, but this being done under anæsthesia, was unfelt, and the after-effects, though in many of the cases resulting in partial paralysis, are reported as having been unattended with actual pain in any case. The remaining 29 were by simple inoculation, and none were attended with pain.

"(4) In conclusion, therefore, it may be stated that the amount of direct or indirect actual suffering, as the result of physiological and therapeutical experiments performed in England and Scotland, under the Act in the year 1884, was wholly insignificant. "GEORGE BUSK, Inspector

"The Right Hon. the Secretary of State."

"16, Harcourt Street, Dublin, May 17

"SIR,—In accordance with your instructions I beg to submit the following table, showing the licences in force in Ireland during the year 1884 under the Act 39 and 40 Vict., c. 77. No certificate has been allowed during the year.

"Several of the licences in force during the previous year have expired, and renewals have not been sought for.

"Under the licences in force thirteen experiments have been made; they were all painless. I am of opinion that the experiments in question were useful ones; eleven of them were intended to elucidate the actions of drugs, and the remaining two to assist the investigation of certain circulatory phenomena which have a bearing upon the treatment of disease.

"I have, &c.,

"W. THORNLEY STOKER

"To the Right Hon. the Chief Secretary for Ireland."

In each case the report is followed by a list of all persons who hold such licences, the places where they are permitted to make experiments, and the nature of the certificate held.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Annual Report of the Museums and Lecture-Rooms Syndicate, recently published, contains the reports of all the professors, lecturers, and heads of departments connected with natural science.

Prof. Thomson (Cavendish Professor of Physics) reports that during the Lent term ninety students attended the demonstrations, and there were ten persons doing original work in the laboratory. Lord Rayleigh states that during the last five years about 2500*l.* has been spent on the Cavendish Laboratory in addition to the University expenditure. This has come partly from fees, partly from the apparatus fund raised by subscription.

The Chemical Laboratory has been much over-crowded and improvements are scarcely possible until the new laboratory has been completed.

The register of the mineralogical collections is completed. The number of students increases; fifteen attended Mr. Solly's demonstrations in the Michaelmas term and nineteen in the Lent term.

The department of mechanism has continued to grow rapidly. During the year two new woorkrooms and a new foundry have been added and have met the most urgent requirements. Upwards of 1000*l.* worth of new machinery has been added at Prof. Stuart's expense during the last two years to meet immediate wants; and during that time the pupils have doubled in number. The lecture-rooms have become over-crowded, and new ones are much wanted. Prof. Stuart urges that the University should now purchase the machinery and apparatus used in teaching, which is his property. The undertaking is now wholly self-supporting, paying interest on the capital involved, and providing an adequate sinking fund.

The classes of practical morphology and elementary biology are now much better accommodated in the new rooms. One hundred Zeiss's microscopes have been purchased. The Balfour library has been enlarged, and proves of great value to students. Seven demonstrators have been fully occupied in the classes, in addition to two ladies who have superintended the women students. In the May Term, 1884, in which two years of students were combined, 206 men and 12 women went through the course of elementary biology. In the Lent term of 1885, 128 men and 7 women attended. In Elementary Morphology there were 68 students in last October term, and 87 in the recent Lent term.

Prof. Macalister has utilised the services of seven assistant Demonstrators, in addition to Mr. Hill, whose labour has been unremitting. Subjects for dissection have been secured from a wide area. Prof. Macalister has presented a series of models of the viscera of the body showing their proper relative positions, casts of frozen sections, 26 crania, and 160 specimens of bones showing peculiarities. No department of University work is so badly housed as the Department of Anatomy; but much good work is done in the limited space.

In the Museum of Comparative Anatomy and Zoology 72 additional species from Dr. Dohrn's collection have been remounted and displayed. An extensive collection of marine invertebrata from the New England coast has been forwarded from the National Museum at Washington, through the kind offices of Prof. Baird. The work of the Curator in Invertebrate Zoology has been principally expended upon the MacAndrew collection of shells. Mr. Cooke has published two extensive papers, and progressed with the rectification of the nomenclature and the catalogue.

A fine adult Echidna from New Guinea has been presented by Dr. Guillemard. Both skin and skeleton have been mounted. A complete skeleton of the red deer in a sub-fossil state has been procured from Burwell Fen by Mr. W. Stubbings, Assistant in the Museum; a complete skeleton of an African elephant, shot by Mr. W. Heape near Port Elizabeth, has been presented. Many other interesting acquisitions are named in the report.

Dr. H. Gadow, the Strickland Curator, has been forming a manuscript catalogue of the skins of birds in the Museum. An exhibited series of specimens is being placed systematically, with the important anatomical parts, nests and eggs, in an educational series. Twenty maps have been placed in the cases to illustrate the geographical distribution of birds. The University collection now consists of 9653 specimens of 3290 species. The Strickland collection, in addition, contains 600 specimens of 3125 species; and, with Mr. E. Newton's collection, there are in all 17,000 specimens, representing probably 4500 species.

Prof. Foster reports that the number of students of elementary physiology has risen from 77 in the Easter term, 1884, to 141 in the recent Lent term, exclusive of women students. Twenty-eight have attended advanced lectures also. Several important additions, such as a gas-engine, a centrifugal machine, recording and other apparatus, have been made to the Laboratory, by the aid of a gift of 500*l.* by an anonymous donor. The inadequacy of accommodation, both for practical work and for lecturing, is severely felt.

Prof. Ray has been successful in organising extended practical courses, as well as systematic lectures. The *post-mortem* examinations at Addenbrooke's Hospital have been placed under his superintendence. At present the only laboratory space available is obtained by encroaching on Dr. Foster's already overcrowded rooms.

Prof. Babington reports that the arrangement of the general Herbarium is now complete. The plants have been placed in orders and genera, according to Bentham and Hooker. The arrangement of species has not as yet been attempted. Mr. Potter and Mr. Gardiner have commenced the formation of a small Botanical Museum similar to that of Comparative Anatomy. Mr. Vines finds the new rooms very suitable both for class purposes and for research. Last term there were 29 advanced and 30 elementary students working in the laboratory.

The Geological Museum has acquired a fine collection of fossils from the Oolites of Dorset, chiefly by the liberality of Prof. Henry Sidgwick. Messrs. Roberts and Small brought useful additions from the Jura. Mr. Marr has added largely to the Cambrian and Silurian series. Mr. Keeping has collected and restored many specimens from Pliocene and Pleiostocene deposits. Mr. J. Robarts has worked most energetically as Prof. Hughes' assistant, in the museum, in teaching and collecting. Work is much hindered by the want of a lecture room and class-room.

Mr. Walter Gardiner, whose original work in vegetable histology is so well known, has been elected to a Fellowship at Clare College.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 6.—"On charging Secondary Batteries," by William Henry Preece, F.R.S.

Mr. Preece said he had for some months past been experimenting with secondary batteries with a view of getting an efficient, uniform, and constant source of current for electric lighting his house. The cells are of the Planté type, manufactured by the Elwell Parker Company of Wolverhampton. Each cell contains fourteen plates of plain sheet lead 17" × 11", which are suspended in well-insulated wood boxes filled with diluted sulphuric acid in the proportion of about 1 to 19. These plates are grouped in two groups of seven, each group being soldered to a lead strip, forming alternately the positive and negative poles of the cell. The plates of the respective poles are prevented from touching each other by ebonite grids or separators introduced by Mr. Charles Moseley to prevent short-circuiting through the buckling of the plates. Each plate offers a surface of 1·3 square feet, so that the total surface of lead of each group opposed to each other is 9·1 square feet; that is, 9·1 square feet of peroxidised lead is opposed to 9·1 square feet of spongy lead. Mr. Preece employs 24 of such cells. The charging current varies from 3 to 3½ amperes per square foot, while the current of discharge used in lighting his house varies from 1 to 1½ ampere per square foot. The total weight of each cell is 120 lbs. The plates are prepared by the Parker-Planté process before insertion in the cell, those forming the positive pole being well peroxidised, while those forming the negative pole are well coated with spongy lead. This process consists in immersing for a few hours the lead plates in a solution of nitric and sulphuric acids in the proportions—

Nitric acid	1
Sulphuric acid	2
Water	17

before fixing in the cells. This not only chemically cleans the lead surfaces, but it favours the formation of sulphate of lead in such a way as to be readily converted into lead peroxide and spongy lead on the passage of a strong current through the cells. The formation of the cells is thus expedited. They are thus, when put together, prepared at once to be charged. If they are not at once charged, local action sets in, and lead sulphate is injuriously formed.

A hydrometer, having a scale graduated from 1·050 to 1·150, is used to indicate the density of the liquid while the cells are being charged and discharged. Mr. Preece puts into his battery a charge of about 120 ampere-hours twice a week. Hourly measurements of E.M.F. current and density of liquid have enabled him to know the condition of his battery at any period of charge or discharge. These measurements have been plotted out into curves, the ordinates showing volts, amperes, and specific gravity, and the abscissæ hourly observations. When each magnitude reaches its constant, bubbles of gas are freely given forth and energy is being wasted. The variation of the electromotive force and current strength is clearly due to the counter-electromotive force of the cells, which becomes a maximum only when the plates are fully formed. The counter-electromotive force partakes of the character of a higher resistance opposing the charging current, and increasing the proportion of the current through the shunt of the dynamo. Hence the changes of electromotive force are more marked than those of the current. Indeed, the changes in the electromotive force, as given by the voltmeter, are sufficient alone to indicate the progress and completion of the charge. They are more reliable than the evolution of gas.

The electrical leakage of Mr. Preece's cells is obviated by standing each cell on three porcelain supports, having cups half filled with resin oil on Messrs. Johnson and Phillip's plan.

Mr. Preece gives the E.M.F. of the battery at its terminals as—

When charging	2·25 per cell
When idle...	2·05 ,,
When discharging	1·90 ,,

and the internal resistance per cell as—

When charging	·0060 ohm
When discharging	·0017 ,,

But the latter is said to vary very markedly within the strength of current of discharge. This is shown by the following experiment, made with 23 cells of a smaller type than those described above, which are used in the Post Office :—

Current of discharge in amperes	Internal resistence in ohms
4·39	0·7608
7·25	0·4607
15·84	0·2816
25·07	0·1969

Thinking that this remarkable diminution of internal resistance might be due to the evolution of heat, Mr. Preece measured the temperature with a delicate thermometer.

Normal temperature of cell 12½° C. current of discharge :—

5 amperes	No alteration of temperature perceived
10 ,, ...	An exceedingly slight change
16 ,, ...	About 12¾°
20 ,, ...	Barely 13°

The current in each case was kept on for twenty minutes, hence the diminution, Mr. Preece says, is not due to heat.

Since the internal resistance varies in this way Mr. Preece now always takes the internal resistance with the same current, viz., 10 amperes.

The author of this paper asserts that the capacity of these batteries certainly improves with age, and up to the present time he has seen no sign of decay or deterioration.

M. Planté informed him that, though in course of time the peroxidised plate becomes very brittle, it is impossible to peroxidise it completely through ; there always remains a metallic core to give it strength. Mr. Preece finds that this is so. Up to the present moment he has made no careful measurements of the efficiency of his battery. He puts in about 240, and takes out about 200 ampere-hours weekly, and does not observe any change or fall in the electromotive force. When the electromotive force of these cells falls, it falls rapidly, indeed almost suddenly. Occasionally one plate of a group becomes inactive from undue local action, or from bad connection (shown by the colour). This plate is removed and put in a "hospital" cell, where it is brought into order either by a greater density of current or by reversal.

Reversing has a great beneficial action on a cell ; it not only improves its capacity, but it removes any cause of irregular working. It is advisable to do this periodically. Mr. Preece has two extra cells, which enables him to have two cells always under reversal by means of the charging current. It takes from 1,000 to 1,200 ampere-hours to reverse a cell, so that at this time of year it takes a month or more to complete the operation, and it will take a year to reverse the whole battery. Sixteen cells have been reversed during the past twelve months.

Chemical Society, May 21.—Dr. Hugo Müller, F.R.S., President, in the chair.—Messrs. E. G. Amphlett and E. G. Hogg were formally admitted fellows of the Society.—The following papers were read :—A colorimetric method for determining small quantities of iron, by Andrew Thomson, M.A. —On some sulphur compounds of calcium, by V. H. Veley. —Spectroscopic observations on dissolved cobaltous chloride, by Dr. W. J. Russell, F.R.S. The characteristic absorption-spectrum given by cobaltous chloride after dissolution in such media as pure and dry potassium chloride, sodium chloride, calcium chloride, alcohol, glacial acetic acid and in chlorhydric acid, is seen also in an aqueous solution. Hydrated cobaltous chloride gives an entirely different spectrum. If a somewhat faint indication of the spectrum of the chloride be taken as a standard, it is found possible to determine with tolerable accuracy when the amount of anhydrous chloride in solutions of varying strength and temperature is identical with that in the standard solution. A solution containing 4·18 grams of cobalt chloride in 10 c.c. of water at 0° C., when observed through a thickness of 7 mm., forms a convenient standard. If to 10 cc. of such a solution 2·9 cc. of water be added, then on raising the temperature to 33° an amount of anhydrous chloride is re-formed identical with that existing in the standard solution at 0° : this rise of temperature exactly counteracts the effect of adding 2·9 cc. of water. A series of determinations were made in this manner, and it was found that the number of c.c. of water added to the 10 cc. of standard being as given in the upper line, the temperature at which the spectrum appeared was as given in the lower line in the table :—

2·1	2·9	4·3	7·4	8·9	10·3	12·1	15·0	16·0
26°	33°	43°	55°	63°	70°	75°	87°	95°

Again, taking the most dilute solution, in which 16 cc. of water had been added to 10 c.c. of the standard solution, it was found that the same change was effected—*i.e.* that the chloride spectrum could be developed in it, by the addition to the solution of either 0·864 gram of hydrogen chloride gas, or 5·26 of sulphuric acid, or 2·47 of calcium chloride ; but that the addition of sodium chloride would not develop the bands, although on heating the solution after saturating it with this salt a temperature of 34·5° was sufficient, instead of 95°, to develop the bands. Zinc chloride was found to act in a different manner. Notwithstanding its power of combining with water, on adding it to the cobalt solution no banded spectrum shows itself, and even when added to a solution in which the spectrum is visible it causes its disappearance. The explanation is that it must have combined with cobalt chloride, forming a new and stable compound. On evaporating the solution this was found to be the case, and a new salt, a compound of cobalt and zinc, crystallised out. Cobalt bromide, both as a solid and in solution, gives a spectrum very similar to that given by the chloride, but the corresponding bands are nearer the red end of the spectrum. The salt is far more soluble in water than the chloride, and has a stronger affinity for water, as is shown by the much higher temperature required to neutralise the power with which water combines with it. The following determinations similar to those made with the chloride show the increase of temperature necessary to counteract the combining power of giving quantities of water with cobalt bromide :—

Standard + Water	Temp.
10 c.c.	0° C.
10 ,, + 3·0	51
10 ,, + 4·3	57
10 ,, + 7·4	91

—The sulphides of titanium, by Prof. T. E. Thorpe, F.R.S.—Note on the formation of titanous chloride, by Prof. T. E. Thorpe, F.R.S.

Zoological Society, June 2.—Prof. W. H. Flower, V.P.R.S., President in the chair. Mr. Sclater exhibited drawings of and made remarks upon the specimens of various species of Coly living in the Society's Collection. Mr. Beddard, on behalf of himself and Mr. Treves, read a paper on the anatomy of the Sondaic Rhinoceros (*Rhinoceros sondaicus*) which had died in the Society's Gardens in January last. A communicawas read from Dr. Julius von Haast, F.R.S., C.M.Z.S , on *Megalapteryx hectori*, an extinct gigantic representative of the *Apteryx*, of which the remains had recently been discovered in New Zealand. Dr. Guillemard, F.Z.S., read the fourth and fifth parts of his report on the collection of birds formed during the voyage of the yacht *Marchesa*. The present communications treated of the birds collected at Celebes and on the Molucca Islands. Mr. J. Bland Sutton, F.Z.S., read a paper on the development and morphology of the human sphenoid bone, in which he attempted to show that the basi-temporals of the bird are not homologous with the *linguIæ sphenoidales*, but with the so-called pterygoid bones of the crocodile, and that the human *lingulæ* are homologous with the sphenotic of the bird. —Mr. Edgar A. Smith, F.Z.S., read a report on a collection of shells, chiefly land and fresh water, obtained by Mr. H. B. Guppy, R.N., Surgeon H.M.S. *Lark*, during a recent visit to Solomon Islands.

PARIS

Academy of Sciences, June 2.—M. Bouley, President, in the chair.—Human locomotion : stereoscopic images of the trajectories described in space by a point of the body while walking, running, or otherwise moving (two illustrations), by M. Marey.—Remarks on the "Registres d'expérience," a collection of sixty-nine volumes in MSS. by Henry Victor Regnault, dealing with a great variety of questions in chemistry, physics, thermodynamics, hygrometry, &c., presented to the Academy by M. Reiset.—On the treatment of nervo-pulmonary asthma and cardiac asthma by inhaling certain vapours all containing a special substance known as pyridine (C_5H_5N), by M. Germain Sée.—Account of a species of anæsthesia unattended by sleep, and with the perfect preservation of the intellect, the voluntary movements, the senses and sensibility to the touch, by M. Brown-Séquard. From numerous experiments made on the dog, monkey, and man, the author shows that, under the influence of an irritation set up in the laryngeal mucous membrane, sensibility to pain may disappear or be diminished for many hours without the least disturbance of the mental faculties, the senses, or the voluntary movements in man and animals.—Remarks on M. Lucien Biart's work on "The Aztecs, their History, Manners, and Customs," presented to the Academy by M. de Quatrefages. It was stated by the Secretary that this volume forms one of a series entitled "The Ethnological Library," to be edited by MM. de Quatrefages and Hamy, and to comprise, besides a general history of the races of mankind, a number of monographs devoted to the detailed study of the various branches of the human family.—Observations of the solar spots, faculæ, and protuberances made at the Observatory of the Roman College during the first quarter of the year 1885, by M. Tacchini. Compared with the corresponding period of the previous year the spots appear to have been more numerous, but of relatively smaller size, while little difference was observed in the recurrence of the faculæ. The same peculiarity was again noted of a maximum of faculæ coinciding with a minimum of spots.—Remarks on the physical appearances of the planet Uranus in the months of March, April, and May of the present year, by Père Lamey.—On a method of measuring the magnetic rotatory force of solid, fluid, and gaseous bodies in absolute unities, by M. Henri Becquerel. The numbers determined in various ways by other observers correspond very closely with that of the author as shown by the subjoined table :—

Gordon	0'·0433
Lord Rayleigh	0'·0430
L. Arons	0'·0439
Becquerel	0'·04341

—An optical method for the absolute measurement of short distances, by M. Macé de Lépinay.—On the spectrum of bodies in "radiant matter," in which many substances emit a phosphorescent light, by M. W. Crookes.—On the velocity with which prismatic sulphur is transformed to octahedric sulphur, by M. D. Gernez.—On the presence of sulphurous acid in the atmosphere of towns, by M. G. Witz. From the analysis of the ozone made at Montsouris and elsewhere the author finds that sulphurous acid exists in the air of towns where coal is consumed, its presence causing a considerable diminution of atmospheric ozone, accompanied by the formation of sulphuric acid ; further, that by the slow but continuous action of sulphurous acid, and under the influence of the frequent changes in the degree of humidity, the peroxide of red lead used in colouring certain placards, is destroyed and sulphated. At the same time the protoxide of lead thus liberated is transformed to an insoluble sulphite. This salt being easily analysed, a new and certain means is thus obtained for determining the condition of the atmosphere in large cities.—The arsenic present in the soil of cemeteries considered from the toxicological standpoint, by MM. Schlagdenhauffen and Garnier.—Classification and anatomy of the Tectibranchea, a family of mollusks abounding in the Bay of Marseilles, by M. A. Vayssière. Of this family twenty-two species are grouped under the sub-order Cephalaspidea, six under Anaspidea, and nine under Notaspidea. All belong to the order of Opistobranchea, the exceptions indicated by Hering being based on erroneous data.—On the spores and reproductive processes in *Sphærocarpus terrestris*, *Targionia hypophylla*, and other plants of the same order, by M. Leclerc du Sablon.—On the problem of repetitions and symmetry in the mineral kingdom (one illustration), by M. P. Curie.—On an apparatus adapted for the comparative study of opaque minerals, which cannot be easily examined under the microscope, by M. A. Inostrauzeff.—On a unique specimen of hydrous silex belonging to the quaternary formation of the Loing Valley, department of Seine-et-Marne, by M. Stan. Meunier.—On the upper Miocene formations of the Cerdagne district, a lacustrine basin on the southern slope of the Eastern Pyrenees, by MM. L. Rérolle and Ch. Depéret.—Description of a self-registering calorimeter adapted for recording the temperature of the human body, three illustrations, by M. A. d'Arsonval.—On electric alcoholic fermentation, by M. Em. Bourquelot. From his experiments the author finds that this fermentation, as originally determined by Dubrunfant, may be modified by the temperature, by dilution, and by the alcohol formed during the fermentation itself.—On the uniformity of the process of spermatogenesis in the order of mammals, by M. Laulanié.—Action of cocaïne on the invertebrate animals, by M. Richard.—A contribution to the study of antiseptics : action of the antiseptics on the higher organisms, iodide and chloride of mercury, by MM. A. Mairet, Pilatte, and Combemal.—Influence of the lunar declinations on the displacement of the atmospheric currents, a reply to M. de Parville, by M. A. Poincaré.

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