THURSDAY, MARCH 24, 1887

THE NECESSITY FOR A MINISTER OF EDUCATION

IF we are justified in judging of the progress of right ideas on the importance to the nation of science and scientific instruction by the outcomes of one week, then certainly we may congratulate ourselves upon the fact that at last the views which we have for the last eighteen years, in season and out of season, been putting forward are beginning to attract public attention.

There can be no doubt that the general interest is now thoroughly aroused on this matter. In spite of the absolute block of anything like a debate upon education in Parliament, scientific and political leaders say their say elsewhere, and the manner in which these utterances are referred to and enlarged upon in the leading journals is a sure indication that the public interest is known to be growing, and that it is now generally acknowledged that our welfare as a nation depends upon a proper consideration of educational questions.

The first utterance we have to refer to is the admirable speech delivered by Lord Hartington on the night our last number went to press. Lord Hartington had consented to give away the prizes and make an address at the Polytechnic Young Men's Christian Institute, an organisation which now numbers nearly 7000 students, for the existence and endowment of which England is indebted to the munificence and clear-sightedness of one individual, Mr. Quintin Hogg.

It was not to be wondered at that Lord Hartington, with such an unaccustomed task before him, should have referred, in the course of his speech, to Prof. Huxley's recent address, in which the fact was emphasised that if peace has her victories, there must be some who are vanquished; that there is a death to the conquered in peace as in war, the victims of peace being starved as a result of continual depression of trade.

The interest of Lord Hartington's speech was that the question which Prof. Huxley had approached from the Darwinian point of view—the survival of the fittest, the destruction of the unfittest—was to him a question of possible contemporary politics which he had to consider, and the consideration he gave to it led him to emphasise Prof. Huxley's view of the situation. It is clear moreover that the opinion given was not one hastily formed, for the former paramount position of this country when she had a monopoly of iron, and coal, and other material resources, and when there was no science to speak of anywhere, either here or abroad, had been fully taken into consideration. We quote from the speech :—

"No doubt we should still have our material resources, our iron and steel, and the muscular energy of what would then be our superabundant population ; but instead of being what we are now, we should be hewers of wood and drawers of water for the world. If ever our raw materials could be manufactured for the uses and wants of the world better in other countries than in our own, we should become the slaves and servants of the rest of the world, instead of its leaders and masters, as we have been hitherto."

Now, if a politician of Lord Hartington's eminence tells us that this may happen as a result of our being beaten in a campaign of peace, it is proper to consider whether we could be very much worse off in the event of a disastrous war. Certainly, to fend off this result by war, we, as a nation, would not hesitate to double the national debt.

Lord Hartington next went on to show that war also now depends upon science.

"There are some who go so far as to deprecate any large expenditure whatever, even when necessary for the efficiency of our services. These people point to the success which we have attained in former times when almost alone we have contended successfully against a whole continent; they point to the undiminished strength and courage of our soldiers and sailors, to the vast resources—industrial, manufacturing, and financial—of the country ; and they tell us that if we only husband these resources they will pull us through in future emergencies as they have done in the past. But I would say that all these arguments are utterly vain and futile unless we can prove that the conditions under which we should have to fight are entirely similar to those under which we have fought in the past. If, on the other hand, it can be proved that wars are no longer decided by personal courage or endurance, but by the possession of scientific knowledge and all the most approved and perfected appliances, then we cannot afford to disregard the teaching and the experience of the rest of the world, and cannot afford to allow ourselves to be behindhand in the possession of the scientific knowledge and appliances that are demanded."

Lord Hartington then insists upon the importance of science both in peace and war.

"If undoubted success can only be gained by the possession of scientific knowledge and the application of the most scientific instruction to the masses of our people, then it follows that we shall fall behind in this industrial competition and warfare if we do not possess ourselves of these necessities."

He holds that the army of peace must be aided by the State as well as the other. We no longer think of keeping out an invasion by train-bands, and volunteers, and our merchant fleet. For peace purposes also, then, local effort alone will not do all that is necessary. We have found this out already, and we have the Science and Art Department as well as the Admiralty and War Office. Lord Hartington holds that the Science and Art Department must be strengthened so far as technical instruction is concerned.

We see, then, that at last we have one political leader who views science and scientific instruction in the true light, and has the courage of his opinion. Science is to be *aided* on precisely the same grounds that we *aid* the army and the navy. It is no longer a question of merely paying for Sweetness and Light, or of giving a poor dog a bone.

It was not to be expected that Prof. Huxley, who has so unceasingly done all in the power of a single individual to place the right views on this matter before the public, would rest content with the note of warning to which Lord Hartington, as we have seen, has so forcibly drawn attention.

Under the title of "The Organisation of Industrial

Education" a letter appeared in the *Times* of the 21st inst., which we print *in extenso* elsewhere. The main purpose of this second outcome is to show that at the present moment what is chiefly lacking in the army of peace is organisation and a proper headquarter staff—an Educational Commander-in-Chief. Reading between the lines of the letter, it is easy to see that one of the things "organisation" is expected to do, nay, must do, is to prevent so-called "economy" from thwarting every attempt at progress. "Economy does not lie in sparing money, but in spending it wisely," is a maxim that must be commended not only to the Treasury, but to local bodies.

It is probably the feeling that the proposals of a strong Minister of Education, with a full knowledge of his subject and in touch with all the most eminent educationalists of his time, would be sure to commend themselves to Parliament, and that the annual charge would be increased, which has induced successive Ministries to postpone the creation of such an office. It is now thirteen years since both the Duke of Devonshire's Commission and Parliament itself discussed the question; the latter on the motion of Mr. (now Sir Lyon) Playfair. Three years ago the Report of the Select Committee presided over by Mr. Childers unanimously recommended that a Minister of Education should be appointed. With the growing feeling on the part of the public on this matter, if an opportunity presents itself of again bringing forward this proposal it will not be allowed to be dropped.

It is clear from Prof. Huxley's letter that the present machinery is not adequate: it can only be strengthened and consolidated by the appointment of a Minister. One enormous advantage of such a Minister would be that we should have an acknowledged Department to apply to, absolutely in sympathy with those who wish to bring about any improvement in our educational machinery. Quite recently we have had two deputations on purely educational matters: one, for an endowment to the Victoria University, to the Chancellor of the Exchequer, and the other, for further aid to technical education, to the Lord President. It is very difficult for a plain man to understand why the Chancellor of the Exchequer should have been chosen in one case and the Lord President in the other: of course there is an official reason, but it only adds point to the grotesqueness of the present arrangements.

We have, however, to refer to these deputations from another point of view. The prayer of the Victoria University has been granted: that the needed assistance in the other matter—technical instruction—will be granted at once is by no means certain. However this may be, well-wishers of science must thank Mr. Mundella for his vigorous pleading of the cause they have at heart.

The object of the last deputation, as Mr. Mundella pointed out, was to ask the Government to take a very modest step in the direction of the organisation of industrial and commercial education. The education of the 4,600,000 on the books of the elementary schools is confined to education of a purely elementary character, and anything in the shape of manual or industrial education is treated in a way very disheartening to those interested in the question. At present our industrial classes are like badly drilled soldiers fighting a battle with antiquated weapons—it is like sending our soldiers into the field, armed with Brown Bess, to meet the best armed soldiers of Europe. Dr. Konrad, in a report on the Prussian system in its bearing on the national economy, said the superiority of the Western to the Eastern workman, and of the German to the Englishman, was well established; and he added that no doubt the Englishman by his enormous perseverance and his wonted diligence got through considerably more work in the sphere to which he had been long accustomed, but he was far behind the German in capacity for adapting himself to new circumstances. This was the result of the better and more general training which the Germans got in their schools. Mr. Mundella acknowledged that there had been repeated attempts to do something in England to improve the condition of things, but where public bodies had interfered they had acted beyond their powers and been punished accordingly. It was freedom from the restrictions under which these authorities laboured that the deputation sought. They asked also for increased powers to promote industrial, scientific, and technical training, and that for this purpose they should be put in connexion with the Science and Art Department. The cost of executing what they proposed would be trifling.

Sir Lyon Playfair contended that a short Act of three clauses would do all that is wanted. We hope soon to see it. Sir B. Samuelson, as Chairman of the Associated Chambers of Commerce, presented a memorial from that body, and Mr. Howell hit the nail on the head by stating that for "unemployed," in connexion with our industrial population, now so often used, the word "unskilled" should be substituted.

We are bound to say that Lord Cranbrook's answer was sympathetic, but he is clearly of opinion that the Government can do nothing because "Parliament has not really pronounced on the subject of technical instruction"!

ROSENBUSCH'S "PETROGRAPHY"

Mikroskopische Physiographie der massigen Gesteine. Von H. Rosenbusch. I. Abtheilung. Zweite gänzlich umgearbeitete Auflage. (Stuttgart, 1886.)

THE first part of the second edition of this important work has at length appeared, the author having wisely decided not to keep back this instalment until the whole has been completed. Petrography advances nowadays with such gigantic strides, and so quickly are new facts accumulated and new theories elaborated, that as soon as the last chapters of a treatise on this science have been written it is almost time to begin re-writing the first.

This book has been looked forward to by petrographers with a certain amount of pardonable impatience, in the hope that it would do something towards clearing away the mists that envelop rock-classification and nomenclature. Since the introduction of the polarising microscope into petrographical research, old familiar names—like greenstone, trap, felstone, trachyte, &c.—have either been discarded or materially modified in their use; and we now talk with Gümbel of lamprophyre, proterobase, picrophyre, palæophyre, palæopicrite, leucophyre, and the like; or we use names manufactured from the localities where the rocks are found, such as tonalite, ortlerite, or palatinite; or, lastly, following in the wake of the organic chemists, we construct complex names by stringing together those of the component minerals, as, for example, quartz-augite-diorite or hornblende-augite-mica-andesite. The result is that either different petrographers call the same rock by different names, or use the same name to designate different rocks. At the same time, so many views have arisen as to the fundamental elements of petrographical classification, that there are almost as many systems of classification as there are petrographers.

Up to the present time Continental geologists have been in the habit of making geological age a primary factor in classification. Now, although this may apply to Germany, it certainly will not hold for other countries. In England and America it has been shown conclusively that rocks identical in structure and composition have been formed in pre-Tertiary and Tertiary times.

The new edition of Rosenbusch's work would, it was hoped, bring order into this chaos, and give us a classification and nomenclature which, without being too rigid, would allow of referring any particular rock to its family. Such a classification, agreeing with all the known facts, would doubtless readily be accepted by all geologists in this country, were it only for the sake of uniformity and unanimity.

A brief review, or epitome, of Prof. Rosenbusch's book may not be unwelcome here. Any criticism had best be reserved until the work is completed. We owe, indeed, such a debt of gratitude to the author for collecting, collating, and arranging the vast quantity of facts which have been accumulating within the last few years, that it would be almost presumptuous to attempt to find fault with a work so excellent, so invaluable in every way.

In the introduction Prof. Rosenbusch gives us his views on classification. These differ very materially from those expressed in the former edition. "A natural system of classification must," he writes, "in the first place lay stress on the geological mode of occurrence (*geologische Erscheinungsform*), as determining structure and the mineral components. In the second place comes chemical composition, and, lastly, geological age." Secondary alteration in structure or mineralogical composition can have no classificatory value.

It is the geological mode of occurrence that almost exclusively determines the structure of an eruptive rock. Eruptive masses of the same chemical and mineralogical composition possess a totally different structure, according as they were poured out at the earth's surface in the form of lava, or consolidated in the deeper regions of the earth's solid crust. This may, of course, also be expressed by saying that the structure of a rock depends, *cæteris paribus*, only on the differences of temperature and pressure to which it has been subjected during its formation.

Classified, then, according to their mode of occurrence, eruptive rocks may be divided into two great groups: (1) the *Plutonic* rocks (*Tiefengesteine*); and (2) the *Volcanic* or *effusive* rocks (*Ergussgesteine*). Occupying an intermediate position between these two chief groups is a third—that of the rocks occurring in the form of dykes (*Ganggesteine*). Both plutonic and volcanic rocks are often found as dykes; but this group comprises those rocks which are found occurring alone in this form, and which possess certain structural peculiarities entitling them to be considered apart from the plutonic and effusive rocks. With regard to the latter it may be remarked that it is in this group that Prof. Rosenbusch does not feel justified in dropping altogether geological age as a classificatory factor. Accordingly these rocks are subdivided by him into *palæovolcanic* and *neo-volcanic;* the former embracing those erupted in pre-Tertiary times, the latter those of Tertiary age.

In the introductory chapter to the plutonic rocks Prof. Rosenbusch treats of the structure and order of crystallisation of the mineral components of these rocks. In this chapter he embodies the substance of his paper on the granular and porphyritic structure of massive rocks, published some time since in the *Neues Jahrbuch*. In that paper he showed how in an eruptive silicate-magma the minerals separate in the order of decreasing basicity, so that at any given moment the uncrystallised magma is more acid than the sum of the separated compounds. Further, that the relative masses of the compounds present in such a magma act only in so far on the order of their separation, that generally those present in less quantity crystallise out first. To facilitate petrographical expression, Prof. Rosenbusch has proposed a couple of words which appear to be worthy of general acceptation. He calls those mineral components which occur in individuals, bounded on all sides by crystallised faces, *idiomorphic; allotriomorphic*, those which owe their boundaries to causes other than an internal arrangement of the molecules composing them. Applying this to the plutonic rocks, he points out that, whereas certain rocks, occurring as dykes, possess a "pan-idiomorphic granular" structure, the plutonic rocks are characterised by a granular structure essentially "hyp-idiomorphic" (a part of the minerals only possessing their own crystallographic form).

The group of the Plutonic rocks is subdivided by Prof. Rosenbusch as follows:—

(*a*) Family of the granitic rocks.
(*b*) Family of the syenitic rocks.
(*c*) Family of the elæolite syenites.
(*d*) Family of the diorites.
(*e*) Family of the gabbros and norites.
(*f*) Family of the diabases.
(*g*) Family of the theralites.
(*h*) Family of the peridotites.

Among these we notice a new name—the *theralites*. Under this head are included the plagioclase-nepheline rocks, formerly represented by the teschenites. The latter have been shown by Rohrbach (Tschermak's *Min und Pet. Mitt.*, 1885, ii. 1-63) to contain no nepheline, and have consequently been referred by him partly to the diorites, partly to the diabases. Still, plutonic rocks representing this mineralogical combination appear to exist (*e.g.* in the Crazy Mountains in Montana, U.S.); and thus the gap left by the removal of the teschenites is filled up. Prof. Rosenbusch derives the name theralite from θηρᾶν (to seek eagerly).

The group that embraces the rocks occurring in the form of dykes, is subdivided, according to mineralogical and chemical composition, into a *granitic*, a *syenitic*, and a *dioritic* series.

Looking at the rocks, however, from the point of view of habit and structure, three types, independent of mineralogical composition, may be established, namely: a "*granitic*," only known to occur among the more acid representatives; a "*granito-porphyritic*," which is represented in each of the above series; and a "*lamprophyric*," which appears to be unrepresented in the more acid subdivisions. The following classification is accordingly proposed for the "dyke-rocks":—

(*a*) Granitic dyke-rocks (aplite, tourmaline-granite, &c.).

(*b*) Granito-porphyritic dyke-rocks (granite-porphyry, syenite-porphyry, elæolite-porphyry, diorite-porphyrite).

(*c*) Lamprophyric dyke-rocks.

This last family may perhaps be best designated as a refuge for certain classes of rocks, such as the kersantites and kersantons, the minettes, and the lamprophyres, which have been long wandering about in the various systems of classification without finding any fixed abode. It is further subdivided into the syenitic lamprophyres (minettes and vogesites) and the dioritic lamprophyres (kersantite and camptonite).

Passing on to the group of the true Volcanic rocks, we note an important distinction between them and those of the Plutonic group, contained in a general law laid down by the author in this chapter. A volcanic (effusive) rock is always more acid and specifically lighter than its plutonic equivalent. To explain this the author suggests that an eruptive magma, during its slow ascent along cracks in the earth's crust, differentiates according to specific gravity, the heavier part, which ultimately gives rise to the plutonic rocks that consolidate within the earth's crust, being more basic, poorer in alkalies, and richer in alkaline earths and iron, than the specifically lighter part which reaches the earth's surface.

The author then proceeds to discuss the recurrence of phase in the crystallisation of the effusive rocks, and defines porphyritic structure as that structure which is produced by the recurrence of the same or similar minerals at two distinct periods of crystallisation. It is this structure which is the most essential characteristic of the effusive rocks. It may, however, be developed in very different ways. When the ground-mass is holocrystalline, the structure is "holocrystalline-porphyritic"; it is "vitro-porphyritic" when the ground-mass is glassy, and "hypocrystalline-porphyritic" when the ground-mass consists partly of vitreous, partly of crystalline elements.

Of the Volcanic group only the palæovolcanic series is discussed in the present volume. It is subdivided as follows:—

(*a*) Family of the quartz porphyries (palæovolcanic equivalents of the granites).

(*b*) Family of the quartzless porphyries (equivalents of the syenites).

(*c*) Family of the porphyrites (equivalents of the diorites).

(*d*) Family of the augite-porphyrites and melaphyres equivalents of the gabbros and diabases).

(*e*) Family of the picrite-porphyrites (equivalents of the peridotites).

The neovolcanic rocks (rhyolites, trachytes, andesites, basalts, phonolites, tephrites, &c.) are reserved for the Second Part, which is promised for Easter of this year, and will contain the plates to the whole volume. Thus completed, the work will form a most valuable addition to petrographical literature. One of its important features is the full collation of literature under each head. Students of petrographical science will thank Prof. Rosenbusch for the inestimable boon he has conferred upon them in indexing almost all the papers dealing with petrographical subjects which had appeared up to the date of publication of his book.

FREDERICK H. HATCH

LOCH CRERAN

Loch Creran: Notes from the Western Highlands. By W. Anderson Smith. (Paisley and London: Alexander Gardner, 1887.)

THE amateur naturalist who has leisure, a genuine interest in his subject, and abundant opportunities of exercising his observation, ought to be an exceptionally happy person; but he is not always well-advised in rushing into print with the result of his fugitive studies. That, however, is one of the foibles of the hour. The public are supposed to welcome somewhat bald catalogues of the common objects of the way-side, the heath, and the sea-shore; the newspaper reporter is glad to be temporarily withdrawn from the Divorce Court and sent to describe the chestnut-trees in Bushey Park; and young ladies, who have got the length of distinguishing between *Ranunculus Ficaria* and *R. acris* narrate in the evening papers the story of their exploration of the hedgerows. The result is harmless enough. It is not science; it is not literature; but it serves to teach a few people here and there to keep their eyes open; and that is something. And perhaps a world groaning under a load of books need not mind an additional volume or two—which it is not compelled to read.

Mr. W. Anderson Smith does not inform us whether these "Notes from the Western Highlands" have been, like some other of his writings, reprinted from a provincial journal; but if they are so, he has done himself injustice in not stating the fact; for carelessness that is comparatively venial in the columns of a newspaper becomes vexatious in a book. And truth compels us to say that Mr. Smith's style is slovenly in the extreme. Mis-spellings abound; the few scraps of French or Latin quoted are almost invariably mangled; there is an occasional lapse of grammar; and now and again the heedless composition provokes a smile, as when he says, "Into the luxurious beds we sink up to the knees, many of them at present with dainty seed-vessels ripe and full." And yet there is a chatty simplicity here and there in the book that is not without attraction. The ways and humours of certain domestic pets are described in a kindly fashion which recommends itself; and there are incidental glimpses of winter life and winter occupations in the West Highlands that are sufficiently pleasant. As for the bulk of the volume, that is devoted to marine zoology; and marine zoology, to be made interesting, not to say intelligible, to the general reader, should be accompanied by illustrations; while, on the other hand, the trained scientific student is not likely to concern himself much with the unmethodical investigations here noted down.

But in merely making incidental memoranda of the every-day experiences of life in his northern home, Mr. Smith has mentioned not a few interesting things; and for these one soon begins to be grateful in reading a volume that is otherwise none too lively. He tells us, for example, how a heron was suspected of stealing ducklings, was watched, and finally caught in the act of devouring one of the birds—which seems a singular occurrence. On the other hand, the appearance of a bat in January, when the West Highlands happen to be visited by a spell of mild weather, is by no means the rare phenomenon he supposes it to be. There are some interesting remarks on the incubation of the cuckoo's egg (pp. 13 and 16) which seem to suggest a need for further inquiry. But we cannot say that we place implicit faith in Mr. Anderson Smith as an observer. His story of how, on one occasion, in passing through a wood, he startled a number of fallow-deer and roebuck may be forgiven on account of the darkness prevailing at the time: we should prefer to wait for some daylight notes before believing that the fallow-deer and the roe have agreed to lay aside their long-standing and mutual antipathy. "The pheasant is an unwieldy bird and of no great power of flight." Did the writer of that sentence ever try to "stop" a rocketer well on the wing and coming down wind; and what was the expression of his face when he wheeled round to find the "unwieldy" bird already disappearing into the next parish? Mr. Smith in this volume revives a controversy in which, as it appears, he has been engaged before, with regard to the lower animals committing suicide; and remarks that it may be assumed they know what death is from the fact that many of them can simulate it with marvellous accuracy. It is no doubt true that the young of certain animals, when confronted with danger, will suddenly become motionless, and remain so until the danger is removed—just as it is a common trick among street arabs for a small boy, when pursued by a bigger boy, to throw himself down in the roadway and lie perfectly still, prepared for the worst. But to assume that the young curlew or the young rat that suddenly stiffens itself and shuts its eyes is aware that it is simulating death, or has any understanding of such a state, is a far jump. Mr. Smith cites the case of a terrier belonging to a friend of his which, having the distemper, deliberately went off and drowned itself. Clearly the verdict here must be temporary insanity; the dog did not know what it was doing. The chief reason for concluding that the lower animals are not aware that they possess the liberty of suicide is that so few of them (or none of them) take advantage of it; if they did know, the overworked cart-horse, the mangy cur, the long-enduring donkey, would forthwith knock their heads against the nearest wall—unless, indeed, it is to be supposed that these animals are so highly intelligent as to have heard of the significant French proverb: "Quand on est mort, c'est pour longtemps." But this question of suicide among animals has always been a stumbling-block. Prof. Edward Forbes accused a whole tribe of star-fish of having a suicidal instinct on no better grounds than that they, on being brought into the air, or put in fresh water, went to bits. He even describes one of them as rejoicing in its power of eluding scientific scrutiny:—"I saw its limbs escaping through every mesh of the dredge. In my despair I seized the largest piece, and brought up the extremity of an arm with its terminal eye, the spinous eyelid of which opened and closed with something exceedingly like a wink of derision." After this we shall not be surprised to hear of a body of scientific experts meeting to consider the question of suicide among animals—with Mark Twain as President of the Committee.

"Loch Creran" is not a vivacious book; but it is unpretentious; and the author, in a rambling and hap-hazard fashion, contrives to give us some idea of his surroundings and pursuits. Indeed, the dweller in towns, who has the patience to follow this somewhat prolix writer, will probably part company with him with no slight feeling of envy.

OUR BOOK SHELF

The Encyclopædic Dictionary. Vol. VI. Part 1. (London: Cassell and Co., 1887.)

THE work to which this volume belongs is much more than a mere dictionary in the ordinary sense. It includes the description of things as well as of words, special attention being given to objects and processes indicated by scientific and technical terms. The information offered is never, of course, exhaustive, but it is sufficient for the purposes the compilers have had in view, and generally it has the merit of being clear, concise, and, as far as it goes, accurate. As a dictionary the work deserves high praise. It contains all the English as well as all the Scotch words now in use, with their significations re-investigated, re-classified, and re-illustrated by examples. A large number of obsolete words have also been introduced. The etymology is inclosed within brackets immediately following each word; and the pronunciation is indicated by diacritical marks, a key to which is given at the foot of the several pages. The present volume includes all words from "quoi" to "shipp," and, so far as we have been able to test it, we have found it lucidly arranged and thoroughly trustworthy.

Descriptive Catalogue of the General Collection of Minerals in the Australian Museum. By A. Felix Ratte. Printed by order of the Trustees. (Sydney: Thomas Richards.)

THIS Catalogue has been carefully compiled, and no doubt it has already been of considerable service to persons making use of the Australian Museum. For the classification of silicates the compiler has taken as a guide Dana's "System of Mineralogy"; for the classification of metallic minerals, Roscoe's "Chemistry." But these authors' systems have not been entirely followed, especially where rare mineral products are concerned. The notes, although generally brief, are adequate, and there is a valuable appendix on gems and ornamental specimens.

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.*]

West Indian Meteorological Confederation

IN the leading article in NATURE, vol. xxxv. p. 241, remarks were made respecting the advantages which would accrue to the West Indian Islands, and to the Meteorological Council of the

Royal Society, if those islands were confederated for meteorological purposes.

The writer was apparently unaware that in the year 1879 those islands agreed to confederation. It was not restricted to the British colonies—Guadaloupe, for instance, passed a vote of credit through its chamber before the decision of the British Meteorological Council was received—but all the work broke down when the Meteorological Council insisted upon Antigua as the central station.

It is unnecessary to say that unmitigated failure was the result.

The advantages to the United States of any West Indian system, however poor, are palpable to the lowest stratum of scientific intelligence; yet we find that Congress disestablished the whole of their West Indian stations without the slightest reason, as far as I have been able to discover. But the words of the Chief Signal Officer have a thousand times the weight of mine, and I quote them accordingly:—

"Among the objects for which appropriations were refused were 'foreign reports.' A request was made for 4000 dollars to pay for these warnings of tropical hurricanes, which, last year, were instrumental in saving millions of dollars of property. Two storms of great fury swept up from the Gulf, one in September and one in October. Warnings of the coming of these storms were given from the West India stations, so that the indications officer on duty in each month was able to give at least two days' notice of the coming of the storm to every port in the Gulf and on the Atlantic coast. The result was an immense saving of valuable property and of human life. The statistics were gathered as fully as possible from all the stations passed over by the cyclones, and the names of the vessels, their value, and the value of their cargoes, remaining in port in obedience to the storm warnings of this service, were ascertained. The reports were not wholly satisfactory, because accurate information could not be obtained from the largest places of the country, such as New York, Philadelphia, Baltimore, and Boston. These cities lie at the head of large harbours that have safe anchorages near their openings, and vessels delayed by a storm almost invariably go down the harbour to there await its conclusion. But, without these great ports, it was ascertained that 6,460,586 dollars of property remained safe in harbour during the September cyclone, and 6,051,393 dollars in October. The failure to appropriate the 4000 dollars asked for for the current fiscal year has reduced the warnings received from the West Indies, and made it less possible to predict with certainty the approach of tropical hurricanes." (Report for 1883, p. 4.)

The anticipations of the Chief Signal Officer have been fully confirmed.

In the face of such opposition I would ask what is the use of proposing schemes of confederation requiring the support of the authorities? There is no doubt that if meteorological confederation is to obtain in the West Indies, it must be done among the British colonies themselves; but who will come forward to undertake such a task? Should anyone attempt it, he will at least have the support of Jamaica.

MAXWELL HALL,

February 15 Jamaica Government Meteorologist

Units of Weight, Mass, and Force

YOUR reviewer, of the well-known initials "P. G. T.," has taken exception to some of the terminology employed by Mr. Anderson in his book "On the Conversion of Heat into Work," particularly to the expressions of "pounds on the square inch" and "tons on the square inch," which he says would define a superficial density if used in their proper sense; and it is this opinion I wish, with your permission, to dispute, as I think "P. G. T." and mathematicians generally, are at present in this endeavour to avoid one ambiguity in dynamical language only creating greater confusion.

I presume that "P. G. T." would have been satisfied with the above expressions provided the word "weight" had been introduced somewhere; but let us examine carefully what is implied by "weight" as used in ordinary language.

Turning to the chapter on elementary dynamical principles in Maxwell's "Theory of Heat," we find that "the word *weight* must be understood to mean the *quantity of the thing as determined by the process of weighing against standard weights.*" And again:—"In a rude age, before the invention of means for overcoming friction, the weight of bodies formed the chief obstacle to setting them in motion. It was only after some progress had been made in the art of throwing missiles, and in the use of wheel-carriages and floating vessels, that men's minds became practically impressed with the idea of mass as distinguished from weight."

The language we employ, including the use of the ambiguous word "weight," was formed in this rude age before the discovery of true dynamical principles and before the theory of gravitation, and now, in order to avoid ambiguity, the mathematician uses, *wherever it is possible*, the word "mass" for greater precision, where an ordinary person would use the word weight.

But unfortunately for his principle the rules of language do not permit him to be consistent, and he is compelled to speak of "*weights* and measures" and of "bodies *weighing* so many pounds or tons" instead of "bodies *massing* so many pounds," or "*masses* and measures," which might be mistaken for a political phrase.

The word "weight" will, then, be found to be used in ordinary language in most cases in the same sense as the word "mass," introduced with laudable intention by the mathematicians to avoid confusion; but unfortunately some mathematicians introduce greater confusion than they remove by appropriating the word "weight" to the subsidiary sense of the word, undistinguishable by those ignorant of dynamics, namely, the force with which the earth attracts the weight.

Thus we find in ordinary treatises on dynamics, after an effort at the definition of the mass, the weight of a body defined as "the force with which it is attracted by the earth."

As Maxwell says, "The only occasions in common life in which it is required to estimate weight considered as a force is when we have to determine the strength required to lift or carry things, or when we have to make a structure strong enough to support their weight." Herein is comprised in general terms the whole province of the theory of engineering, and consequently the engineer always employs the gravitational measure of forces.

The force with which the earth attracts the standard weight is taken as the gravitation unit of force; and for brevity the force with which the earth attracts a pound weight (the mathematician would say a pound mass) is called the force of a pound, abbreviated again to "a pound." Hence we have steam pressures, gunpowder pressures, moduli of elasticity, tenacities, &c., as well as the expressions objected to by "P. G. T." in Mr. Anderson's book, expressed in pounds or tons on the square inch, without creating any confusion in the mind of the practical man; and we find the words "pound" or "ton" used side by side, now in the sense of weight or mass, and now in the sense of force; as, for instance, in the statement, "A train, weighing 100 tons moving against a resistance of 20 pounds a ton, is drawn by an engine exerting a pull of 2 tons, &c."

But when the practical man opens the ordinary text-book on dynamics, then the confusion begins. Take, for instance, the familiar equation $W = Mg$: what does it mean? The writers tell us that W means the weight and M the mass of the body. Having defined "weight" as the force with which the body is attracted by the earth, the writer implies that he is keeping to the statical gravitational unit of force, and therefore his unit of mass is the mass of g pounds, if W, the weight, is measured in pounds. But, after defining a pound as a unit of mass, he ought to take M as the weight in pounds, and then the equation $W = Mg$ means that the earth attracts M pounds with a force of W poundals where $W = Mg$.

The confusion is intolerable ("most tolerable, and not to be endured"), and entirely due to the erroneous mathematical definition of the word "weight," combined with straining the units of mass and force so as to fit into the equation $P = Mf$, when absolute units are not employed.

To show the absurdity of the definition that "the weight of a body is the force with which it is attracted by the earth," take the question, "What is the weight of the earth?" According to this definition, the answer is "Zero," but ordinary people would calculate the result in millions of tons, from the data of the mean radius and the mean density.

Take again a question of a similar nature: "Prove that 288 pounds at the pole weigh the same as 289 pounds at the equator." To realise this question we must imagine a balance constructed of which the arm is curved into a quadrant of the earth, reaching along a meridian from the pole to the equator, and supported by a fulcrum in latitude 45°; then 288 pounds at the pole will equilibrate 289 pounds at the other end of the balance at the equator. Without requiring a balance with so long an arm, we can have 289 pounds at the bottom of the shaft of a mine weighing the same as 288 pounds at the surface, provided the shaft is of sufficient depth.

Some years ago, being troubled myself with this confusion of language, I wrote to Prof. Maxwell to ask him for a good illustrative example of the correct and incorrect use of the word "weight," and received the following characteristic reply on a postcard:—"Compare St. John xix. 39, ὡσεὶ λίτρας ἑκατόν, with the A.V. (authorised version), and keep to the original Greek." The translation in the authorised version is "about a hundred pounds *weight*."

Here we see that Maxwell recognised the ambiguous nature of the word "weight," and advised its omission wherever possible; but the exigencies of language compel us to use it; and in fact we shall generally find writers, even after the above incorrect definition of weight, proceed subsequently to use the word in its ordinary meaning of daily life.

I wish to repeat that writers on dynamics only create confusion in appropriating the word "weight" to the sense of the force of attraction of the earth on a body, as we never speak of "a force *weighing* so many pounds"; and I wish to support the language in ordinary use by engineers and practical men as perfectly correct in using the words "pound" or "ton" side by side in two senses, first as meaning the weight (or mass) of a body, and secondly as meaning the force with which the body is attracted by the earth; one being sometimes distinguished as a pound weight, and the other as a pound force.

If we use Prof. James Thomson's admirable word "poundal" for the British absolute unit of force, this slight confusion of terms will disappear, although engineers will still continue to think in gravitation units of force, as gravity is the one universal force from which there is no escape; and I fear it will be impossible ever to persuade them to think in C.G.S. units like the centimetre, gramme, dyne, erg, &c., which, though admirably adapted for the minute measurements of experiments in physics, are unsuitable for large magnitudes.

In conclusion, let the equation $W = Mg$ be dismissed from the text-books, as leading to statements such as "The mass of a body weighing W pounds is $\frac{W}{g}$;" the true equivalent equation being $W = M$, and therefore unnecessary; and with it let the confusing "astronomical unit of mass" disappear, and introduce instead the "constant of gravitation" in our equations. Let us also recognise that the primary idea of "weight" is the same as "mass," and form our dynamical definitions on the usages of ordinary language. A. G. GREENHILL

Woolwich, February 28

Mr. Herbert Spencer's Definition of Life

I HAVE read with much interest the report in NATURE of Prof. Judd's address to the Geological Society, in which he attempts to show that Mr. Herbert Spencer's definition of life is not restricted to those cases only which display the ordinarily acknowledged characteristics of vitality; a certain correspondence between internal and external changes being displayed by minerals.

I write to draw attention to what I think tends to show that the mass of evidence brought forward really tells *in favour* of the definition; bearing in mind that the hypothesis of evolution "implies insensible modifications and gradual transitions, which render definition difficult—which make it impossible to separate absolutely the phases of organisation from one another" ("Principles of Biology," vol. ii. p. 10), and that consequently there can be no "absolute" commencement of life.

The fact, treated by Mr. Spencer when seeking a definition of life, that there is a correspondence between life and its circumstances gives the clue showing us that the "vitality of minerals" is a misnomer; a fallacy he himself exposes when he treats of the internal actions—the feathery crystallisation—displayed by the misnamed storm glass in correspondence with external changes. Using his own words, we see that:—

"Subtle as is the dependence of each internal upon each external change, the connection between them does not, in the abstract, differ from the connection between the motion of a straw and the motion of the wind that disturbs it. In either case a change produces a change, and there it ends. The alteration wrought by some environing agency on an inanimate object, does not tend to induce in it a secondary alteration, that anticipates some secondary alteration in the environment. But in every living body [in a living body, mark!] there is a tendency towards secondary alterations of this nature; *and it is in their production that the correspondence consists.* The difference may be best expressed by symbols. Let A be a change in the environment; and B some resulting change in an inorganic mass. Then A having produced B, the action ceases. Though the change A in the environment, is followed by some consequent change *a* in it; no parallel sequence in the inorganic mass simultaneously generates in it some change *b* that has reference to the change *a*. But if we take a living body of the requisite organisation, and let the change A impress on it some change C; then, while in the environment A is occasionally *a*, in the living body C will be occasioning *c*: of which *a* and *c* will show a certain concord in time, place, or intensity. . . . ." (vol. i. p. 78).

"That the word *correspondence* will not include, without straining, the various relations to be expressed by it," is best met by the reply "that we have no word sufficiently general to comprehend all forms of this relation between the organism and its medium, and yet sufficiently specific to convey an adequate idea of the relation; . . . The fact to be expressed in all cases, is, that certain changes, continuous or discontinuous, in the organism, are connected after such a manner that, in their amounts, or variations, or periods of occurrence, or modes of succession, they have a reference to external actions, constant or serial, actual or potential—a reference such that a definite relation among any members of the one group, implies a definite relation among certain members of the other group; and the word *correspondence* appears the best fitted to express this fact." (vol. i. p. 79).

In deer-stalking we see a realisation of these symbols. In the deer the primary internal change—the perception of odour, or, as I believe it is called, "winding"—is followed by that secondary internal change which induces a desire to increase the distance between the living organism and the inferred source of danger, a change differing not only in degree, but in kind, differing *toto cœlo* from any of those actions which take place in minerals and crystals.

That the address contains many valuable facts furthering not only Mr. Spencer's view of life, but also his views of evolution, becomes apparent when we consider how it carries out and develops these ideas to an extent which would have been impossible at the time when the "Principles of Biology" were first published, now twenty years since. I say "furthering," for I wish now to touch upon a very important point, which I cannot but think has been much enlarged and amplified by Prof. Judd. It is to the much more expanded meaning which can now be attached to the fact *that the degree of life varies as the degree of correspondence between internal and external relations.*

For the correspondence displayed by a crystal or mineral is shown to be of a very much lower degree than that displayed by the simplest plant or animal. These latter present correspondences of greater complexity, greater rapidity, and greater length in the series of them than the former, which, during its long "millions of years," can respond only to the two or three forms of molar and molecular forces alluded to. The changes in the mineral simply respond to changes in the environment; whereas in an organism it is a *relation* between changes in it which responds to a *relation* between changes in the environment.

Churchfield, Edgbaston F. HOWARD COLLINS

An Equatorial Zone of almost Perpetual Electrical Discharge

THE recent reference in your columns to Edlung's theory of the aurora borealis, recalls a very curious observation that I have made in my travels of a zone of almost perpetual electrical discharge in the belt of the "doldrums" all round the world.

Anywhere in that belt, a more or less intermittent display of sheet lightning commences the moment the twilight of sunset has sufficiently faded away, and continues with varying intensity till the light of morning prevents further observation.

The localisation of this belt of lightning is very obvious as we run a section across the equator on board ship. There is very little electrical discharge in the high-pressure belt of anti-cyclones which encircle the earth approximately under the lines of the tropics; but as we approach the low-pressure band of the "doldrums," where the two trade-winds, or the two monsoons meet, then the display of lightning is of nightly occurrence, even if there are no actual thunderstorms.

This electric discharge has a diurnal period like every other meteorological element; for night after night, as I have slept on deck in Malaysia during the change of the monsoons, I have noticed a very marked diminution of the lightning after 1 or 2 a.m. If a total eclipse of the sun could last for twelve hours, I have no doubt that we should see more or less lightning all the time, with a regular set of diurnal variations.

Edlung and others have noticed the gradual decrease in the frequency of thunderstorms as we recede from the equator; but I wish to show now, not only that the discharge is of nightly occurrence, but that the locality of maximum effect is not so much on the equator as in the "doldrums." The sheet lightning may be the reflection of distant thunderstorms, or it may be the silent discharge of electricity. Meteorologists are much divided as to the possibility of the latter; but it is certain that the amount of sheet lightning is out of all proportion to the frequency of actual thunderstorms.

Is it not possible that we may find in this perpetual lightning, some clue to the origin of earth-currents everywhere? and in the diurnal variation in the discharge, some probable reason for the hourly variation of the aurora, and of some magnetic elements? No doubt it is at present difficult to connect the electricity of lightning with the electro-magnetic effects of terrestrial magnetism or the aurora; and though Edlung's theory is defective in this respect, I cannot help thinking that he is right in collating thunderstorms on the equator with the glow discharge of electricity on the Arctic circle; and it is in the hope that the discovery of the constancy of electrical discharge in the "doldrums" may perhaps assist in the evolution of a true theory of the aurora, that I have penned this short notice.

RALPH ABERCROMBY

21 Chapel Street, London, March 15

Scorpion Virus

PROF. BOURNE's experiments, related in the Proceedings of the Royal Society of January 6, 1887, seem to establish the fact that although the scorpion may be provoked to strike and wound itself or another scorpion, it is incapable, in either case, of causing any toxic action, however active the virus may prove in respect of other creatures. That it is, in short, with the scorpion as it is with the cobra or viper: they poison other creatures, but not themselves or each other.

Some years ago an exhaustive series of experiments brought me to the conclusion that a cobra is not poisoned by cobra virus, whether inoculated by its own fangs, by those of another cobra, or by a hypodermic syringe. The same in the case of daboia and other viperine snakes.

It seemed, however, that the bungarus, a less deadly snake than the cobra, occasionally is affected, though slowly, by the cobra virus, but that it escapes more frequently than it suffers; and when it does suffer the effect of the poison is greatly diminished. On the other hand, non-venomous snakes, lizards, frogs, fish, mollusca, and other low forms of life, all rapidly succumb to snake poison.

The details of these experiments are to be found in the "Thanatophidia of India," published in 1872, and in referring to them Prof. Bourne remarks: "They show conclusively that the cobra poison will not affect a cobra, and will not even affect the viperine ptyas." I would correct the latter part of the quotation so far as to say that the ptyas is a colubrine harmless snake, not a viperine snake, and that it rapidly succumbs to the cobra virus.

Prof. Bourne has helped to dispel another of the popular delusions which cling round venomous creatures.

March 14 J. FAYRER

THE RELATION OF TABASHEER TO MINERAL SUBSTANCES

MR. THISELTON DYER has rendered a great service, not only to botanists, but also to physicists and mineralogists, by recalling attention to the very interesting substance known as "tabasheer" (NATURE, vol. xxxv. p. 396). As he truly states, very little fresh information has been published on the subject during recent years, a circumstance for which I can only account by the fact that botanists may justly feel some doubt as to whether it belongs to the vegetable kingdom, while mineralogists seem to have equal ground for hesitation in accepting it as a member of the mineral kingdom.

It is very interesting to hear that so able a physiologist as Prof. Cohn intends to investigate the conditions under which living plants separate this substance from their tissues. That unicellular Algæ, like the Diatomaceæ, living in a medium which may contain only one part in 10,000 by weight of dissolved silica, or even less than that amount, should be able to separate this substance to form their exquisitely ornamented frustules is one of the most striking facts in natural history, whether we regard it in its physiological or its chemical aspects.

Sir David Brewster long ago pointed out the remarkable physical characters presented by the curious product of the vegetable world known as "tabasheer," though so far as I can find out it has not in recent years received that attention from physicists which the experiments and observations of the great Scotch philosopher show it to be worthy of.

Tabasheer seems to stand in the same relation to the mineral kingdom as do ambers and pearls. It is in fact an *opal* formed under somewhat remarkable and anomalous conditions which we are able to study; and in this aspect I have for some time past been devoting a considerable amount of attention to the minute structure of the substance by making thin sections and examining them under the microscope. It may be as well, perhaps, to give a short sketch of the information upon the subject which I have up to the present time been able to obtain, and in this way to call attention to points upon which further research seems to be necessary.

From time immemorial tabasheer has enjoyed a very high reputation in Eastern countries as a drug. Its supposed medicinal virtues, like those of the fossil teeth of China and the belemnites ("thunderbolts") of this country, seem to have been suggested by the peculiarity of its mode of occurrence. A knowledge of the substance was introduced into Western Europe by the Arabian physicians, and the name by which the substance is generally known is said to be of Arabic origin. Much of the material which under the name of "tabasheer" finds its way to Syria and Turkey is said, however, to be fictitious or adulterated.

In 1788 Dr. Patrick Russell, F.R.S., then resident at Vizagapatam, wrote a letter to Sir Joseph Banks in which he gave an account of all the facts which he had been able to collect with respect to this curious substance and its mode of occurrence, and his interesting letter was published in the Philosophical Transactions for 1790 (vol. lxxx. p. 273).

Tabasheer is said to be sometimes found among the ashes of bamboos that have been set on fire (by mutual friction?). Ordinarily, however, it is sought for by splitting open those bamboo stems which give a rattling sound when shaken. Such rattling sounds do not, however, afford infallible criteria as to the presence or absence of tabasheer in a bamboo, for where the quantity is small it is often found to be closely adherent to the bottom and sides of the cavity. Tabasheer is by no means found in all stems or in all joints of the same stem of the bamboos. Whether certain species produce it in greater abundance than others, and what is the influence of soil, situation, and season upon the production of the substance are questions which do not seem as yet to have been accurately investigated.

Dr. Russell found that the bamboos which produce tabasheer often contain a fluid, usually clear, transparent, and colourless or of greenish tint, but sometimes thicker and of a white colour, and at other times darker and of the consistency of honey. Occasionally the thicker varieties were found passing into a solid state, and forming tabasheer.

Dr. Russell performed the interesting experiment of drawing off the liquid from the bamboo-stem and allowing it to stand in stoppered bottles. A "whitish, cottony sediment" was formed at the bottom with a thin film of the same kind at the top. When the whole was well shaken together and allowed to evaporate, it left a residue of a whitish-brown colour resembling the inferior kinds of tabasheer. By splitting up different joints of bamboo Dr. Russell was also able to satisfy himself of the gradual deposition within them of the solid tabasheer by the evaporation of the liquid solvent.

In 1791, Mr. James Louis Macie, F.R.S. (who afterwards took the name of Smithson), gave an account of his examination of the properties of the specimens of tabasheer sent home by Dr. Russell (Phil. Trans. vol. lxxxi., 1791, p 368). These specimens came from Vellore, Hydrabad, Masulipatam, and other localities in India. They were submitted to a number of tests which induced Mr. Macie to believe that they consisted principally of silica, but that before calcination some vegetable matter must have been present. A determination of the specific gravity of the substance by Mr. Macie gave 2·188 as the result; another determination by Mr. Cavendish gave 2·169.

In this same paper it is stated that a bamboo grown in a hot-house at Islington gave a rattling noise, and on being split open by Sir Joseph Banks yielded, not an ordinary tabasheer, but a small pebble about the size of half a pea, externally of a dark brown or black colour, and within of a reddish-brown tint. This stone is said to have been so hard as to cut glass, and to have been in parts of a crystalline structure. Its behaviour with reagents was found to be different in many respects from that of the ordinary tabasheer; and it was proved to contain silica and iron. The specimen is referred to in a letter to Berthollet published in the *Annales de Chimie* for the same year (October 1791). There may be some doubt as to whether this specimen was really of the nature of tabasheer; if such were the case, it would seem to have been a tabasheer in which a crystalline structure had begun to be set up.

In the year 1806, MM. Fourcroy and Vauquelin gave an account of a specimen of tabasheer brought from South America in 1804 by Humboldt and Bonpland (*Mém. de l'Inst.*, vol. vi. p. 382). It was procured from a species of bamboo growing on the west of Pichincha, and is described as being of a milk-white colour, in part apparently crystalline in structure, and in part semi-transparent and gelatinous. It was seen to contain traces of the vegetable structure of the plant from which it had been extracted. On ignition it became black, and emitted pungent fumes.

An analysis of this tabasheer from the Andes showed that it contained 70 per cent. of silica, and 30 per cent. of potash, lime, and water, with some organic matter. It would, perhaps, be rash to conclude from this single observation that the American bamboo produced tabasheer of different composition from that of the Old World; but the subject is evidently one worthy of careful investigation.

It was in the year 1819 that Sir David Brewster published the first account of his long and important series of observations upon the physical peculiarities of tabasheer (Phil. Trans., vol. cix., 1819, p. 283). The specimens which he first examined were obtained from India by Dr. Kennedy, by whom they were given to Brewster.

Brewster found the specimens which he examined to be perfectly *isotropic*, exercising no influence in depolarising light. When heated, however, it proved to be remarkably *phosphorescent*. The translucent varieties were found to transmit a yellowish and to reflect a bluish-white light—or, in other words, to exhibit the phenomenon of *opalescence*. When tabasheer is slightly wetted, it becomes white and opaque; but when thoroughly saturated with water, perfectly transparent.

By preparing prisms of different varieties of tabasheer, Brewster proceeded to determine its refractive index, arriving at the remarkable result that tabasheer "has a lower index of refraction than any other known solid or liquid, and that it actually holds an intermediate place between water and gaseous bodies!" This excessively low refractive power Brewster believes to afford a complete explanation of the extraordinary behaviour exhibited by tabasheer when wholly or partially saturated with fluids. A number of interesting experiments were performed by saturating the tabasheer with oils of different refractive powers, and by heating it in various ways and under different conditions, and also by introducing carbonaceous matter into the minute pores of the substance by setting fire to paper in which fragments were wrapped.

The mean of experiments undertaken by Mr. James Jardine, on behalf of Brewster, for determining the specific gravity of tabasheer, gave as a result 2·235. From these experiments Brewster concluded that the space occupied by the pores of the tabasheer is about two and a half times as great as that of the colloid silica itself!

From this time forward Brewster seems to have manifested the keenest interest in all questions connected with the origin and history of a substance possessing such singular physical properties. By the aid of Mr. Swinton, Secretary to the Government at Calcutta, he formed a large and interesting collection of all the different varieties of tabasheer from various parts of India. He also obtained specimens of the bamboo with the tabasheer *in situ*. In 1828 he published an interesting paper on "the Natural History and Properties of Tabasheer" (*Edinburgh Journal of Science*, vol. viii., 1828, p. 288), in which he discussed many of the important problems connected with the origin of the substance. From his inquiries and observations, Brewster was led to conclude that tabasheer was only produced in those joints of bamboos which are in an injured, unhealthy, or malformed condition, and that the siliceous fluid only finds its way into the hollow spaces between the joints of the stem when the membrane lining the cavities is destroyed or rent by disease.

Prof. Edward Turner, of the University of London, undertook an analysis of tabasheer, the specimens being supplied from Brewster's collection (*Edinburgh Journal of Science*, vol. viii., 1828, p. 335). His determinations of the specific gravities of different varieties were as follows:—

Chalky tabasheer	2·189
Translucent tabasheer	2·167
Transparent tabasheer	2·160

All the varieties lose air and hygroscopic water at 100° C., and a larger quantity of water and organic matter (indicated by faint smoke and an empyreumatic odour) at a red heat. The results obtained were as follows:—

	Loss at 100° C.	Loss at red heat
Chalky tabasheer	0·838 per cent.	1·277 per cent.
Translucent tabasheer	1·620 ,, ,,	3·840 ,, ,,
Transparent tabasheer	2·411 ,, ,,	4·518 ,, ,,

Dr. Turner found the ignited Indian tabasheer to consist almost entirely of pure silica with a minute quantity of lime and vegetable matter. He failed to find any trace of alkalies in it.

In 1855, Guibourt (*Journ. de Pharm.* [3], xxvii. 81, 161, 252; *Phil. Mag.* [4], x. 229) analysed a specimen of tabasheer having a specific gravity of 2·148. It gave the following result:—

Silica	=	96·94
Potash and lime	=	0·13
Water	=	2·93
Organic matter	=	trace

Guibourt criticised some of the conclusions arrived at by Brewster, and sought to explain the source of the silica by studying the composition of different parts of the bamboo. While the ashes of the wood contained 0·0612 of the whole weight of the wood, the pith was found to contain 0·448 per cent., the inner wood much less, and the greatest proportion occurred in the external wood. On these determinations Guibourt founded a theory of the mode of formation of tabasheer based on the suggestion that at certain periods of its growth the bamboo needed less silica than at other times, and that when not needed, the silica was carried inwards and deposited in the interior.

In the year 1857, D. W. Rost van Tonningen, of Buitenzorg, undertook an investigation of the tabasheer of Java, which is known to the natives of that island under the name of "singkara" (*Naturkundig Tijdschrift voor Nederlandsch Indie*, vol. xiii., 1857, p. 391). The specimens examined were obtained from the *Bambusa apus* growing in the Residency of Bantam; it is described as resembling in appearance the Indian tabasheers. Its analysis gave the following result:—

Silica	=	86·387
Iron oxide	=	0·424
Lime	=	0·244
Potash	=	4·806
Organic matter	=	0·507
Water	=	7·632
Total ...		100·000

Apart from the question of its singular mode of origin, however, and its remarkable and anomalous physical properties, tabasheer is of much interest to mineralogists and geologists. All the varieties hitherto examined, with the exception of the peculiar one from the Andes, are in composition and physical characters true opals; this is the case with all the Indian and Java varieties. They consist essentially of silica in its colloidal form, the water, lime, potash, and organic matter being as small and variable in amount as in the mineral opals; and, as in them, these substances must be regarded merely as mechanical impurities.

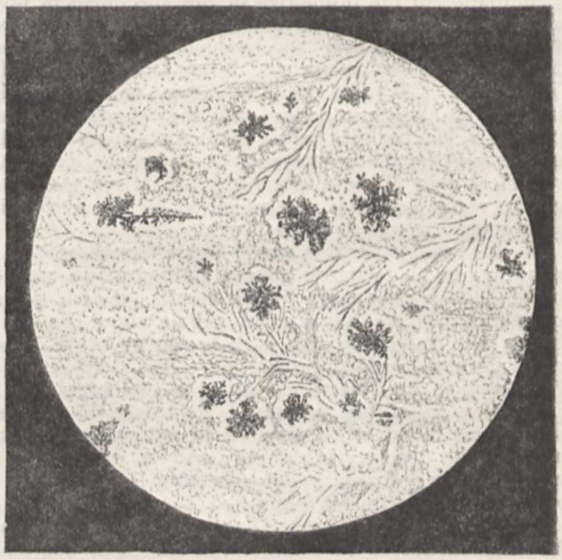
The tabasheers must be studied in their relations on the one hand with certain varieties of the natural semi-opals, hydrophanes, beekites, and floatstones, some of which they closely resemble in their physical characters, and on the other hand with specimens of artificially deposited colloid silica formed under different conditions. Prof. Church, who has so successfully studied the beekites, informs me that some of those remarkable bodies present singular points of analogy with tabasheer.

By the study of thin sections I have, during several years, been endeavouring to trace the minute structure of some of these substances. In no class of materials is it more necessary to guard one's self against errors of observation arising from changes induced in the substance during the operations which are necessary to the preparation of transparent sections of hard substances. Unfortunately, too, it is the custom of the natives to prepare the substance for the market by an imperfect calcination, and hitherto I have only been able to study specimens procured in the markets which have been subjected to this process. It is obviously desirable, before attempting to interpret the structures exhibited under the microscope, to compare the fresh and uncalcined materials with those that have been more or less altered by heat.

Tabasheer would seem, from Brewster's experiments, to be a very intimate admixture of two and a half parts of air with one part of colloidal silica. The interspaces filled with air appear, at all events in most cases, to be so minute that they cannot be detected by the highest powers of the microscope which I have been able to employ. It is this intimate admixture of a solid with a gas which probably gives rise to the curious and anomalous properties exhibited by this singular substance.

The ultra-microscopical vesicles filled with air in all probability give rise to the opalescence which is so marked a property of the substance. Their size is such as to scatter and throw back the rays at the blue end of the spectrum and to transmit those at the red end.

When the vesicles of the substance are filled with Canada balsam, and a thin slice is cut from it, this opalescence comes out in the most striking manner; very thin sections are of a rich orange-yellow by transmitted light, and a delicate blue tint by reflected light.



Section of Indian tabasheer, seen with a magnifying power of 250 diameters.

I do not know of any substance which in such thin films displays such striking opalescence.

That the excessively low refractive power of tabasheer is connected with the mechanical admixture of the colloidal silica with air seems to be proved by the experiments of Brewster, showing that with increase of density there was an increase in the refractive index, from 1·111 in specimens of the lowest specific gravity, to 1·182 in those of the highest specific gravity. Where the surface was hard and dense, Brewster found the refractive index to approach that of semi-opal. The wonderful thing is that a substance so full of cavities containing gas should nevertheless be transparent.

By the kindness of Mr. F. Rutley, F.G.S., I am able to supply a drawing taken from one of my sections of tabasheer.

The accompanying woodcut gives some idea of the interesting structures exhibited in some sections of tabasheer, though much of the delicacy and fidelity of the original drawing has been lost in transferring it to the wood.

In this particular case, the faint punctation of the surface may possibly indicate the presence of air-vesicles of a size sufficiently great to be visible under the microscope. But in many other instances I have failed to detect any such indication, even with much higher powers. The small ramifying tubules might at first sight be taken for some traces of a vegetable tissue, but my colleague Dr. Scott assures me that they do not in the least resemble any tissue found in the bamboo. I have myself no doubt that it is an inorganic structure. It is not improbably analogous to the peculiar ramifying tubules formed in a solution of water-glass when a crystal of copper sulphate is suspended in it, as shown by Dr. Heaton (Proc. Brit. Assoc., 1869, p. 127). Similar forms also occur on a larger scale in some agates, and the artificial cells of Traube may probably be regarded as analogous phenomena.

The aggregates of globular bodies seen in the section so greatly resemble the globulites of slags and natural glasses, and in their arrangement so forcibly recall the structures seen in the well-known pitchstone of Corriegills in Arran, that one is tempted to regard them as indicating the beginnings of the development of crystalline structure in the tabasheer. But I have good grounds for believing the structure to have a totally different origin. They seem in fact to be the portions of the mass which the fluid Canada balsam has not succeeded in penetrating. By heating they may be made to grow outwards, and as more balsam is imbibed they gradually diminish, and finally disappear.

I must postpone till a future occasion a discussion of all the structures of this remarkable substance and of the resemblances and differences which they present to the mineral opals on the one hand, and to those of the opals of animal origin found in sponge spicules, radiolarians, and the rocks formed from them, some of which have recently been admirably investigated by Dr. G. J. Hinde (Phil. Trans., 1885, pp. 425–33).

I cannot, however, but think that it would be of the greatest service to botanists, physicists, and mineralogists alike, if some resident in India would resume the investigations so admirably commenced by Dr. Patrick Russell nearly a century ago; and it is in the hope of inducing someone to undertake this task that I have put together these notes. There are certain problems with regard to the mode of occurrence of this singular substance which could only be solved by an investigator in the country where it is found.

Most parcels of the commercial tabasheer appear to contain different varieties, from the white, opaque, chalk-like forms, through the translucent kinds to those that are perfectly transparent. It would be of much interest if the exact relation and modes of origin of these different varieties could be traced. It would also be important to determine if Brewster was right in his conclusion that the particular internodes of a bamboo which contain tabasheer always have their inner lining tissue rent or injured. The repetition of Dr. Russell's experiment of drawing off the liquids from the joints of bamboos and allowing them to evaporate is also greatly to be desired. My colleague Prof. Rücker, F.R.S., has kindly undertaken to re-examine the results arrived at by Brewster in the light of more recent physical investigations, and I doubt not that some of the curious problems suggested by this very remarkable substance may ere long find a solution.

JOHN W. JUDD

EXHIBITION OF MARINE METEOROLOGICAL INSTRUMENTS

THE eighth Annual Exhibition of the Royal Meteorological Society was held in the Library of the Institution of Civil Engineers, 25 Great George Street, Westminster, from Tuesday, March 15th, to Friday, the 18th. The exhibition was specially devoted to marine meteorological instruments and apparatus, and such new instruments as have been invented and first constructed during the past twelve months.

A very interesting and valuable collection of instruments from the *Challenger* Commission, the Scottish Marine Station at Granton, the Scottish Meteorological Society, and Mr. J. Y. Buchanan, were brought from Edinburgh under the charge of Dr. H. R. Mill, who showed several in action. This set included various forms of deep-sea thermometers, from the early pattern of the Miller-Casella to the Scottish frame for Negretti and Zambra's reversing thermometer, which has been adapted from Magnaghi's by Dr. Mill. Two specimens of the Miller-Casella thermometer, after four months' immersion in brackish water, were shown, with the following results: in No. 1, which was placed at the surface, the copper case was clean, but the scale figures were entirely obliterated from the porcelain; in No. 2, which was suspended in 9 fathoms, and at 1 foot above the bottom, the copper was entirely covered with a green crust, but the scale figures were not rendered illegible. Various forms of piezometers for ascertaining the depth when the temperature is known, or the temperature when the depth is known, were also exhibited. These were nearly all constructed by Mr. Buchanan on board the *Challenger*. Water-bottles for obtaining samples of water at the bottom, or any required depth below the surface, were suspended from the gallery to show their action when in use. The most interesting were Buchanan's sounding-rod and water-bottle for great depths, and Mill's self-locking slip water-bottle for moderate depths.

The Meteorological Council contributed sets of instruments as supplied to merchant ships and the Royal navy; the Royal Meteorological Institute of the Netherlands exhibited a set as supplied to the Dutch navy; and the Deutsche Seewarte sent a set as issued to the German navy.

The Rev. C. J. Steward exhibited a set of instruments as used at the Lochbuie Marine Institute, Isle of Mull, which, among others, included a dimenuion thermometer in a box for river temperatures, the box being suitable for the bottoms of pools, or rough stony bottoms; and a large disk for ascertaining the transparency of the sea.

In connexion with the deep-sea thermometers Mr. Casella showed some apparatus originally employed in testing these instruments for the Admiralty and the Royal Society, and damaged during the experiments; viz., a bottle broken at a pressure corresponding to 2½ miles of sea-water, a steel bar bent at 3 miles, and an iron plug broken at 4 miles. Specimens of almost every pattern of deep-sea thermometer were exhibited, including Johnson's registering metallic, the records of which are obtained by the varying expansion of brass and steel bars acting upon indices; Miller-Casella maximum and minimum; and Negretti and Zambra's turnover thermometer.

The barometers exhibited included patterns used in the British, Dutch, French, and German navies. The English marine barometer has an iron cistern and contracted scale, and the gun barometer is mounted with india-rubber packing to prevent breakage caused by gun-firing. MM. Richard Frères, of Paris, sent one of their self-recording aneroids, for use on board ship; and Mr. Abercromby showed several curves taken at sea by one of these instruments in various parts of the world.

The anemometers shown were: Sir Snow Harris's, which is an improved form of Lind's; Hagemann's, Robinson's, Black's pressure, and Whipple's maximum pressure, the latter being quite a new instrument. Dr. Black exhibited his marine rain-gauge and evaporator. Among the miscellaneous instruments were various forms of patent logs, current meters, clinometers, and a model of a section of a vessel fitted with lightning conductor.

In addition to the instruments, a number of charts diagrams, &c., were exhibited, showing the meteorological conditions prevailing over the various oceans of the globe. The advance made in synoptic meteorology over the North Atlantic was clearly shown by comparing Leverrier's charts (1864) with the daily synchronous weather charts just published by the Meteorological Council. The specimens exhibited of the latter were (1) August 1-6, showing the meteorological conditions in the summer; (2) February 9-14, showing the conditions in the winter; and (3) February 24 to March 4, showing the conditions in early spring, and the persistence of the European anticyclone, producing cold dry winds over England. The Meteorological Council also exhibited a set of large charts showing the mean temperature of the sea surface round the coasts of the British Isles for each month. Dr. Mill had several interesting diagrams showing the distribution of temperature in a section of the Clyde sea area at seven periods from April 1886 to February 1887. Mr. Abercromby exhibited forty-six photographs and diagrams of clouds taken in various parts of the world; and Mr. Dyason showed a number of coloured drawings of clouds, &c. The Astronomer Royal sent the photographic registers of magnetic declination and horizontal force at the Royal Observatory, Greenwich, showing the earthquake shock which occurred on the morning of February 23.

The most interesting of the new instruments was the Watkin aneroid with open scale, by Mr. Hicks. Instead of the usual one-circle of figures, the scale of this instrument consists of a spiral of three complete turns. On the aneroid being put under an air-pump or taken up a mountain, the point of the index is gradually drawn *towards* the centre, so that it follows the *decreasing* spiral scale; but when the index moves in the opposite direction, the point moves *away* from the centre, thus following the *increasing* spiral. This is effected by the index-hand being made to slide in and out, so that one end may advance or recede from the centre, and thus follow the spiral scale. Attached to the spindle is a cross-piece, in which the index slides, and a hollow drum fixed to the dial-plate has a flexible chain or cord wound round it, the ends being fastened on the projecting pins riveted to the index. Consequently, if the spindle and the piece attached to it are revolved, one portion of the chain or cord winds off the drum, the other is wound on to the same extent, and the index is caused to slide through the cross-piece, the direction of motion being controlled by the direction in which the spindle is revolved.

MM. Richard Frères sent specimens of their self-recording thermometer, hygrometer, dry and wet bulb thermometers, and rain-gauge.

GEOGRAPHY AT THE UNIVERSITIES

AT last, after years of apparently fruitless labour, the Royal Geographical Society have been eminently successful in persuading almost simultaneously the two great English Universities to recognise geography as a University study, and to make definite provision for teaching it. In pursuance of a proposal made by the President and Council of the Royal Geographical Society to the Vice-Chancellors of the two Universities, and of the replies thereto, a deputation of a few members of their Council visited Oxford and Cambridge in turns, to meet delegates appointed by those Universities, in order to explain their proposal more fully, and to discuss any modifications that might be suggested. The main features of the proposal were, that the Royal Geographical Society offered to give 150*l.* annually to each University if they would establish a Lectureship or Readership in Geography, giving the Lecturer an adequate University status, and contributing, on their part, an equal sum, so as to raise the stipend of each Lectureship to 300*l.* They also offered to give the two Universities a Scholarship or Exhibition of 100*l.* in alternate years for geographical students. The Royal Geographical Society was to be represented on the Board that selected the Examiners, and on that which adjudged the Scholarship.

The meeting at Oxford with delegates from that University, including the present and past Vice-Chancellors, took place five weeks ago, at which the proposal was well discussed and favourably entertained, subject to the foreseen difficulty of finding adequate funds from the University resources; nevertheless everything seemed in train for its being eventually carried out, though after a little delay, in the intended manner. An unexpected incident, however, gave a new and collateral impulse, and has hurried the Lectureship into existence at once. It happened that the Readership in Ancient History became vacant, and it seems to have occurred to those with whom the election of a successor rested, that as there was a great difficulty in finding funds for geography, and as a Professorship of Ancient History was already in existence, and, again, as ancient history was taught by most classical tutors, the Readership in Ancient History might be abolished without much loss, and one in geography might be with propriety established in its place. There was a nearly even division of opinion on the matter, but the vote for geography prevailed and carried the day, and the advertisement inviting candidates has already been published. So Oxford now takes an independent line, and accepts only the offer of the Scholarship.

The Cambridge meeting took place about three weeks ago. The proposal was carefully discussed, and modifications were asked for. At Cambridge, as at Oxford, the University funds are seriously embarrassed by engagements already entered into, chiefly connected with building operations; and there seemed no way, so narrow was the available surplus, of raising the whole of the annual amount of 150*l.* in a direct form, but only 50*l.* of it However, it appeared that indirect means existed by which this nominal sum would indirectly and eventually be raised to even something more than the proposed amount, and an amendment specifying only 50*l.* was therefore provisionally accepted. After this had received the approval of the Council of the Royal Geographical Society, it was submitted to the Council of the University of Cambridge, and adopted by them in the terms of the following recommendation: –

"That the approval of the Senate be given to the delivery in the University in the ensuing academical year of one or more courses of lectures on geography by lecturers selected by the Royal Geographical Society, that a teacher of geography be appointed by a Committee on which the Royal Geographical Society is represented, and that the Senate accept the proposal of the Royal Geographical Society to award in alternate years an Exhibition of 100*l.* or prizes of 50*l.* and 25*l.* That before the end of the Easter Term, 1888, a University Lecturer in Geography be appointed, for a period of five years, at a stipend of 200*l.* a year, of which sum 50*l.* is to be paid out of the common University fund and 150*l.* by the Royal Geographical Society. The appointment of the Lecturer to be made by a joint Committee of the representatives of the Royal Geographical Society and of the Council of the Senate, subject to the confirmation of the Senate; the Lecturer to submit his scheme of lectures to the Committee of Management; and power is to be given to the Council of the Senate, with the concurrence of the Committee of Management, to cancel the appointment of the Lecturer at any time."

This recommendation has to be submitted to the Senate at the beginning of next term, but its ultimate acceptance is placed almost beyond doubt through the very favourable reception given to the proposals of the Royal Geographical Society by the Council of the University.

THE ORGANISATION OF INDUSTRIAL EDUCATION

THE following is the letter by Prof. Huxley to which reference is made in our leading article (p. 482):—

"When a statesman of Lord Hartington's authority concurs with and enforces the opinions I ventured to express some little time ago, I have every reason for private and personal satisfaction. But the circumstance has a public importance as evidence that our political chiefs and leaders are giving their serious attention to those social questions which lie far above the region of party strife, and are of infinitely greater moment than the topics which ordinarily absorb the attention of politicians.

"The organisation of industrial and commercial education is not the least of these great problems. That it has to be solved, under penalty of national ruin, proves to be no mere alarmist fancy, but the belief of an experienced man of affairs, whose imperturbable coolness and strong common-sense are proverbial.

"It is an interesting question for us all, therefore, How do we stand prepared for the task thus imperatively set us? My conviction is that we are in some respects better off than most people imagine, in others worse. I conceive that two things are needful: on the one hand, a machinery for providing instruction and gathering information; on the other hand, a machinery for catching capable men wherever they are to be found and turning them to account. Now, I apprehend that both these kinds of machinery are to be found, though in a fragmentary and disconnected condition, in several organisations which, though independent, supplement one another.

"The first of these is that of the School Boards, which provide elementary education, and sometimes, though too rarely, have at their disposal scholarships by which capable scholars can attain a higher training. The second is the organisation of the Department of Science and Art. The classes, now established all over the country in connexion with the Department, not only provide elementary instruction, accessible to all, but offer the means whereby the pick of the capable students may obtain in the schools at South Kensington as good a higher education in science and art as is to be had in the country. It is from this source that the supply of science and art teachers, who in turn raise the standard of elementary instruction, is derived. The third organisation is that of the technical classes connected with the City and Guilds Institute, or with the Society of Arts, or with provincial Universities and Colleges, which provide special technical instruction for those who have, or ought to have, already acquired the elements of scientific and artistic knowledge in the science and art classes.

"A fourth organisation for the advancement of the interests of industry and commerce, of the nature of that which I imagined it was the intention of the founders of the Imperial Institute to create, and such as is, I believe, now actually in course of creation in the City of London, will complete the drill-grounds of the army of industry, and, so far as I can judge, omit nothing of primary importance. But, leaving the last aside as still in the embryonic condition, these excellent organisations are all mere torsos, fine—but fragmentary.

"The ladder from the School Boards to the Universities, about which I dreamed dreams many years ago, has not yet acquired much more substantiality than the ladder of Jacob's vision.

"The Science and Art Department has done, and is doing, admirable work, which I regret to see more often made the subject of small and carping criticism than of the praise which is its due. I trust it may not be diverted from efficiently continuing that work by having duties for which it is unfit forced upon it. That which the Department needs, in my judgment, is nothing but the means of doing that which Commission after Commission, Royal and departmental, have declared to be its proper business.

"As Dean of the Normal School I may be permitted to declare that it is impossible for us to perform the functions allotted to us unless the recommendations made by impartial and independent authority are carried into effect.

"The school exists, and common-sense surely suggests either make it efficient or abolish it. The alternative of abolition is not likely to be adopted, as that step would be equivalent to striking the keystone out of the edifice of scientific instruction for the masses of the people which it has taken a quarter of a century to raise, and which is the essential foundation for any sound system of technical education. The alternative of efficiency means spending a few thousand pounds on additional buildings; but the guardians of the national purse do not seem to feel the force of the adage about 'spoiling a ship for a halfpennyworth of tar.'

"The state of affairs in regard to that which ought to be the centre of our system of technical education is nearly the same. The Central Institute is undoubtedly a splendid monument of the munificence of the City. But munificence without method may arrive at results indistinguishably similar to those of stinginess. I have been blamed for saying that the Central Institute is 'starved.' Yet a man who has only half as much food as he needs is indubitably starved, even though his short rations consist of ortolans and are served up on gold plate. And I have excellent authority for saying that little more than one-half of the plan of operations of the Institute, drawn up by the Committee of which I was a member, has been carried out, or can be carried out, if the funds allotted for the maintenance of the Institute are not largely increased. At the same time, the Institute is doing all that could be rationally expected of it. Some of the guilds and many provincial towns are making admirable provision for elementary technical education. Such work, in my judgment, ought to be left to local administrators, whatever aid it may be thought desirable to give them. But the local schools should be brought into relation with the Central Institute, and this should be put upon such a footing as to subserve its proper purpose of training teachers and giving higher technical instruction.

"Economy does not lie in sparing money, but in spending it wisely. And it is, to my mind, highly necessary that some man or body of men, whom their countrymen trust, should consider these various organisations as a whole and determine the manner in which they should be correlated and in which it is desirable that the resources, public and private, which are available should be distributed among them.

"Lord Hartington has many claims on the gratitude and respect of his countrymen. I venture to express the wish that he would add to them by taking up this great work of organising industrial education and bringing it to a happy issue."

AUGUST WILHELM EICHLER

THE death of Dr. August Wilhelm Eichler, briefly announced in a previous number, is a great loss to botanical science, and especially to systematic botany. Year by year we are losing men of wide and consequently sound knowledge of plants without their places being adequately filled. We have doubtless arrived at a stage in botany where specialists are necessary; yet we venture to assert that men of general attainments are better qualified than specialists, in a narrow sense, for the head of large botanical establishments, such as the one over which the late Dr. Eichler presided, and which greatly extended its reputation during the nine years he was Director.

Dr. Eichler was barely forty-eight years of age, but before entering upon the absorbing duties connected with the University and Botanic Garden of Berlin he had already made a name as a botanical author.

For some years he was assistant to Von Martius at Munich, and succeeded him as editor of the colossal "Flora Brasiliensis," now nearly completed. This was in 1868, but he had previously been a considerable and excellent contributor to this work, having elaborated several difficult families in a masterly manner. The work by which he is more generally known is the "Blüthendiagramme," in which he admirably illustrates and explains the morphology and organogeny of the Phanerogamia. His labours were chiefly in the direction of morphology. His continued careful study of the female flower of the Coniferæ may be regarded as having finally settled the homologies of the different elements of the inflorescence of that family. One of his later contributions to science, if not his last, is entitled "Zur Entwickelungsgeschichte der Palmenblätter," in which the author fully elucidates the development of the various types of leaf in the Palmæ.

As a lecturer Dr. Eichler was exceedingly popular and successful; and he was regarded as an able administrator of the Botanic Garden. He was successively Professor of Botany at Munich, Gratz, Kiel, and Berlin, having been appointed to the last post in 1878. Two years later, "at the comparatively youthful age of thirty-nine," he was chosen a member of the Berlin Academy of Sciences; and in 1881 he was elected Foreign Member of the Linnean Society of London. He was also honorary and corresponding member of many other learned societies; and all who knew him, however slightly, will join in regretting his early death.

NOTES

BARON EGGERS, commissioned by Dr. Urban and assisted by the Royal Academy of Sciences of Berlin, is about to undertake the botanical investigation of the hitherto unexplored higher mountains of St. Domingo. The specimens collected for distribution will be arranged (under corresponding numbers) in two series. One will consist only of species which have not yet been distributed in Baron Eggers' West Indian collections; the other and larger series will include everything except the commonest tropical species. The first-named series will be disposed of at forty shillings per century, the latter at thirty shillings. Dr. J. Urban, assisted by other systematists, will determine the collections and receive the names of subscribers. As the expense and difficulty of transit in the island must limit the number of collections for sale, early application to Dr. Urban is desirable. Dr. Urban's address is Friedenau, bei Berlin.

A CONVERSAZIONE given by the Council of the City and Guilds of London Institute was held at the Central Institution, Exhibition Road, on Wednesday evening, the 16th inst., and was attended by about 1300 visitors. Lord Selborne received the guests. A large number of interesting objects of scientific and artistic interest were exhibited, and during the evening demonstrations were given by the Professors in the various departments, as well as by several gentlemen who are associated with the work of the Institute.

ON the 15th inst. a meeting was held at Grimsby to consider the expediency of establishing there an Institution for Technical Education with regard to Fish and Fisheries, and a Marine Fish-Culture Station. Mr. W. Oldham Chambers, Secretary of the National Fish-Culture Association, pointed out to the meeting the advantages of the proposed Station and Institute. Resolutions in support of the scheme were unanimously adopted, and an influential local Committee was appointed to further the object in view. Letters have been received from the various Fish Trade Associations and other bodies, heartily approving of the undertaking. The Manchester, Sheffield, and Lincolnshire Railway Company are prepared to grant a site for the Institute, and to erect a building, free of cost, at Cleethorpe, near Grimsby.

WE are sorry to see that the income of the Mason Science College, Birmingham, during the year ending "Founder's Day," February 23, fell short of the expenditure by the sum of 1646*l.* After deducting what may be termed extraordinary expenditure, there remained a deficiency of 1074*l.* The Council, in their last report, remind the Trustees that the annual deficits, which since 1881 have been charged against the accumulated surplus, have now reduced this fund to the sum of 1419*l.*, and that the estimates for the current financial year anticipate that the balance of the fund will be required. It is not creditable to the well-off citizens of Birmingham that an institution capable of doing great work for their town and district should have to meet these constantly recurring deficiencies.

THE spring meeting of the Institution of Mechanical Engineers, under the presidency of Mr. E. H. Carbutt, will take place on Monday, May 16, and the following day. On Tuesday, May 17, the Duke of Cambridge will dine with the members of the Institution.

IN order to determine between the rival sites for the Sedgwick Memorial Museum at Cambridge, and at the same time advance the chances of proceeding early with a portion at least of the building, the Council of the Senate propose to submit a grace next term to settle the question of site. The grace will take the form of authorising negotiations with Downing College for a site opposite the old Botanic Garden. If this be rejected, the latter affords the only practicable site.

MISS GORDON has presented to the Museum of the Royal Gardens, Kew, the collections and drawings made by her late brother, General Gordon, illustrative of the Coco de Mer (*Lodoicea seychellarum*), a palm peculiar to the Seychelles, and remarkable, among other things, for possessing the largest known seed in the vegetable kingdom. The seeds are well known in European museums. One amongst General Gordon's specimens is a model which he had made of the fruit in its mature state, before the external fibrous but perishable husk had become detached. Some of the specimens are placed, with others already possessed by Kew, in No. 2 Museum. The rest will be shown, with the drawings made by his own hand, in No. 3 Museum.

THE Cambridge University Local Examination Report for the past year states that in zoology and physiology the answers showed very inefficient teaching. Botany is somewhat better done; but many senior candidates had not been taught the use of floral diagrams. In physical geography, while the answering was generally good, many had used antiquated text-books. Chemistry was fairly done, the candidates choosing, out of the alternative questions, the practical rather than the theoretical. Qualitative analysis was well done, both by seniors and juniors. The seniors showed general ignorance about the laws of multiple proportion, and combination by volume. Heat was badly done by both seniors and juniors. Many seemed never to have read any text-book, and to have presented themselves on the strength of a few isolated facts. Statics was very unequally mastered. There was better acquaintance with the mathematical than with the practical part of the subject. Electricity (senior subject) had not been studied seriously enough to warrant its inclusion in the examination. The mathematical subjects of the examination are reported on much more favourably.

THE botanical collections of the late Thomas Moore, F.L.S. Curator of the Botanic Garden at Chelsea, belonging to the Society of Apothecaries, have been acquired for the Herbarium of the Royal Gardens, Kew. The most important portions are:—(1) The general fern herbarium, which contains the types of the numerous species described by Moore, especially those introduced into European cultivation. (2) The collection of forms and varieties of British ferns, which is probably unique in richness and completeness; it is especially interesting as the basis of Mr. Moore's well-known and beautifully illustrated works on the fern flora of the British Isles. (3) The fern herbarium of R. Heward, F.L.S., which is especially strong in West Indian species.

BRITISH field botanists will be glad to learn that the Scottish Rights of Way Society has been successful in its action brought in the Court of Session against the proprietor of Glen Doll in Clova. Lord Kinnear has found that "the pursuers had established a sufficient use and possession of the road for more than forty years to entitle them to a judgment." There is probably no portion of the Highlands of Scotland from which botanists would feel it a greater hardship to be excluded. For years it has been so well watched by keepers that access to it has been impossible, except to such botanists as are swift and sure of foot. The present owner is the first who has denied a right of way through it, and, if we are not mistaken, the action only concerns this right to use the road. It is to be feared that efforts will not be wanting to confine the public to the road, and to deny all access to those parts so interesting to the field botanist.

A SERIES of charts showing the surface temperatures of the Atlantic coast waters, from the eastern coast of Maine to the extreme southerly coast of Florida, is being prepared by the United States Fish Commission. The Commission is aided in this important undertaking by the Lighthouse Board and the Signal Service. Observations have thus far been made at twenty-four lighthouse stations, showing the surface temperatures at these localities during the past five years. The temperatures at each station are shown in detail for each year by ten-day means, and the facts are combined with those brought out on a series of isothermal charts giving the relations of the different stations. The results are likely to be of great value in connexion with the study of the migration of the mackerel, menhaden, shad, and other migratory fishes.

AN interesting discussion has just been started in the Paris Academy of Medicine, concerning the bad results of mental straining in young persons. Attention has especially been called to the fact that many French girls, under the pressure of competition, are injuring their health by over-work at school. About 12,000 of them are trying to get the superior diploma which would confer upon them the right of getting an appointment in Government schools. Only 2000 will be able to get appointments.

AN excellent address on the physical training of girls was lately given by Dr. Rayner W. Batten to the Gloucestershire branch of the British Medical Association. It is printed in the *British Medical Journal*. Speaking of ladies' Colleges, Dr. Batten says he does not know of more than one that has such a thing as a proper playground, whilst a leading College, if not the first in the country, with abundant means and ample opportunities, makes no pretence of having any playground at all. Dr. Batten urges that drill and calisthenic exercises are not enough. There must be recreation as well, "and at present, in our ladies' Colleges," he says, "the exercise, with the exception of tennis, has little of the recreative element in it." Dr. Batten is of opinion that all Colleges should have playgrounds—large spaces, open to the fresh air and sunlight—that every girl should be made to play, two half-holidays a week at least being given for that purpose, and that the games should be varied, so that girls may not have to go on doing what they are conscious of not doing well. "Every girl will soon find out her strong and weak points in play as well as in work, and if the game is to be a recreation she must be allowed to choose her own form, the only obligation being that she is to play, and that no books or work are to be brought on the playground."

AT the meeting of the Essex Field Club on Saturday next, the 26th inst., Prof. Sylvanus P. Thompson will read a paper on William Gilbert, the founder of the science of electricity, and an Essex worthy entitled to rank with Ray among the pioneers of science. Those wishing to attend the meeting should communicate with the Secretary, Buckhurst Hill, Essex.

ON the night of March 7, about 11.30, a brilliant meteor was seen in Dalcarlia, in Central Sweden. It was first seen in the north-west, going in a southerly direction, but soon afterwards it changed its course more easterly. Its colour was a brilliant white, and its greatest size about that of the moon. It was lost to sight behind the horizon, leaving only a faint trail behind.

FROM a recent official French Report on oyster-culture in France we learn that the two principal centres are at Arcachon in the south-west and Auray in the north-west. The Bay of Arcachon has since 1854 held a foremost place in oyster-breeding. In 1857 there were twenty parks, or district oyster-beds: in 1865 the number had increased to 297, with an output of over 10,000,000 oysters. At the present time the little bay, which has a total area of 37,500 acres, has oyster-beds covering an area of 15,000 acres, which provide annually about 300,000,000 oysters for consumption. With regard to the oyster-beds at Auray, on the coast of Brittany, these, though not so important as those of Arcachon, have still a considerable output, and, from being exhausted and unproductive when their rehabilitation was first undertaken, have become full to overflowing. In 1876–77 we find that 7,000,000 oysters were placed on the market from Auray; in 1885 the number had risen to over 70,000,000.

THE ideas of M. Victor Meunier with regard to the domestication of apes are discussed in the new number of the *Revue d'Anthropologie* by Madame Clémence Royer, the French translator of Darwin. Madame Royer does not doubt that, under a proper system of training, apes might be made good workers. They lack perseverance, indeed, but in general intelligence they are, she thinks, superior to the dog, the horse, or even the elephant. She points out, however, that it would be necessary to feed domesticated apes with great quantities of fruit, bread, and eggs, that the process of educating them would be costly, and that for many generations they would probably be injuriously affected by the climate of Europe. Her opinion is that, if the experiment is to be made, it should be made first of all in tropical countries, where apes might be taught to labour in connexion with the cultivation of coffee, cocoa, and cotton.

AN interesting paper on "The Application of Gems to the Art of the Goldsmith" was read to the Society of Arts on Tuesday, the 15th inst., by Mr. Alfred Phillips. It is printed in the Society's Journal. Mr. Phillips gives a very favourable account of the capacity of English workmen employed by goldsmiths at the present day. When masters encourage them to depart from the beaten track, they readily adapt themselves, Mr. Phillips says, to work which, ten years ago, would have been sent as a matter of course to specialists on the Continent.

A HEALTH EXHIBITION will be opened in Warsaw on May 15 next.

AN International Agricultural Exhibition of Tools and Implements will be held at Parma in September next.

THE Royal Bavarian Academy of Sciences is collecting the numerous treatises of Joseph Fraunhofer, hitherto dispersed in numberless serials, and is about to publish them in one volume.

PROF. VERNEUIL AND L. H. PETIT have issued the first number of a periodical publication called "Études expérimentales et cliniques sur la Tuberculose." It is published by means of a fund especially raised for the promotion of the study of tuberculosis.

M. H. GADEAU DE KERVILLE has just published a work on evolution. It is entitled "Causeries sur le Transformisme," and contains an exposition of the facts and theories upon which the doctrine of evolution is based.

A BOOK on therapeutics, by M. G. Hayem, Professor in the Paris Medical School, has just been published.

THE February number of the Italian Geographical Bulletin contains a detailed account, by Dr. G. A. Colini, of the rich ethnological collection recently presented to the Prehistoric and Ethnographic Museum of Rome by General Genè, Commander of the Italian possessions on the East Coast of Africa. The collection includes a great variety of objects, such as arms, costumes, implements, ornaments, utensils from Abyssinia, Somali Land, and the Afar (Danakil) country. Amongst them are baking-ovens, braziers, incense-burners, cooking-utensils, pestles for grinding coffee, pepper, durrha, &c.; baskets, matting, veils, robes, loin-cloths, wooden sandals, lamps, swords, match-lock guns, knives, hairpins, &c., illustrating the arts and industries of the East African peoples.

WE have received the four latest Bulletins of the U.S. Geological Survey (Nos. 30–33). No. 30 contains Mr. C. D. Walcott's second contribution to "Studies on the Cambrian Faunas of North America." A systematic review of our present knowledge of fossil insects, including myriapods and arachnids, by Mr. S. H. Scudder, is presented in No. 31; and an elaborate account of mineral springs of the United States, by Dr. A. C. Peale, in No. 32. No. 33 is made up of notes, by Mr. J. S. Diller, on the geology of Northern California.

MR. EDWARD COOKWORTHY ROBINS, whose collected papers on technical education and applied science, buildings and fittings, &c., were reviewed in NATURE some time ago, is now engaged on a general work of reference on the same subject. It will appear shortly under the title of "Technical School and College Buildings," in a quarto volume of about 250 pages, with upwards of 100 full-page illustrations, plates, and maps.

IN the Proceedings of the American Antiquarian Society (vol. iv. p. 62) Mr. Frederick W. Putnam gives an account of twelve jade objects found in Nicaragua and Costa Rica, ten of which were ornaments made by cutting celts into halves, quarters, or thirds, a portion of the cutting edge of the celt remaining on each piece. Mr. O. W. Huntington, who was asked to report upon the nature and source of the material of these ornaments, is of opinion that the specimens "are unquestionably Chinese jade." They have, he says, "all the characters of that mineral, although the largest specimen from Costa Rica is rather unusual in its colour, and would not be taken for jadeite at sight." The *American Naturalist*, which calls attention to these facts, thinks "it will now be in order to collate during the next ten years the evidence for and against contact between the Orient and the western shores of America."

SOME interesting notes from Venezuela have lately been contributed by Dr. Ernst, of Caracas, to the Proceedings of the Berlin Anthropological Society. The writer brings together much valuable information as to the manners and customs of the aboriginal population, and about their food, ornaments, implements, weapons, and canoes.

THE additions to the Zoological Society's Gardens during the past week include a Mauge's Dasyure (*Dasyurus maugæi* ♀) from Australia, presented by Mr. W. Miller; two White-crowned Pigeons (*Columba leucocephala*) from the West Indies, presented by Lieut.-Colonel Dawkins; two Long-tailed Grass Finches (*Poephila acuticauda*) from Australia, presented by Mr. Walter Burton; an Algerian Tortoise (*Testudo mauritanica*) from North Africa, presented by Mr. J. M. Green; a European Pond Tortoise (*Emys europæa*), South European, presented by Mr. Henry Garle; five European Tree Frogs (*Hyla arborica*), European, presented by Mr. F. W. Green; an Axis Deer (*Cervus axis* ♀), a Collared Fruit Bat (*Cynonycteris collaris*), sixteen Puff Adders (*Vipera arietans*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

RESEARCHES ON THE DIAMETER OF THE SUN.—Herr Auwers has published in the *Sitzungsberichte der Königlich Preussischen Akademie der Wissenschaften zu Berlin*, 1886, No. l., the first part of an elaborate investigation of the value of the sun's diameter as found from meridian observations, and of the apparent variations thereof. The discussion now published refers to variations in the mean annual values only of the diameter. The series of observations discussed are the meridian observations of the sun made at Greenwich, 1851–83; at Washington, 1866–82; at Oxford (Radcliffe Observatory), 1862–83; and at Neuchâtel (transit observations only), 1862–83. The "personal equations" of the various observers are first determined on the supposition that there may be periodic annual variations, both in the horizontal and vertical diameters of the sun, such for instance as have been supposed by Secchi and others to exist, with a period corresponding to the sunspot cycle. The first determination of "personal equation" is therefore made by comparing observations taken in each year with others taken in the same year only. The resulting diameters are, however, such as to convince Herr Auwers that, although inequalities exist in each of the series of observations discussed, their comparison with each other and with the sunspot curve is sufficient to show that they have no connexion either with the latter or with a progressive change, but are most probably due to uncorrected "personal equations." A second determination of these on the assumption that, for some observers at least, they are liable to change, but that the sun's diameter is not subject to annual variation, leads to much more satisfactory results, and is regarded by Herr Auwers as the correct solution of the problem. The effect of personality on the deduced solar diameter, which on the average, for an individual observer, amounts to about 1″ (sometimes 3″, 4″, and even 10″), may be inferred from the fact that the values of the horizontal and vertical diameters of the sun, deduced from thirty-three years' observation with the Greenwich transit-circle, and referred to the mean of Dunkin, Ellis, Criswick, and J. Carpenter, as standard, are respectively 32′ 2″·48 and 32′ 2″·00; whilst, referred to the mean of fifty-four observers, the same observations give, for the horizontal and vertical diameters respectively, the values 32′ 1″·99 and 32′ 2″·73.

COMET 1887 *b* (BROOKS, JANUARY 22).—The following ephemeris for Berlin midnight, is by Dr. R. Spitaler (*Astr. Nach.* No. 2776).

1887		R.A. h. m. s.		Decl. ° ′		Brightness
March 24	...	4 18 8	...	35 46·5 N.	...	0·72
26	...	4 21 20	...	34 26·1	...	
28	...	4 24 26	...	33 8·9	...	0·66
30	...	4 27 26	...	31 54·9	...	
April 1	...	4 30 21	...	30 43·9	...	0·61
3	...	4 33 11	...	29 35·7 N.	...	

The brightness on January 24 is taken as unity.

MINOR PLANET NO. 262.—This object has received the name of Valda.

HARVARD COLLEGE OBSERVATORY.—The late Uriah A. Boyden having left proprety to the value of 230,000 dollars in trust for the purpose of astronomical research, the Trustees of the fund have transferred the property to the President and Fellows of Harvard College, in order that the researches proposed by Mr. Boyden may be directed at the Harvard College Observatory. These researches will be supported by a portion of the means of the Observatory, in addition to the trust fund itself. By the terms of the will the money is to be devoted to observations "at such an elevation as to be free, so far as practicable, from the impediments to accurate observations which occur in the observatories now existing, owing to atmospheric influences."

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 *MARCH* 27—*APRIL* 2

(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 March 27

Sun rises, 5h. 49m.; souths, 12h. 5m. 30·1s.; sets, 18h. 22m.; decl. on meridian, 2° 35′ N.: Sidereal Time at Sunset, 6h. 41m.

Moon (at First Quarter on April 1) rises, 7h. 19m.; souths, 14h. 12m.; sets, 21h. 16m.; decl. on meridian, 9° 44′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	5 19	11 26	17 33	0 40 N.
Venus ...	6 38	13 47	20 56	12 41 N.
Mars ...	6 3	12 30	18 57	4 37 N.
Jupiter ...	20 47*	1 52	6 57	11 28 S.
Saturn ...	10 39	18 48	2 57*	22 30 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

March	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
27	μ Ceti	4	18 42	19 35	108 359
29	71 Tauri	6	20 38	near approach	47 —
29	θ^1 Tauri	4½	21 17	22 13	117 335
29	θ^2 Tauri	4½	21 26	22 8	91 0
29	75 Tauri	6	21 46	near approach	226 —
29	B.A.C. 1391	5	22 16	23 7	159 288
29	85 Tauri	6	23 12	near approach	42 —
31	115 Tauri	6	0 9	0 45	173 258
April					
2	B.A.C. 2731	6½	21 20	22 30	111 288

March h.
27 ... 0 ... Venus in conjunction with and 4° 50′ north of the Moon.

April
1 ... 22 ... Saturn in conjunction with and 3° 23′ north of the Moon.

Variable Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
Algol	3 0·8	40 31 N.	Mar. 28,	19 3	*m*
ζ Geminorum	6 57·4	20 44 N.	,, 30,	22 0	*m*
δ Libræ	14 54·9	8 4 S.	,, 30,	22 21	*m*
U Coronæ	15 13·6	32 4 N.	,, 30,	22 43	*m*
U Herculis	16 20·8	19 9 N.	Apr. 1,		*m*
U Ophiuchi	17 10·8	1 20 N.	Mar. 28,	4 58	*m*
			and at intervals of	20 8	
W Sagittarii	17 57·8	29 35 S.	Mar. 29,	3 0	*M*
R Lyræ	18 51·9	43 48 N.	,, 31,		*m*
η Aquilæ	19 46·7	0 43 N.	Apr. 2,	2 0	*M*
S Sagittæ	19 50·9	16 20 N.	,, 2,	4 0	*M*
T Aquarii	20 44·0	5 34 S.	Mar. 28,		*m*
T Cephei	21 8·1	68 2 N.	,, 31,		*M*
δ Cephei	22 25·0	57 50 N.	,, 28,	2 0	*m*

M signifies maximum; *m* minimum.

GEOGRAPHICAL NOTES

IN a recently-issued Colonial Office Report on the Gambia will be found some useful data on the climate of that colony which completely upset the results of previous observations and greatly reduce the temperatures hitherto accepted. The mean temperature, according to these latest observations, varies from 68°·5 in January to 80° in July at 7 a.m., and from 73°·7 in January to 82°·5 in July at noon. The same Report contains some interesting statements relating to the ethnology of the colony.

THE principal paper in the just-issued Bulletin (only No. 4 of 1885) of the American Geographical Society is on the historical and geographical features of the Rocky Mountain Railways, by Mr. James Douglass. There is also a translation of Baron Nordenskjöld's reply to criticisms on the "Voyage of the *Vega*." The criticisms relate to points of minor importance.

THE new number of the "Antananarivo Annual and Madagascar Magazine" (Christmas, 1886), consists, besides a reprint of Mr. A. R. Wallace's chapter on the fauna of Madagascar, mainly of papers on linguistic topics and on Malagasy folk-lore. M. Grandidier's paper on the channels and lagoons of the east coast of the island is translated with some interesting remarks by Mr. Sibree appended. Mr. Sibree points out that it would only require about thirty miles of canals to connect all these lagoons and so create a safe and extensive internal waterway of the greatest commercial value. The Rev. W. Montgomery contributes a paper on the Malagasy game of "Fanerana," in many respects resembling chess.

IN the new number (Heft i. Band 10.) of the *Deutsche Geographische Blätter*, we find a useful and careful, if rather too favourable, study of the trade-routes of Mexico, old and new, and their commercial importance, by Herr A. Scobel. From a scientific point of view the most valuable paper is that of Dr. Otto Finsch on his visit three years ago to the atoll of Diego Garcia in the Chagos Archipelago, about half-way between the Seychelles and Ceylon. Dr. Finsch was only a few hours on the islands, but his notes on the people (mostly of the Negro type from the Mauritius) and the richness of the bird life are interesting. An open space in the little east island was covered with "millions" of birds, whose combined cry was deafening. Eggs, also in "millions," lay about everywhere, unprotected by any nest. The commonest among these birds was the sooty tern (*Sterna fuliginosa*). Next to the Laccadives, the Chagos Islands seem to be the favourite breeding-place of this bird in the Indian Ocean. The variety in the colouring of the eggs was unprecedented in Dr. Finsch's experience, especially considering the fact that they all belonged to birds of the one species named above. The only other species noticed in the island by Dr. Finsch was the noddy (*Anous stolidus*). The birds arrive in the islands in the month of June, and stay till the young are fledged; by November they have all taken their departure. As on most coral islands, the animal world generally is very poor.

THE same number contains an account of Fontana's exploration of Eastern Patagonia in 1885, and also a short biography of Emin Pasha. From the latter we learn that Edward Schnitzer was born at Oppeln, in Silesia, in 1840; received his early education at Neisse, in Upper Silesia, and studied medicine at Breslau, Berlin, and Königsberg. From his earliest years he had a special taste for natural history, and especially ornithology, and in the latter department he has all along been a diligent collector. In 1864 we find Schnitzer at Antivari, in Albania, as a surgeon in the Turkish service. In 1870 he accompanied Ismail Pasha to Syria and Arabia, and afterwards to Trebizond, Erzeroum, and Epirus. At Ismail's death in 1874, Schnitzer came to Constantinople, and in 1875 made a short visit to his German home. Entering the Egyptian service, he, in 1876, followed Gordon Pasha from Cairo into the Soudan, where, under the title of Emin Effendi, he was appointed chief surgeon, and in 1878 Governor-General of the Equatorial Province, with the title of Bey. His work as administrator, scientific explorer, and collector, since then is well known. To Bremen and Vienna he has sent some 2000 bird-skins, carefully labelled with all necessary information, and including some twenty-five new species.

SINCE the time of Herodotus travellers in Africa have brought home reports of pygmy tribes scattered about in various regions of Africa. Readers of Schweinfurth will remember the Akkas whom he met in the Monbuttu country, and now Dr. Ludwig Wolf, who, with Wissmann, recently explored the Sankuru, the great southern tributary of the Congo, gives us many details of a similar pygmy race among whom he sojourned for some time, in the district to the north-west of the station Luluaburg. He found entire villages inhabited by tiny men and women, of a height of not more than 1·40 metre. Among their neighbours they are known as Batua. These are nomad tribes devoting themselves exclusively to the chase and the manufacture of palm wine. Their villages, consisting of huts, are met with in clearings in the forests which cover the greater part of the country. Each district thus possesses a village of pygmies. As is the case of the Akkas among the Monbuttus, so the Batua among the Bakubu are regarded as little benevolent beings whose special mission is to provide the tribes among whom they sojourn with game and palm-wine. In exchange, manioc, maize, and bananas are given to the pygmies. Generally they live apart, but sometimes they unite themselves with races of larger stature. They excel in the art of scaling palm-trees to collect the sap, and in setting traps for game. Their agility is almost incredible. In hunting they bound through the high grass like grasshoppers, facing the elephant, antelope, and buffalo with the greatest audacity, shooting their arrows with rare precision, following up rapidly with a stroke of the lance. Physically the Batua are very well made, having absolutely no deformity. They are simply little men, well proportioned, very brave, and very cunning. Their mean height is 1·30 metre. Their skin is a yellow-brown, less dark than that of larger races. Their hair is short and woolly. Neither the Akkas nor the Batua have any beard.

SUNLIGHT COLOURS[1]

SUNLIGHT is so intimately woven up with our physical enjoyment of life that it is perhaps not the most uninteresting subject that can be chosen for what is — perhaps somewhat pedantically—termed a Friday evening "discourse." Now, no discourse ought to be possible without a text on which to hang one's words, and I think I found a suitable one when walking with an artist friend from South Kensington Museum the other day. The sun appeared like a red disk through one of those fogs which the east wind had brought, and I happened to point it out to him. He looked, and said, "Why is it that the sun appears so red?" Being near the railway station, whither he was bound, I had no time to enter into the subject, but said if he would come to the Royal Institution this evening I would endeavour to explain the matter. I am going to redeem that promise, and to devote at all events a portion of the time allotted to me in answering the question why the sun appears red in a fog. I must first of all appeal to what everyone who frequents this theatre is so accustomed, viz. the spectrum; I am going not to put it in the large and splendid stripe of the most gorgeous colours before you with which you are so well acquainted, but my spectrum will take a more modest form of purer colours some twelve inches in length.

I would ask you to notice which colour is most luminous. I think that no one will dispute that in the yellow we have the most intense luminosity, and that it fades gradually in the red on the one side and in the violet on the other. This then may be called a qualitative estimate of relative brightnesses; but I wish now to introduce to you what was novel last year, a quantitative method of measuring the brightness of any part.

Before doing this I must show you the diagram of the apparatus which I shall employ in some of my experiments.

RR are rays (Fig. 1) coming from the arc light, or, if we were using sunlight, from a heliostat, and a solar image is formed by a lens, L_1, on the slit S_1 of the collimator C. The parallel rays produced by the lens L_2 are partially refracted and partially reflected. The former pass through the prisms P_1P_2, and are focused to form a spectrum by a lens, L_3, on D, a movable ground glass screen. The rays are collected by a lens, L_4, tilted at an angle as shown, to form a white image of the near surface of the second prism on F.

Passing a card with a narrow slit, S_2, cut in it in front of the spectrum, any colour which I may require can be isolated. The consequence is that, instead of the white patch upon the screen, I have a coloured patch, the colour of which I can alter to any hue lying between the red and the violet. Thus, then, we are able to get a real patch of very approximately homogeneous light to work with, and it is with these patches of colour that I shall have to deal. Is there any way of measuring the brightness of these patches? was a question asked by General Festing and myself. After trying various plans, we hit upon the method I shall now show you, and if anyone works with it he must become fascinated with it on account of its almost childish simplicity—a simplicity, I may remark, which it took us some months to find out. Placing a rod before the screen, it casts a black shadow surrounded with a coloured background. Now I may cast another shadow from a candle or an incandescence lamp, and the two shadows are illuminated, one by the light of the coloured patch and the other by the light from an incandescence lamp which I am using tonight. [Shown.] Now one stripe is evidently too dark. By an arrangement which I have of altering the resistance interposed between the battery and the lamp, I can diminish or increase the light from the lamp, first making the shadow it illuminates too light and then too dark compared with the other shadow which is illuminated by the coloured light. Evidently there is some position in which the shadows are equally

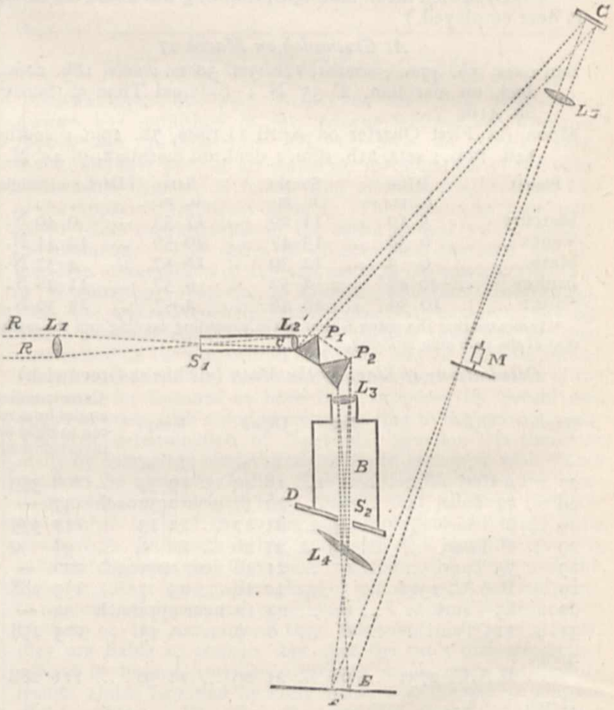


Fig. 1.—Colour Photometer.

luminous. When that point is reached, I can read off the current which is passing through the lamp, and having previously standardised it for each increment of current, I know what amount of light is given out. This value of the incandescence lamp I can use as an ordinate to a curve, the scale number which marks the position of the colour in the spectrum being the abscissa. This can be done for each part of the spectrum, and so a complete curve can be constructed which we call the illumination curve of the spectrum of the light under consideration.

Now, when we are working in the laboratory with a steady light, we may be at ease with this method, but when we come to working with light such as the sun, in which there may be constant variation owing to passing, and maybe usually imperceptible, mist, we are met with a difficulty; and in order to avoid this, General Festing and myself substituted another method, which I will now show you. We made the comparison light part of the light we were measuring. Light which enters the collimating lens partly passes through the prisms and is partly reflected from the first surface of the prism; that we utilise, thus giving a second shadow. The reflected

[1] Lecture delivered by Capt. W. de W. Abney, R.E., F.R.S., at the Royal Institution, on February 25, 1887.

rays from P_1 fall on G, a silver-on-glass mirror. They are collected by L_3, and form a white image of the prism also at F. The method we can adopt of altering the intensity of the comparison light is by means of rotating sectors, which can be opened or closed at will, and the two shadows thus made equally luminous. [Shown.] But although this is an excellent plan for some purposes, we have found it better to adopt a different method. You will recollect that the brightest part of the spectrum is in the yellow, and that it falls off in brightness on each side, so, instead of opening and closing the sectors, they are set at fixed intervals, and the slit is moved in front of the spectrum, just making the shadow cast by the reflected beam too dark or too light, and oscillating between the two till equality is discovered. The scale number is then noted, and the curve constructed as before. It must be remembered that, on each side of the yellow, equality can be established.

This method of securing a comparison light is very much better for sun work than any other, as any variation in the light whose spectrum is to be measured affects the comparison light in the same degree. Thus, suppose I interpose an artificial cloud before the slit of the spectroscope, having adjusted the two shadows, it will be seen that the passage of steam in front of the slit does not alter the relative intensities; but this result must be received with caution. [The lecturer then proceeded to point out the contrast colours that the shadow of the rod illuminated by white light assumed.]

I must now make a digression. It must not be assumed that everyone has the same sense of colour, otherwise there would be no colour-blindness. Part of the researches of General Festing and myself have been on the subject of colour-blindness, and these I must briefly refer to. We test all who come by making them match the luminosity of colours with white light, as I have now shown you; and as a colour-blind person has only two fundamental colour-perceptions instead of three, his matching of luminosities is even more accurate than is that made by those whose eyes are normal or nearly normal. It is curious to note how many people are more or less deficient in colour-perception. Some have remarked that it is impossible that they were colour-blind, and would not believe it, and sometimes we have been staggered at first with the remarkable manner in which they recognised colour to which they ultimately proved deficient in perception. For instance, one gentleman when I asked him the name of a red colour patch, said it was sunset colour; he then named green and blue correctly, but when I reverted to the red patch he said green. On testing further he proved totally deficient in the colour-perception of red, and with a brilliant red patch he matched almost a black shadow. The diagram shows you the relative perceptions in the spectrum of this gentleman and myself. There are others who only see three-quarters, others half, and others a quarter the amount of red that we see, whilst some see none. Others see less green and others less violet, but I have met with no-one that can see more than myself or General Festing, whose colour-perceptions are almost identical. Hence we have called our curve of illumination the "normal curve."

We have tested several eminent artists in this manner, and about one-half of the number have been proved to see only three-quarters of the amount of red which we see. It might be thought that this would vitiate their powers of matching colour, but it is not so. They paint what they see, and although they see less red in a subject, they see the same deficiency in their pigments; hence they are correct. If totally deficient, the case of course would be different.

Let us carry our experiments a step further, and see what effect what is known as a turbid medium has upon the illuminating value of different parts of the spectrum. I have here water which has been rendered turbid in a very simple manner. In it has been very cautiously dropped an alcoholic solution of mastic. Now mastic is practically insoluble in water, and directly the alcoholic solution comes in contact with the water it separates out in very fine particles, which, from their very fineness, remain suspended in the water. I propose now to make an experiment with this turbid water.

I place a glass cell containing water in front of the slit, and on the screen I throw a patch of blue light. I now change it for turbid water in a cell. This thickness much dims the blue; with a still greater thickness the blue has almost gone. If I measure the intensity of the light at each operation, I shall find that it diminishes according to a certain law, which is of the same nature as the law of absorption. For instance, if one inch diminishes the light one-half, the next will diminish it half of that again, the next half of that again, whilst the fourth inch will cause a final diminution of the total light of one-sixteenth. If the first inch allows only one-quarter of the light, the next will only allow one-sixteenth, and the fourth inch will only permit 1/256 part to pass. Let us, however, take a red patch of light and examine it in the same way. We shall find that, when the greater thickness of the turbid medium we used when examining the blue patch of light is placed in front of the slit, much more of this light is allowed to pass than of the blue. If we measure the light we shall find that the same law holds good as before, but that the proportion which passes is invariably greater with the red than the blue. The question then presents itself: Is there any connection between the amounts of the red and the blue which pass? Lord Rayleigh, some years ago, made a theoretical investigation of the subject; but, as far as I am aware, no definite experimental proof of the truth of the theory was made till it was tested last year by General Festing and myself. His law was that for any ray, and through the same thickness, the light transmitted varied inversely as the fourth power of the wave-length. The wave-length 6000 lies in the red, and the wave-length 4000 in the violet. Now 6000 is to 4000 as 3 to 2, and the fourth powers of these wave-lengths are as 81 to 16, or as about 5 to 1. If, then, the four inches of our turbid medium allowed three-quarters of this particular red ray to be transmitted, they would only allow $(\frac{3}{4})^5$, or rather less than one-fourth, of the blue ray to pass. Now this law is not like the law of absorption for ordinary absorbing media, such as coloured glass for instance, because here we have an increased loss of light running from the red to the blue, and it matters not how the medium is made turbid, whether by varnish, suspended sulphur, or what not. It holds in every case, so long as the particles which make the medium turbid are small enough; and please to recollect that it matters not in the least whether the medium which is rendered turbid is solid, liquid, or air. Sulphur is yellow in mass, and mastic varnish is nearly white, whilst tobacco-smoke when condensed is black, and very minute particles of water are colourless: it matters not what the colour is, the loss of light is *always* the same. The result is simply due to the scattering of light by fine particles, such particles being small in dimensions compared with a wave of light. Now, in this trough is suspended 1/1000 of a cubic inch of mastic varnish, and the water in it measures about 100 cubic inches, or is 100,000 times more in bulk than the varnish. Under a microscope of ordinary power it is impossible to distinguish any particles of varnish: it looks like a homogeneous fluid, though we know that mastic will not dissolve in water. Now a wave-length in the red is about 1/40,000 of an inch, and a little calculation will show that these particles are well within the necessary limits. Prof. Tyndall has delighted audiences here with an exposition of the effect of the scattering of light by small particles in the formation of artifical skies, and it would be superfluous for me to enter more into that. Suffice it to say that when particles are small enough to form the artificial blue sky they are fully small enough to obey the above law, and that even larger particles will suffice. We may sum up by saying that very fine particles scatter more blue light than red light, and that consequently more red light than blue light passes through a turbid medium, and that the rays obey the law prescribed by theory. I will exemplify this once more by using the whole spectrum and placing this cell, which contains hyposulphite of soda in solution in water, in front of the slit. By dropping in hydrochloric acid, the sulphur separates out in minute particles; and you will see that, as the particles increase in number, the violet, blue, green, and yellow disappear one by one and only red is left, and finally the red disappears itself.

Now let me revert to the question why the sun is red at sunset. Those who are lovers of landscape will have often seen on some bright summer's day that the most beautiful effects are those in which the distance is almost of a match to the sky. Distant hills, which when viewed close to are green or brown, when seen some five or ten miles away appear of a delicate and delicious, almost of a cobalt, blue colour. Now, what is the cause of this change in colour? It is simply that we have a sky formed between us and the distant ranges, the mere outline of which looms through it. The shadows are softened so as almost to leave no trace, and we have what artists call an atmospheric effect. If we go into another climate, such as Egypt or amongst the high Alps, we usually lose this effect. Distant mountains stand out crisp with black shadows, and the want of atmosphere is much felt. [Photographs showing these differences were shown.] Let us ask to what this is due. In such climates as England there is always a certain amount of moisture present in the atmosphere, and this moisture may be present as very minute particles of water—so minute indeed that they will not sink down in an atmosphere of normal density—or as vapour. When present as vapour the air is much more transparent, and it is a common expression to use, that when distant hills look "so close" rain may be expected shortly to follow, since the water is present in a state to precipitate in larger particles; but when present as small particles of water the hills look very distant, owing to what we may call the haze between us and them. In recent weeks everyone has been able to see very multiplied effects of such haze. The ends of long streets, for instance, have been scarcely visible though the sun may have been shining, and at night the long vistas of gas lamps have shown light having an increasing redness as they became more distant. Everyone admits the presence of mist on these occasions, and this mist must be merely a collection of intangible and very minute particles of suspended water. In a distant landscape we have simply the same or a smaller quantity of street-mist occupying, instead of perhaps 1000 yards, ten times that distance. Now I would ask, What effect would such a mist have upon the light of the sun which shone through it?

It is not in the bounds of present possibility to get outside our atmosphere and measure by the plan I have described to you the different illuminating values of the different rays, but this we can do:—First, we can measure these values at different altitudes of the sun, and this means measuring the effect on each ray after passing through different thicknesses of the atmosphere, either at different times of day, or at different times of the year, about the same hour. Second, by taking the instrument up to some such elevation as that to which Langley took his bolometer at Mount Whitney, and so to leave the densest part of the atmosphere below us. Now, I have adopted both these plans. For more than a year I have taken measurements of sunlight in my laboratory at South Kensington, and I have also taken the instrument up to 8000 feet high in the Alps, and made observations *there*, and with a result which is satisfactory in that both sets of observations show that the law which holds with artificially turbid media is under ordinary circumstances obeyed by sunlight in passing through our air: which is, you will remember, that more of the red is transmitted than of the violet, the amount of each depending on the wave-length. The luminosity of the spectrum observed at the Riffel I have used as my standard luminosity, and compared all others with it. The result for four days you see in the diagram.

I have diagrammatically shown the amount of different colours which penetrated on the same days, taking the Riffel as ten. It will be seen that on December 23 we have really very little violet and less than half the green, although we have four-fifths of the red.

The next diagram before you shows the minimum loss of light which I have observed for different air thicknesses. On the top we have the calculated intensities of the different rays outside our atmosphere. Thus we have that through one atmosphere, and two, three, and four; and you will see what enormous absorption there is in the blue end at four atmospheres. The areas of these curves, which give the total luminosity of the light, are 761, 662, 577, 503, and 439; and if observed as astronomers observe the absorption of light, by means of stellar observations, they would have had the values, 761, 664, 578, 504, and 439—a very close approximation one to the other.

Next notice in the diagram that the top of the curve gradually inclines to go to the red end of the spectrum as you get the light transmitted through more and more air, and I should like to show you that this is the case in a laboratory experiment. Taking a slide with a wide and long slot in it, a portion is occupied by a right-angled prism, one of the angles of 45° being towards the centre of the slot. By sliding this prism in front of the spectrum I can deflect outwards any portion of the spectrum I like, and by a mirror can reflect it through a second lens, forming a patch of light on the screen overlapping the patch of light formed by the undeflected rays. If the two patches be exactly equal, white light is formed. Now, by placing a rod as before in front of the patch, I have two coloured stripes in a white field, and though the background remains of the same intensity of white, the intensities of the two stripes can be altered by moving the right-angled prism through the spectrum. The two stripes are now apparently equally luminous, and I see the point of equality is where the edge of the right-angled prism is in the green. Placing a narrow cell filled with our turbid medium in front of the slit, I find that the equality is disturbed, and I have to allow more of the yellow to come into the patch formed by the blue end of the spectrum, and consequently less of it in the red end. I again establish equality. Placing a thicker cell in front, equality is again disturbed, and I have to have less yellow still in the red half, and more in the blue half. I now remove the cell, and the inequality of luminosity is still more glaring. This shows, then, that the rays of maximum luminosity must travel towards the red as the thickness of the turbid medium is increased.

The observations at 8000 feet, here recorded, were taken on

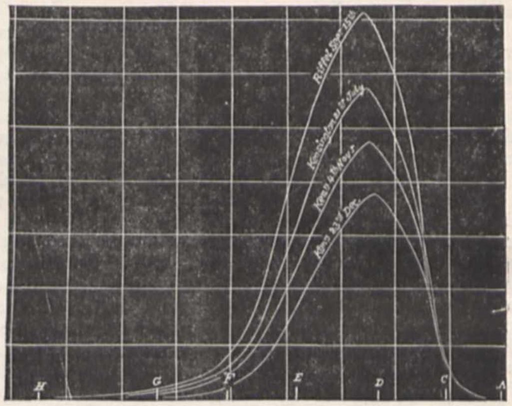


FIG. 2.—Relative Luminosities.

September 15 at noon, and of course in latitude 46° the sun could not be overhead, but had to traverse what would be almost exactly equivalent to the atmosphere at sea-level. It is much nearer the calculated intensity for no atmosphere intervening, than it is for one atmosphere. The explanation of this is easy. The air is denser at sea-level than at 8000 feet up, and the lower stratum is more likely to hold small water particles or dust in suspension than is the higher.

For, however small the particles may be, they will have a greater tendency to sink in a rare air than in a denser one, and less water vapour can be held per cubic foot. Looking, then, from my

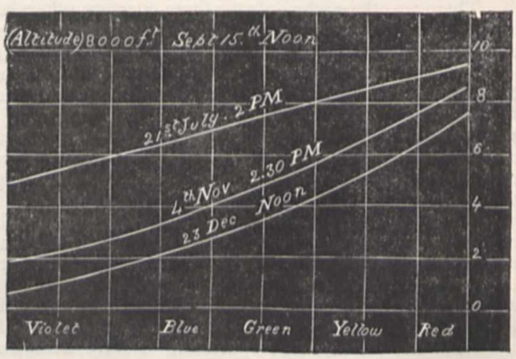


FIG. 3.—Proportions of Transmitted Colours.

laboratory at South Kensington, we have to look through a proportionately larger quantity of suspended particles than we have at a high altitude when the air thicknesses are the same; and consequently the absorption is proportionately greater at sea-level that at 8000 feet high. This leads us to the fact that the real intensity of illumination of the different rays outside the atmosphere is greater than it is calculated from observations near sea-level. Prof. Langley, in this theatre, in a remarkable and interesting lecture, in which he described his journey up Mount Whitney to about 12,000 feet, told us that the sun was really blue outside our atmosphere, and at first blush the amount of extra blue which he deduced to be present in it would, he thought, make it so; but though he surmised the result from experiments made with rotating disks of coloured paper, he did not, I think, try the method of using pure colours, and consequently, I believe, slightly exaggerated the blueness which would result. I have taken Prof. Langley's calculations of the increase of intensity for the different rays, which I may say do not quite agree with mine, and I have prepared a mask which I can place in the spectrum giving the different proportions of each ray as calculated by him, and this when placed in front of the spectrum will show you that the real colour of sunlight outside the atmosphere, as calculated by Langley, can scarcely be called bluish. Alongside I place a patch of light which is very closely the colour of sunlight on a July day at noon in England. This comparison will enable you to gauge the blueness, and you will see that it is not very blue, and, in fact, not bluer perceptibly than that we have at the Riffel, the colour of the sunlight at which place I show in a similar way. I have also prepared some screens to show you the value of sunlight after passing through five and ten atmospheres. On an ordinary clear day you will see what a yellowness there is in the colour. It seems that after a certain amount of blue is present in white light the addition of more makes but little difference in the tint. But these last patches show that the light which passes through the atmosphere when it is feebly charged with particles does not induce the red of the sun as seen through a fog. It only requires more suspended particles in any thickness to induce it.

In observations made at the Riffel, and at 14,000 feet, I have found that it is possible to see far into the ultra-violet, and to distinguish and measure lines in the sun's spectrum which can ordinarily only be seen by the aid of a fluorescent eye-piece or by means of photography. Circumstantial evidence tends to show that the burning of the skin, which always takes place in these high altitudes in sunlight, is due to the great increase in the ultra-violet rays. It may be remarked that the same kind of burning is effected by the electric arc light, which is known to be very rich in these rays.

Again, to use a homely phrase, "You cannot eat your cake and have it." You cannot have a large quantity of blue rays present in your direct sunlight, and have a luminous blue sky. The latter must always be light scattered from the former. Now, in the high Alps you have, on a clear day, a deep blue-black sky, very different indeed from the blue sky of Italy or of England; and as it is the sky which is the chief agent in lighting up the shadows, not only in those regions do we have dark shadows on account of no intervening—what I will call—mist, but because the sky itself is so little luminous. In an artistic point of view this is important. The warmth of an English landscape in sunlight is due to the highest lights being yellowish, and to the shadows being bluish from the sky-light illuminating them. In the high Alps the high lights are colder, being bluer, and the shadows are dark, and chiefly illuminated by reflected direct sunlight. Those who have travelled abroad will know what the effect is. A painting in the Alps, at any high elevation, is rarely pleasing, although it may be true to Nature. It looks cold, and somewhat harsh and blue.

In London we are often favoured with easterly winds, and these, unpleasant in other ways, are also destructive of that portion of the sunlight which is the most chemically active on living organisms. The sunlight composition of a July day may, by the prevalence of an easterly wind, be reduced to that of a November day, as I have proved by actual measurement. In this case it is not the water particles which act as scatterers, but the carbon particles from the smoke.

Knowing, then, the cause of the change in the colour of sunlight, we can make an artificial sunset, in which we have an imitation light passing through increasing thicknesses of air largely charged with water particles. [The image of a circular diaphragm placed in front of the electric light was thrown on the screen in imitation of the sun, and a cell containing hyposulphite of soda placed in the beam. Hydrochloric acid was then added: as the fine particles of sulphur were formed, the disk of light assumed a yellow tint, and as the decomposition of the hyposulphite progressed, it assumed an orange and finally a deep red tint.] With this experiment I terminate my lecture, hoping that in some degree I have answered the question I propounded at the outset: why the sun is red when seen through a fog.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—From the University accounts for 1886, just issued, we learn that the Mathematical Tripos Examiners are paid 348*l.*; Examiners in Natural Science, 575*l.*; in Medicine and Surgery, 210*l.*; all extremely moderate payments.

Science Professors received 3725*l.* from the University Chest, 1800*l.* from the Common University Fund (derived from tax on the Colleges), besides payments from special endowments; Readers, Demonstrators, and other officers connected with Science and Medicine, 2100*l.* from the University Chest; 1800*l.* from the Common University Fund. Total, 9425*l.* for teachers mainly.

The University Observatory cost 786*l.*, in addition to 164*l.* from the Sheepshanks Fund. The Botanic Garden cost 1223*l.*; the Museums and Lecture Rooms, 4221*l.*, including 100*l.* for Dr. Guillemard's collection of bird-skins from the voyage of the *Marchesa*, 11*l.* for bird-skins bought by Prof. Newton at the Jardine sale, and 8*l.* 10*s.* for a skeleton of a European elk. The Pathological Laboratory cost 167*l.* out of the foregoing amount; the Department of Human Anatomy, 356*l.*; the Woodwardian Museum, 498*l.*; the Chemical Laboratory, 517*l.*; the Cavendish Laboratory, 274*l.*, including 60*l.* for instruments. The new dissecting-room (iron) for Human Anatomy cost 350*l.*, an additional class-room for Physiology 10*l.*, charged to the Museums Reserve Fund.

At Gonville and Caius College, Dr. Shuttleworth's Scholarship of 60*l.* for three years, open to medical students of the University of not less than eight terms' standing, given for proficiency in Botany and Comparative Anatomy, has been awarded to Francis Henry Edgeworth, B.A., Scholar of the College.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 3.—"On the Limiting Distance of Speech by Telephone." By William Henry Preece, F.R.S.

The law that determines the distance to which speaking by telephone on land-lines is possible, is just the same as that which determines the number of currents which can be transmitted through a submarine cable in a second.

It is dependent on a time-constant varying with the conditions of the circuit, invariable for the same uniform circuit, but differing for different circuits. It represents the time that elapses from the instant contact is made at the sending-end to the instant that the current begins to appear at the receiving-end. It is given by the following equation:—

$$a = Bkrl^2,$$

B being a constant dependent principally on the units used; k the inductive capacity per unit length (mile or knot); r the resistance per unit length, and l the lengths in miles or knots.

The number of reversals which can be produced at the end of a wire per second is quite independent of the impressed E.M.F., and therefore of the strength of the current. But it depends upon the sensitiveness of the apparatus used to receive the currents. This is why such discordant results are obtained by different observers who attempt to measure the velocity of currents of electricity. It is also why the telephone is such an admirable instrument for research—for it is sensitive to the least increment or decrement of current.

The inductive capacity of overhead and underground wires was measured with great care on very dry days in different parts of the country.

The results come out as follows:—

	Capacity per mile, microfarads	Resistance per mile, B.A. ohms
No. 7½ iron wire	0·0168	12·0
No. 12½ copper wire	0·0124	5·7
Gutta-percha-covered wire in iron pipes	0·2500	23·0
Gutta-percha-covered wire in cables	0·2900	10·25

It then became necessary to determine the speed of the current through wires of different lengths, resistances, and capacities.

It was found that, for mixed wires, the speed was given by the equation

$$t = 32 \times 10^{-8} \text{ KR},$$

but for copper alone the constant was 22×10^{-8}.

The limiting distance through which it is possible to speak varies inversely with the speed of the current, and that the speed of the current varies inversely with the product of the total resistance and the total capacity of the circuit. Hence the number of reversals that it is possible to send through any circuit varies inversely with the product of the total resistance (R) and the total capacity (K), or the limiting distance—

$$S = KR \times \text{constant} \quad . . . . (1)$$

This is only another form of Thomson's law for $K = lk$, and $R = lr$, and

$$\therefore S = krl^2 \times \text{constant}.$$

If the equation (1) be put into this form,

$$A = krx^2, \quad . . . . (2)$$

and A be given the following values:—

Copper (overhead)	15,000
Cables and underground	12,000
Iron (overhead	10,000

the limiting distance (x) through which speech is possible is

$$x^2 = A/kr.$$

There is an interesting consequence of Thomson's law which comes out of these experiments, and that is, whether the line be a single wire completed by the earth, or a double wire making a metallic circuit, the rate of speed between the two ends is exactly the same, and therefore the distance we can speak through is just the same whether we use a single or double wire circuit. This is owing to the fact that though in the latter case we double the total resistance, we halve the total capacity, and therefore the product remains the same.

The difference between copper and iron is clearly due to self-induction, or to the electro-magnetic inertia of the latter, and the difference between copper overground and copper underground is due to the facility that the leakage of insulators offers to the rapid discharge to earth, at innumerable points, of the static charge, which in gutta-percha-covered wire can find an exit only at the ends.

It is also evident that there is no difficulty in working telephones through underground wires, even though they attain fifty miles in length, and in fact it would be better to work underground with proper copper wire from London to Brighton, than to use iron wires along the railway telegraph poles, owing to the absence of external disturbances in the former case.

March 17.—"Second Note on the Geometrical Construction of the Cell of the Honey Bee (Roy. Soc. Proc. vol. xxxix. p. 253, and vol. xli. p. 442)." By Prof. H. Hennessy, F.R.S.

The author deduces from the results established in his communications as above cited that, while the trihedral pyramid at the apex of the cell may be inscribed in a sphere whose diameter, D, is equal to the sum of the three edges of the pyramid, another sphere may be inscribed within the cell touching all of its nine faces and whose diameter, D', is equal to the diameter of the cell, and that between these diameters the following relation exists:—

$$\frac{D}{D'} = \left(\frac{3}{2}\right)^{\frac{3}{2}}.$$

The connexion between the geometrical cell and its inscribed and circumscribing spheres is pointed out as possibly bearing on the mode of formation of the actual cells.

"A Coal-dust Explosion." By W. Galloway. Communicated by R. H. Scott, M.A., F.R.S.

Zoological Society, March 1.—Prof. W. H. Flower, F.R.S., President, in the chair.—Prof. Jeffrey Bell read extracts from a communication sent to him by Mr. Edgar Thurston, Superintendent of the Government Central Museum, Madras, containing observations on two species of Batrachians of the genus *Cacopus*.—Mr. O. Salvin (on behalf of Mr. F. D. Godman) exhibited a pair of a large and rare Butterfly (*Ornithoptera victoriæ*), the male of which had been hitherto undescribed. These specimens were obtained at the end of May 1886 by Mr. C. M. Woodford, at North-West Bay, Maleita Island, one of the Solomon group.—Mr. E. B. Poulton read a paper containing an account of his experiments on the protective value of colourand markings in insects (especially in Lepidopterous larvæ) in their relation to Vertebrata. It was found that conspicuous insects were nearly always refused by birds and lizards, but that they were eaten in extreme hunger: hence the unpleasant taste failed as a protection under these circumstances. Further, conspicuous and unpalatable insects, although widely separated, tended to converge in colour and pattern, being thus more easily seen and remembered by their enemies. In the insects protected by resembling their surroundings it was observed that mere size might prevent the attacks of small enemies. Some such insects were unpalatable, but could not be distinguished from the others. In tracing the inedibility through the stages, it was found that no inedible imago was edible in the larval stage; in this stage therefore the unpleasant taste arose.—Mr. G. A. Boulenger read a paper descriptive of the fishes collected by the late Mr. Clarence Buckley in Ecuador. The set of all the species in the collection acquired by the British Museum in 1880 contained a large number of highly interesting and well-preserved specimens. Amongst them were representatives of ten species described as new to science.—Mr. Richard S. Wray, read a note on a vestigial structure in the adult Ostrich representing the distal phalanges of the third digit.—Mr. John H. Ponsonby communicated (on behalf of Mr. Andrew Garrett) the second and concluding part of a paper on the Terrestrial Mollusks of the Viti or Fiji Islands.—Mr. Edgar A. Smith gave an account of a small collection of shells from the Loo-Choo Islands, made by Mr. H. Pryer.

Geological Society, February 18.—Annual General Meeting.—Prof. J. W. Judd, F.R.S., President, in the chair.—Having presented the various medals, and the proceeds of the Donation Funds in the gift of the Society, the President read his Anniversary Address, which we have already printed.—The ballot for the Council and Officers was taken, and the following were duly elected for the ensuing year:—President: Prof. J. W. Judd, F.R.S. Vice-Presidents: H. Bauerman, Prof. T. G. Bonney, F.R.S., A. Geikie, F.R.S., Henry Woodward, F.R.S. Secretaries: W. T. Blanford, F.R.S., and W. H. Hudleston, F.R.S. Foreign Secretary: Warington W. Smyth, F.R.S. Treasurer: Prof. T. Wiltshire. Council: H. Bauerman, W. T. Blanford, F.R.S., Prof. T. G. Bonney, F.R.S., A. Champernowne, Thomas Davies, Prof. P. M. Duncan, F.R.S., A. Geikie, F.R.S., Henry Hicks, F.R.S., Rev. Edwin Hill, W. H. Hudleston, F.R.S., J. W. Hulke, F.R.S., Prof. T. McKenny Hughes, Prof. T. Rupert Jones, F.R.S., Prof. J. W. Judd, F.R.S., R. Lydekker, J. E. Marr, E. T. Newton, Prof. H. G. Seeley, F.R.S., Warington W. Smyth, F.R.S., J. J. H. Teall, Prof. T. Wiltshire, Rev. H. H. Winwood, Henry Woodward, F.R.S.

February 23.—Prof. J. W. Judd, F.R.S., President, in the chair.—The following communications were read:—On the origin of dry chalk valleys and of Coombe rock, by Mr. Clement Reid. Whilst engaged in examining the Pleistocene deposits of Sussex, for the Geological Survey, the author observed that the Coombe rock differs from anything commonly seen in the strongly glaciated districts of the Yorkshire and Lincolnshire Wolds. As in these localities, the seaward slope of the South Downs is broken by the line of a partially buried sea-cliff before passing under the low-lying drift areas. Subsequent to the formation of this sea-cliff a mass of angular flint and chalk detritus spread out from the Downs over the low lands, being seldom found far up the valleys. This is the Coombe rock, which passes further on into a worthless mixture of angular flint and loam, and at a still greater distance into almost clean brick-earth. It is not of glacial origin, neither is it marine, nor is it a gravel formed by ordinary fluviatile action. The rolling outline of the Downs, and the steep-sided dry valleys point to conditions which have passed away. However much rain may fall, the upper parts of these valleys are always dry, and no running water can be found where the incline of the bottom of the valley exceeds the slope of the plane of saturation—never more than 60 feet per mile. The author discussed the various explanations which have been offered. In suggesting an origin for the dry valleys and Coombe rock, he considers that the fauna and flora, both at Fisherton and Bovey Tracey, point to a great degree of cold, from 20° to 30° lower than what now prevails in the South of England. The ground would thus be frozen to the depth of several hundred feet, and the drainage system of the chalk entirely modified. There would be no underground circulation. The summer rains would immediately run off any steep slope, often in violent torrents. These would tear up the layer of rubble already loosened by the frost, carrying down masses of unthawed chalk too rapidly for solvents to have much effect. No Coombe rock is found in valleys that have a greater slope than 100 feet per mile. There is no need of excessive rainfall; it might have been a dry period corresponding to that of the loess. If the time had not been short, all soft rocks in the South of England would have been planed down to one gently undulating surface like the plains of Russia and Siberia. Such tundra-conditions may have occurred more than once.—Probable amount of former glaciation of Norway, as demonstrated by the present condition of rocks upon and near the western coast, by Mr. W. F. Stanley.

Mathematical Society, March 10.—Sir James Cockle, F.R.S., President, in the chair.—The following communications were made:—A metrical property of plane curves, by R. Lachlan.—Note on the Weierstrass functions, by Mr. A. G. Greenhill.—Second paper on the change of the independent variable; with applications to some functions of the reciprocant kind, by C. Leudesdorf.—A note on knots, by Mr. A. B. Kempe, F.R.S.

Chemical Society, March 3.—Dr. Hugo Müller, F.R.S., President, in the chair.—The following papers were read:—Tartaric and racemic acids and the magnetic rotatory power of their ethyl salts, by Dr. W. H. Perkin, F.R.S.—Anhydracetonebenzil, by Mr. Francis R. Japp, F.R.S., and Mr. Cosmo Innes Burton.—Condensation compounds of benzil with ketones, by the same.—Constitution of glycosine, by Mr. Francis R. Japp, F.R.S., and Mr. E. Cleminshaw.—Diphenylglyoxaline and methyldiphenylglyoxaline, by Mr. Francis R. Japp, F.R.S.—Dehydracetic acid, by Dr. W. H. Perkin, Jun.—The colouring-matter of *Drosera Whittakeri*, by Prof. E. H. Rennie.—Further notes on the di-haloid derivatives of thiocarbamide, by Dr. George McGowan.

Anthropological Institute, March 8.—Mr. Francis Galton' F.R.S., President, in the chair.—Mr. A. L. Lewis read a paper on stone circles near Aberdeen. In this paper Mr. Lewis described in detail two circles near Dyce and Portlethen respectively, and drew particular attention to the fact that they differ in two important particulars from the circles of Southern Britain. In former papers on stone circles the author had insisted on the presence of a special reference to the north-east, but in these circles the main direction is north and south. They are further distinguished from the southern circles by the existence of an oblong stone flanked by two upright stones, which is indeed their principal feature, and which exists nowhere except in the Aberdeen district, where it is almost universal. Mr. Lewis regarded the Aberdeen circles as having more affinity to the "giants' graves" found in the north of Ireland, than to the English circles to which it has always been sought to ally them.—The following papers were also read:—Palæolithic implements from the drift-gravels of the Singrauli Basin, South Mirzapore, by Mr. J. Cockburn.—Stone implements from Perak, by Mr. Abraham Hale.

Entomological Society, March 2.—Dr. D. Sharp, President, in the chair.—Mr. Slater exhibited, with the object of showing the effect of food in causing variation in Lepidoptera, two specimens of *Arctia caja*, one of which was bred from a larva fed on lime-leaves, and the other from a larva fed on low plants, the ordinary pabulum of the species.—Capt. H. J. Elwes exhibited a large number of Lepidoptera-Heterocera, caught by him at Darjeeling, in Sikkim, at an elevation of 7000 feet, on the night of August 4, 1886, between 9 p.m. and 1 a.m. The specimens exhibited represented upwards of 120 species, belonging to Bombyces, Noctuæ, Geometræ, Crambidæ, &c., many of which were believed to be undescribed. Capt. Elwes stated that Mr. A. R. Wallace's observations on the conditions most favourable for collecting moths in the tropics were fully confirmed by his own experience during four months' collecting in Sikkim and the Khasias. The conditions referred to were a dark wet night in the rainy season; a situation commanding a large extent of virgin forest and uncultivated ground; and a whitewashed veranda with powerful lamps in it. He also made some remarks on the Khasia Hills, the southern slopes of which he believed to be the true habitat of the greater part of those insects described many years ago by Prof. Westwood and others as coming from Sylhet. A discussion ensued, in which Mr. McLachan, Dr. Sharp, Mr. Champion, Mr. Kirby, and others took part.—The Rev. W. W. Fowler exhibited a specimen of *Cathormiocerus socius*, taken at Sandown, Isle of Wight.—Mr. S. Stevens exhibited specimens of *Cathormiocerus maritimus* and *Platytarsus hirtus*.—Mr. F. Grut said he was requested by M. Péringuey, of Cape Town, to announce that the latter was engaged on a monograph of the genus *Hipporrhinus*, and that he would be glad to receive specimens and other assistance from British entomologists.—Mr. Gervase F. Mathew, R.N., communicated a paper entitled "Descriptions of new species of Rhopalocera from the Solomon Islands."—Mr. G. T. Baker communicated the following papers: "Description of a new species of the Lepidopterous genus *Carama*, together with a few notes on the genus"; and "Description of a new genus of Rhopalocera allied to *Thecla*."

Institution of Civil Engineers, February 22.—Mr. Edward Woods, President, in the chair.—A paper was read on irrigation in Lower Egypt, by Mr. William Willcocks.

March 1.—Mr. Edward Woods, President, in the chair.—A paper was read on dredging-operations and appliances, by Mr. John James Webster. The author described the objects for which dredging-operations are generally carried out, and spoke of the advantage of obtaining the aid of natural scour, when possible, for supplementing or dispensing with dredging. The various kinds of appliances used were fully described.

March 15.—Mr. Edward Woods, President, in the chair.—A paper was read on the treatment of gun-steel, by Colonel Eardly Maitland, R.A.

PARIS

Academy of Sciences, March 14.—M. Janssen, President, in the chair.—Reply to M. Houzeau's additional note, by M. Lœwy. It is argued that M. Houzeau's mistake lies in the arrangement proposed by him in 1871, which is practically that of a sextant with fixed opening. The principle of the sextant is based on the combination of two mirrors, which in virtue of known optical conditions must give it an undoubted superiority over M. Houzeau's apparatus, which is provided with only one mirror.—On a problem relating to the theory of minima surfaces, by M. Gaston Darboux. To the different solutions of the problem given in vol. cii. of the *Comptes rendus* (1886), is here added another which rests on a new genesis of minima surfaces proposed in an important memoir by M. Ribaucour.—On the great movements of the atmosphere, and on M. Colladon's note of March 7, by M. H. Faye. The paper deals with M. Colladon's suggestion, based on M. Weyher's recent experiments, that rotatory movements with vertical axis may have both an ascending and a descending direction, thus presenting a middle term between the extreme views of M. Faye and his opponents.—On the artificial production of the ruby, by M. Fremy. Some remarks are presented on the two processes elaborated by MM. Fremy and Feil, in connexion with the recent death of M. Feil. A third method is referred to which has since been brought to great perfection with the co-operation of M. Verneuil. A paper followed, by MM. Fremy and Verneuil, on the action of the fluorides on alumina in connexion with the same subject.—The small *Ursus spelæus* of Gargas, by M. Albert Gaudry. A description is given of this species of cave-bear, a skeleton of which, made up with the bones of several individuals, has just been mounted in the new room for palæontological specimens in the Natural History Museum.—Details collected from various sources on the earthquake of February 23, by M. F. Fouqué. An account is given of the vibrations recorded at the Observatories of Lisbon, Wilhelmshafen, and Seville; the general conclusion being that the magnetic disturbances were not the cause, but rather the effect, of the shocks.—Report on MM. Guyou and Simart's memoir on the development of naval geometry as applied to the question of the stability of vessels, by the Commissioners, MM. Phillips, Lévy, Sarrau, and de Jonquières. The report speaks favourably of MM. Guyou and Simart's studies, which greatly reduce the elaborate calculations hitherto required to be worked out in determining questions of stability from the theoretical and practical stand-points.—Experiments on the effects of the transfusion of blood into the heads of decapitated animals (second note), by MM. G. Hayem and G. Barrier. The experiments show that the time is limited to about ten seconds, during which it is possible by transfusion of arterial blood to momentarily revive the action of the sensor and motor cortical centres.—On a correlation between earthquakes and the declinations of the moon, by M. H. de Parville. A systematic study of lunar and terrestial phenomena continued for a quarter of a century leads the author to infer a distinct relation between lunar declination and earthquakes, the general law being that the disturbances occur either at the equilune, the lunistice, or exactly when the sun and moon have the same declination.—On the variations in the absorption-spectra of didymium, by M. Henri Becquerel. Fresh experiments here described confirm the previous conclusion of the author regarding the presence of foreign substances in didymium, as revealed by its absorption-spectra. Some of these bodies may possibly be diverse combinations of the same with another substance or with itself, such combinations being so stable that it has hitherto been impossible to transform one into the other. —On the specific heat of a salt-solution, by M. P. Duhem. The method employed by the author to find the expression of the heat of solution is here shown to lead also to the expression of the specific heat of a salt-solution.—On a standard pile, by M. Gouy. The author describes a convenient standard of electromotor force, formed with zinc, sulphate of zinc, mercury, and dioxide of mercury.—Researches on the application of rotatory force to the study of certain compounds produced in the solutions of tartaric acid, by M. D. Gernez.—On a general method of forming the manganites from the permanganates, by M. G. Rousseau. The metallic permanganates are transformed to manganates at a temperature ranging from 100° to 150° C., and as the law of decomposition here formulated is applicable to the compounds of the whole series, it is proposed as a general method for obtaining most of the metallic manganates.—On the reticulated structure of the protoplasm of the Infusoria, by M. Fabre-Domergue.

Berlin

Physiological Society, February 25.—Prof. Munk in the chair.—The President communicated two treatises sent, for publication in the Proceedings of the Society, by Prof. Kronecker, of Berne. In the first, Prof. Kronecker had, in conjunction with Fräulein Popoff, examined the formation of serous albumen in the intestinal canal. As reagents they made use of the hearts of frogs and tortoises, void of blood, which were stimulated to contraction only when blood or a solution of serous albumen was poured through them, but under every other albuminous or saline solution remained inactive. Stomachic peptone was incapable of nourishing the heart. When, however, the peptone was kept for some time in the stomach or in an intestinal coil connected with the mesentery, then it acted on the heart in the same way as did serous albumen. Pancreatic peptone was incapable, either of itself or after remaining in the stomach or the intestine, of stimulating the heart to contraction; by exposure for a considerable time to the air, the peptone likewise became nutritious to the heart.—In the second treatise, containing an investigation by Prof. Kronecker and Fräulein Rink, it was demonstrated that in peptone solution two kinds of Bacteria are developed in the presence of air: *Bacillus restituens*, which transformed the peptone into serous albumen, exactly in the same way as did the living mucous membrane of the stomach; and *Bacillus virescens*, which liquefied the alimentary gelatine and imparted a deep blue colouring to all sterilised substrata when exposed to the air. This latter Bacillus operated poisonously on the heart. —Dr. Benda spoke of the function of the cross-striped muscle substance. By anatomical investigation of the muscles of the river crayfish he had arrived at the conviction that it was only the cross striped substance which generated the contraction, while it was in the highest degree probable that the protoplasm discharged the office of mediation between the ends of the motory nerves and the contractile substance.—Prof, Ewald described some comparative experiments performed on three patients to ascertain the amount of nourishment with different commercial peptones, with eggs, and with eggs to which were added pepsine and hydrate of chlorine. The nutritive fluids were supplied *per enema*, and the individually very changeable nitrogenous transpositions were determined by careful analyses of the ingesta and egesta.

Meteorological Society, March 1.—Prof. von Bezold in the chair.—Dr. Kremser communicated the results of an investigation into the variability of atmospheric temperature in Germany. Variability he understood, in accordance with Hann's definition, to be the difference between the mean temperature on two consecutive days. Such variability was found by Dr. Kremser to attain its greatest magnitude in the mountains and in the eastern provinces, and its least range along the coasts of the Baltic and North sea, and on the islands. The maximum was in the Riesengebirge, 4°·3 F., the minimum on the islands of the North Sea, 2°·3. If the monthly means were arranged in chronological sequence for the year, there was presented an annual march of temperature with a chief maximum in December and a secondary in June. The variability of temperature at each of the different hours, 6 a.m., 2 p.m., and 10 p.m., yielded values differing from those of the variability of the daily means of temperature. Yet the yearly march of variability of each of the different hours already specified was similar to the yearly march of variability of the daily means. The greatest change of temperature affecting an individual period of twenty-four hours was observed in Clausen, amounting to 68° F. In Berlin, the greatest change to which the same period was liable was 24°·7; in Munich it was 30°·6. A variability of 18°·0 affecting a period of twenty-four hours might be expected in the course of a year in the east and south, but along the North Sea coast only in a period of three years. As the basis for the above conclusions, Dr. Kremser had made use of the observations of ten years.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

Gairloch: J. H. Dixon (Edinburgh).—Catalogue of Siwalik Vertebrata contained in the Geological Department of the Indian Museum, Calcutta; part 1, Mammalia; part 2, Aves, Reptilia, and Pisces: R. Lydekker (Calcutta). —Catalogue of Pleistocene and Prehistoric Vertebrata contained in the Geological Department of the Indian Museum, Calcutta: R. Lydekker (Calcutta).—Memoirs of the Geological Survey of India. Palæontologia Indica, ser. xiii. Salt Range Fossils: W. Waagen; ser. xii. The Fossil Flora of the Gondwana System, vol. iv. part 2, The Fossil Flora of some of the Coal-Fields in Western Bengal: O. Feistmantel (Trübner).—*Challenger* Reports, vol. xviii., 3 parts.—Science of Thought: F. Max Müller (Longmans).—Le Commozioni Telluriche il Terremoto del 23 Febbraio, 1887 (Roux, Torino). —On Over-work and Premature Mental Decay, 4th edition: C. H. F. Routh (Baillière, Tindall, and Cox).—Geological History of Lake Lahontan: J. C. Russell (Washington)—Transactions of the Academy of Science of St. Louis, vol. iv. No. 4 (St. Louis).—Proceedings of the American Philosophical Society, vol. xxiii. No. 124 (Philadelphia).—Essentials of Histology, 2nd edition: E. A. Schäfer (Longmans).—Natural History Transactions of Northumberland, Durham, and Newcastle-upon-Tyne, vol. viii. part 2 (Williams and Norgate).—Verhandlungen des deutschen Wissenschaftlichen vereins zu Santiago, 3 Heft (Valparaiso).—A Plea for a Midland University: H. W. Crosskey (Cornish, Birmingham).—Proceedings of the Academy of Natural Sciences of Philadelphia, part 3, October to December 1886 (Philadelphia).—American Naturalist, January (Lippincott).—Annalen der Physik und Chemie, No. 4, 1887; Beiblätter der Physik und Chemie, No. 2, 1887 (Barth, Leipzig).

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