THURSDAY, NOVEMBER 10, 1887.

A CONSPIRACY OF SILENCE.

THE Duke of Argyll is eminent as a statesman, and has won distinction as a man of science. The mental qualities, however, which lead to success in these capacities are widely different; nay, in the opinion of some, are almost oppugnant. To the man of science, truth is as a "pearl of great price," to buy which he is ready to part with everything previously obtained; to the statesman, success is the one thing needful, for the sake of which hardly any sacrifice appears too great. This is not said wholly as a reproach: it "takes all sorts to make a world." The ardour of the follower of the ideal, which may degenerate into recklessness, is wholesomely checked and beneficially qualified by the calmness of one who has to deal practically with mankind, and has learned by experience that evolution rather than catastrophic change is the law of life, and is in accordance with the analogy of Nature. Still the two types of mind are commonly diverse, and the Duke of Argyll has recently afforded a remarkable instance of the extreme difficulty of combining in one person these apparently opposite characters.

This instance is afforded by an article which appeared in the *Nineteenth Century* for September last, and is commented on by Prof. Huxley in the number for the present month. The Duke's article bears the somewhat imposing title of "The Great Lesson." Prof. Huxley's reply forms a part of an article entitled "Science and the Bishops." As the charge which the Duke has in effect brought against men of science is a very grave one, and as some of the readers of NATURE may not be constant readers of the chief monthly magazines, a brief notice of both accusation and reply may not be without interest.

The moral of "The Great Lesson" is, practically, "beware of idolatry." The scientific world, in the Duke's opinion, has been for some time bowing down to the idol of Darwin and the theory of evolution, which is the fundamental dogma of that cult. Like a prophet of old he raises a warning voice, and points out that the feet of the golden image are in part composed of clay. In the North has been hewn the stone which shall shatter those fragile supports and lay the idol prone in the dust! To abandon metaphor, this is the state of the case. Among the results of Mr. Darwin's labours during the voyage of the *Beagle* in the years 1831-36, when he accumulated that vast store of observations which served as a foundation for "the Origin of Species by means of Natural Selection," was a theory of the formation of Coral Reefs and Atolls, set forth in a volume entitled "On the Structure and Distribution of Coral Reefs" (published in 1842 and republished in 1874). Of this theory the Duke gives an outline in "The Great Lesson," executing this portion of his task so fully in the spirit of a just judge, and with so little of the craft of an advocate, as to leave nothing to be desired for lucidity of statement and cogency of reasoning. In fact, in the judge's summing up, the case for the defence appears stronger than that for the prosecution—so much so, indeed, as to suggest that the difference is due to their inherent merits rather than to the mode of statement. However, be that as it may, the Duke thus pronounces judgment, and in so doing passes a censure, stinging if deserved, on the men of science of this generation.

These are his words (*Nineteenth Century*, p. 305):—

"Mr. Murray's new explanation of the structure and origin of coral reefs and islands was communicated to the Royal Society of Edinburgh in 1880, and supported with such a weight of fact and such a close texture of reasoning that no serious reply has ever been attempted. At the same time, the reluctance to admit such an error in the great idol of the scientific world, the necessity of suddenly disbelieving all that had been believed and repeated in every form for upwards of forty years, of cancelling what had been taught to the young of more than a whole generation, has led to a slow and sulky acquiescence, rather than to that joy which every true votary of science ought to feel in the discovery of a new truth, and—not less—in the exposure of a long-accepted error."

Again:—

"The overthrow of Darwin's speculation is only beginning to be known. It has been whispered for some time. The cherished dogma has been dropping very slowly out of sight. Can it be possible that Darwin was wrong? Must we indeed give up all that we have been accepting and teaching for more than a generation? Reluctantly, almost sulkily, and with a grudging silence so far as public discussion is concerned, the ugly possibility has been contemplated as too disagreeable to be much talked about; the evidence old and new has been weighed again and again, and the obviously inclining balance has been looked at askance many times. But, despite all averted looks, I apprehend it has settled to its place for ever, and Darwin's theory of the coral islands must be relegated to the category of the many hypotheses which have indeed helped science for a time, by promoting and provoking further research, but which in themselves have now finally kicked the beam."

This, then, is "The Great Lesson":—

"It is that Darwin's theory is a dream. It is not only unsound, but is in many respects the reverse of the truth. With all his conscientiousness, with all his caution, with all his powers of observation, Darwin in these matters fell into errors as profound as the abysses of the Pacific."

This is plain speaking. In words which admit of no ambiguity the Duke declares that Darwin was wrong; that Mr. Murray set him right; and that the latter, instead of receiving a welcome, was met with a virtual conspiracy of silence on the part of scientific men. Of these three assertions—which are to a considerable extent independent one of another—the first and second are obviously very much matters of opinion, because, if the third statement be true, it is clear that no verdict has been delivered by experts, but that, like an Irish jury, they have professed themselves unable to agree, because the facts were so strong that even they could not bring in a verdict of acquittal. The third assertion, however, is much more a matter of fact, not difficult to substantiate, and at any rate, if incorrect, easy to disprove.

In regard, then, to the first and second it may suffice to follow Prof. Huxley's example and be content with expressing a doubt as to the accuracy of the Duke's assertions. In the face of statements so definite as those quoted above, this may seem presumptuous. They read almost like the sentence of an ecclesiastical court, which it is heresy to question. *Caledonia locuta est, causa finita est*, seems to be their tone; and if one whisper a doubt, one expects the familiar conclusion, *Anathema sit!* But men of science, as all the world knows, are sceptics. Have they yet awakened and rubbed their eyes, and said of Darwin's theory "Lo! it was a dream"? What says Prof. Huxley? He asserts that Darwin's confidence in the accuracy of his own theory was not seriously shaken, as the Duke alleges, and quotes as conclusive evidence a letter from Prof. Judd, who gives the results of a conversation which he had with Darwin no long time before the death of the latter. Prof. Huxley also intimates that to himself—though tolerably familiar with coral reefs—the new theory is at first sight so far from fascinating that, until he can devote a considerable time to a re-examination of the whole subject, he must be content to remain "in a condition of suspended judgment," and that Prof. Dana, "an authority of the first rank on such subjects," has pronounced against the new hypothesis in explicit terms. Undoubtedly, Mr. Murray has obtained distinguished converts, but with such differences of opinion among those best qualified to judge, it is certainly going further than is warranted by facts to insinuate if not to assert that he has convinced the scientific public. Very probably more than a minority of them are in my own position, which perhaps I may be pardoned for stating. They, like myself, have never had the opportunity of forming an independent judgment upon the matter, but they see some very serious difficulties—difficulties which are of a general rather than of a special nature—in the new explanation. At present these difficulties do not appear to them to have been overcome; so that, while admitting that Mr. Murray's hypothesis may sometimes apply, and that Darwin either may have expressed himself a little too sweepingly, or may have been understood so to do, the theory of the latter is capable of a more general application, and presents less serious general difficulties, than does that of Mr. Murray.

We come, then, to the third charge, which is the most serious one, because it affects the morality of scientific men; and many of them, like myself, are old-fashioned enough to resent being called a knave more than being called a fool. Has Mr. Murray been met by "a conspiracy of silence"? The Duke, in asserting this, must have been strangely oblivious of, or, among the cares of a statesman, have failed to keep himself *au courant* with, the literature of geology. Prof. Huxley denies the assertion, and adduces in his support an answer to an inquiry which he had addressed to Prof. Judd. The facts, according to these authorities, are briefly as follows:—Mr. Murray's views were duly published, as the Duke himself states; they were favourably regarded by the authorities at the *Challenger* Office; they were expounded, one might almost say advocated, on more than one occasion (*e.g.* in this very journal) by Dr. A. Geikie. His text-book in the year 1882 not only took the leading place, as it still does, but also was then the only complete text-book on a large scale for this country. On p. 468 is a full statement of Mr. Murray's views. They have also been referred to at more or less length in many treatises and journals, both English and foreign. As Prof. Judd remarks, "If this be a 'conspiracy of silence,' where, alas! can the geological speculator seek for fame?"

Thus the main charge is disproved. One special item in it, however, as peculiarly offensive, yet calls for a brief notice. The Duke states: "Mr. John Murray was strongly advised against the publication of his views in derogation of Darwin's long-accepted theory of the coral islands, and was actually induced to delay for two years." Now, if these words do not amount to an imputation of bad faith on the part of Mr. Murray's adviser, and are not by insinuation extended to others, I do not know what they mean, or why they have been penned. But, as Prof. Huxley observes, "whether such advice were wise or foolish, just or immoral, depends entirely on the motive of the person who gave it." The remark is perfectly just. Who, I would ask, who is old enough to look back on a quarter of a century of work, has not occasionally said, "Wait a bit," to some younger friend, who has come in the first incandescence of a brilliant hypothesis? I have so sinned. Sometimes I have been wrong and my young friend right, but not always. Still, I know myself fallible. As the late Master of Trinity said, "We are all fallible mortals, even the youngest amongst us." Yet I am not ashamed. I will not put on sackcloth and ashes, and I mean to sin again. Perhaps it is because I am naturally unimaginative; perhaps I am come to the season of autumn leaves; but I have always looked askance at a brilliant hypothesis, and now distrust it more than ever. I have lived long enough to see many a one go up *whoosh!* like a sky-rocket, all stars and sparks, and come down exploded, all stick and stink!

So the "great lesson" has been read, and the scientific world, I fear, has not repented or rent its clothes. But it has heard, and not without indignation. The Duke of Argyll has made grave charges against the honour and good faith of men of science, and they ought to be grateful to Prof. Huxley for his prompt repulse of the attack and his stern rebuke of the assailant. As it seems to me, reply is only possible on one point—namely, the special charge mentioned above. Hence the Duke of Argyll is bound to establish or to withdraw the accusation.

Men of science are justly sensitive on this question. Doubtless they are no more exempt from human frailty than any other class of men: we all fail sometimes—nay, too often—to live up to our ideal standard; still, such shortcomings are not common, and anything like a "conspiracy of silence" or any kind of scientific "boycotting" is a thing so improbable as to be almost incredible. Each man must testify according to his own experience; so in conclusion, though it may be deemed impertinent, I will express my own. I have lived now for not a few years among the rank and file of scientific men on more intimate terms than can have been possible for the Duke of Argyll, owing to his exalted station and his high occupations of State, and I am bound to declare that, in a fairly wide experience, I have never found men as a class less self-seeking or more earnest in their desire for truth, more steadfast as friends, or more generous as antagonists.

T. G. BONNEY.

A TEXT-BOOK OF ALGEBRA.

A Text-book of Algebra. By W. Steadman Aldis, M.A (Oxford: Clarendon Press, 1887.)

THIS work is, as we are told in the preface, "the outcome of lectures delivered in the College of Physical Science at Newcastle-upon-Tyne." It discusses, more fully than is usual in books on algebra, the fundamental principles of the science, and its aim is to be of service to the independent student who has not the advantage of "access to large libraries, or intercourse with other mathematical scholars." The object of the author, as might be expected from his eminence as a mathematician and his experience as a teacher, is, in our judgment, likely to be successfully attained in the use of his work. The book is hardly adapted for those students whose object it is to attain such skill and facility in algebraical work as is necessary to face an examination paper in algebra, set by the University examiner of the present day. The examples, though sufficient for illustrating the principles, are not numerous enough for the purpose of developing such skill, nor selected with that special object; and such aids to the attainment of exactness as the various tentative methods of finding the factors of algebraical expressions of different forms, and other aids to insight into their constitution, are only incidentally alluded to. Still, even this class of students will find it a book worthy of reference, when they are revising the fundamental principles on which the science is based, and realizing that all its operations are reducible to a few fundamental laws.

The book is divided into four sections, treating respectively of the fundamental laws and the algebraical operations founded thereon, of equations, of series, and of arithmetical applications.

In the first chapter, headed "Arithmetical Notions," the arithmetical basis of algebra is laid down in a careful discussion of the laws of the simple operations of arithmetic; the commutative laws of addition and multiplication, and the distributive and associative laws of multiplication, being shown to result, both for integral and fractional numbers, from our fundamental conceptions of number. In this chapter particular numbers only are used, and the expression of the results by the use of letters denoting any numbers whatever is relegated to the following chapter on "Algebraical Notation." This would seem to indicate that Prof. Aldis agrees with a commonly accepted notion, that algebra begins with the introduction of letters to denote unspecified numbers. We hold, on the contrary, that, in arithmetic, letters may, and ought to, be freely used to express the unknown quantities of a question, or to sum up in general terms properties of numbers or rules which have been established for solving particular problems; and that only when a result has been obtained by means of organized algebraical operations, instead of by ordinary reasoning, has algebra, properly so called, been employed.

In the second chapter the general results of the first are summed up in a series of formulæ, numbered (1) to (21), to which are afterwards added others, numbered (22) to (25), expressing the laws of indices. The extension of the use of the signs + and − to indicate opposite affections of the quantities denoted by the letters to which they are prefixed is carefully explained; and it is shown by the illustration of "steps" that still wider interpretations may be given to the symbols and formulæ. Upon this foundation the subsequent chapters dealing with the elementary operations on algebraical expressions are based, explicit reference being made to one or other of the formulæ by its number to justify each step in the establishment of the various processes. This method of procedure is sound and logical in itself, yet we fear that the effect of referring to so many apparently independent formulæ must be confusing to the student, and likely to give him incorrect ideas as to the number of independent laws to which all algebraical operations are reducible. This might have been avoided by a preliminary discussion of the formulæ, showing that with the understanding that the letters may denote either positive or negative quantities they are reducible to some five or six fundamental laws, to which, rather than to the particular exemplifications of the laws in these formulæ, it would have been better in the sequel to refer. Thus the formulæ numbered (1), (2), (3) are all included in the commutative law of addition or aggregation—that in an aggregate of positive and negative terms the order of aggregation is indifferent: so, too, (3), (4), (5), (6) are summed up in the "Rule of Signs"—that the addition of a positive aggregate of terms is equivalent to the addition of each term with its actual sign, and that of a negative aggregate is equivalent to the addition of each term with its sign reversed, and similarly for other groups of the formulæ.

The discussion of the highest common factor, lowest common multiple, and fractions, is followed by a chapter on fractional and negative indices, at the outset of which the question of incommensurables is discussed, and it is shown by apt illustrations that the literal symbols of algebra may represent incommensurable as well as commensurable quantities, since the same laws hold good for the former as have been established for the latter. We should have expected that, as a natural sequel to this chapter, logarithms and their properties and uses would have been discussed, but we find no mention even of the word till we come, much later on in the book, to the Exponential Series. There is no logical necessity for postponing the discussion of the nature and properties of logarithms till we can show how their values can be practically calculated, while the enormous practical importance of an acquaintance with their theory and use is a good reason for its introduction at the earliest possible stage.

A chapter on surds and impossible quantities concludes the first section. In this it is shown that the impossible quantity of ordinary algebra is only relatively impossible, since it becomes interpretable as an "operational quantity" when the letter to which it is attached is taken to denote a length in a definite direction—a view which is further illustrated by the discussion of the cube roots of unity as "operational quantities." This, though not a full account of the matter, is satisfactory so far as it extends, and sufficient for the student at this stage.

The specially distinctive features of Prof. Aldis's work are contained in this first section. We trust we have made it plain that we think it well worthy of the study of the student who desires to attain a clear, logical view of the foundations of algebraical science. The remaining sections demand less comment as presenting less novelty of treatment.

The most noticeable feature in the section on equations is the introduction of the notation, and a discussion of some of the properties, of determinants. We cannot but regret the space that is devoted in this section to the discussion of the processes for the extraction of square and cube roots in the old traditional shape. In the chapter on division the law of formation of the quotient and remainder of a rational integral function of x after division by $x-a$ has been established. Starting from this, a discussion involving nothing more than elementary considerations would lead up to Horner's process in all its generality, which might then be exemplified in the extraction, not only of square and cube roots, but of roots of any degree, both for algebraical expressions and for numbers. How long shall we have to wait for a due recognition in elementary treatises of this comprehensive method, which, whether from a theoretical or from a practical point of view, is one of the most valuable results of a study of algebra?

The section on series commences with the establishment of the usual formulæ for permutations and combinations, as preliminary to the binomial theorem. We observe with satisfaction that the path to the proof of each general formula is smoothed by the prior discussion of a particular case, by which, as every good teacher knows, the principle involved may be more distinctly brought out than in the general proof, where it is too likely to be lost sight of in the generality of the symbols employed. To the chapter on geometrical progression is attached, as we think it always should be, one of its most important applications—namely, that to compound interest and annuities. The chapters on the binomial theorem and other series usually discussed in elementary algebra are clear and satisfactory, though we think a little more prominence should have been given to the distinction of *convergent* and *divergent* series, and a fuller discussion of the tests of convergency and divergency.

The last section includes under the general heading of "Arithmetical Applications," chapters on proportion, continued fractions, indeterminate equations (limited to those of the first degree), inequalities, notation and numbers, and probabilities. It is not intended, we presume, that the study of some at least of these should be postponed till after the study of the previous sections, but that as *Applications* they do not form a necessary part of the general sequence of algebraical results, though it appears to us rather strange that a place for proportion, at any rate, should not have been found in such sequence.

R. B. H.

PRACTICAL BOTANY.

Practical Botany. By F. O. Bower and Sydney H. Vines. Part II. (London: Macmillan and Co., 1887.)

ABOUT twelve or fourteen years ago there occurred in England two events which have had so marked an influence on the development of scientific botany in this country that they are likely never to be lost sight of by our younger school of morphologists and physiologists. One of these events was the introduction into this country of the teaching of Prof. Sachs, of Würzburg; the second and even more important one was the institution by Mr. Thiselton Dyer of a course of botanical instruction at South Kensington on a scale never before attempted. Those who had the good fortune to attend Mr. Dyer's courses of practical botany in the well-known laboratory at what is now the Normal School of Science must always carry with them the stimulating remembrance of the thorough teaching there instituted; and the effect of the exact instruction and inspiriting demonstration so efficient at South Kensington can be obviously traced in the excellent teaching and work of the enthusiastic younger botanists of to-day. The influence took effect on the early development of the present productive botanical laboratories at Cambridge and elsewhere, and the stimulus has since radiated thence in all directions, as is shown not only by the numerous publications of the last eight or ten years, but also by contributions to the new journal, *The Annals of Botany*, just published by the Oxford Clarendon Press, and by the activity and discussions of the botanists at the recent brilliant meeting of the British Association in Manchester.

The salient features of the new course of structural botany were the thorough study of leading types of the vegetable kingdom by means of material dissected and prepared by the students themselves, and the stress laid on the rule that the students should carefully draw what they saw, and thus gather their ideas at first hand. The method was similar to that employed by Prof. Huxley in his course on animal morphology.

It is evident that the little hand-book of practical botany now under review is the outcome of experience gained in continuing this important method of instruction. Part I. of the present work was published two years ago, and dealt with selected types of the Vascular plants. Part II. is now before us, and completes the scheme. It comprises studies of the chief types of lower Cryptogams, from the moss downwards.

We have already pointed out that the essential features of the new teaching are the exact and thorough study of types. Nothing is assumed; but the students are urged to see everything for themselves, and to draw all they see. These important points decide the plan of the work under review. It will be found an excellent and trustworthy guide to any who use it with the types at hand: it will be all but useless to the mere crammer, for there are no illustrations to take the place of actual objects in producing impressions on the student's mind; no lengthy descriptions to interfere with the directness or clearness of the impressions; and no classified "tips" to vitiate and confuse the teaching. We regard it as an excellent sign of the progress of botany in this country that an English work of this description should be forthcoming, and students are greatly indebted to Dr. Vines and Dr. Bower, and those who have contributed to this admirable little monument of practical teaching.

As special features in the book we may commend the selection of types; they are good, for the most part easily obtained, and well known. The treatment of the types in the book is clear, concise, and yet sufficient. The usage of bolder lettering for the chief word in the paragraph is an admirable device for fixing the student's attention on one thing at a time, and is aided by the numbering and lettering of the paragraphs. The division into sections dealing with groups of characters, leading the student on from the more obvious features to those less easily investigated, also stamps the work as that of experienced teachers, and is eminently English.

The only part of the plan to which objection is likely to be raised by teachers is what may perhaps be termed the reversal of the order of the types. We are ourselves inclined to the opinion that it would have been better to begin with the more lowly organized types, and work upwards to those in which the anatomy and histology become more complex. There is much to be said in favour of the method adopted, but we think that the following two objections to it alone outweigh all we have heard in its favour.

(1) The types are obviously selected as illustrating the chief structural peculiarities of plants, and it might be better to at least indicate the relations of these structures in an order more in accordance with their probable development in the vegetable kingdom.

(2) The plan of teaching which marks the book is the educational one, *i.e.* the observer is led on from simple to less simple ideas. This is only carried out consistently, however, within the individual sections of the book: why should it not be followed throughout the work?

Of course the objection may be anticipated that the sections really lead the student on from the macroscopic to the microscopic characters, and that Algæ and Fungi, for instance, are less easy to investigate, and therefore come last, because they involve the use of the higher powers of the microscope so much. We do not admit that this latter is a difficulty, however, and in reply would simply propose for psychological study the mental attitude of a tyro struggling with his first transverse section of a sunflower-stem. The cutting, preparation, mounting, and finally the involved pattern of cell-walls which he has to unravel, at once plunge him into difficulties at least as great as those met with on the threshold of the study of the Algæ. Moreover, there is evidence in the work that the student is supposed to be acquainted with the use of the microscope, such as would be obtained from a proper course of elementary biology.

Of course, however, it is always open to a teacher to reverse the order of the types in the book; and it only remains for us to say a few words regarding some of those employed in the second volume. *Polytrichum* is selected as the chief type of the mosses, and we think Dr. Bower has done well to illustrate the details of structure by this complex form, surmounting the difficulty presented by its peculiar sporogonium by a comparative study of that of *Funaria*—itself an excellent type. We are glad to see *Marchantia* treated in detail. It is, of course, an out-of-the-way form, and is peculiar even in its own group, but it is an instructive plant, and one that has earned a reputation from the physiological lessons it teaches us. *Polysiphonia* serves as the chief type of the red seaweeds, and although it has many peculiarities, it has the advantage of being common: the structures of several other Florideæ are shortly compared with that of *Polysiphonia*. *Fucus serratus* forms an excellent type for the study of the brown sea-weeds, and as it is easily obtained, it should be employed in every laboratory course: the details of the actual process of fertilization still offer an interesting problem to any intelligent student, but the chief stages in the process are not difficult to observe.

Passing to the green Algæ, *Œdogonium* seems to us a type well worth thorough study in the laboratory; it is by no means uncommon, and an effort should be made to introduce a definite species of the larger forms as a type. Short studies of *Coleochæte* and of *Ulothrix* are also given. *Vaucheria sessilis* is offered as an example of the Siphoneæ, and we are glad to see it brought well into the foreground; this again is a plant of increasing importance as an instructive plant. Most of the details of the process of fertilization in this Alga offer less difficulties than is commonly supposed, and students should be encouraged to spend some time on their study. A short *résumé* of the main points is given. No doubt the presence of *Protococcus* or *Hæmatococcus* in schedules of elementary biology explains its omission from the present work: *Pleurococcus* and *Volvox* are given, however, and they illustrate several points of importance. In spite of—or perhaps on account of—its very marked peculiarities, we look upon *Spirogyra* as one of the most instructive types that the student can examine, and Dr. Bower has done well to give it a prominent position. It deserves more attention, however, and we would strongly urge an exhaustive treatment of its life-history, germination, and some of the physiological lessons it teaches.

Passing over less important forms, we may now say a few words respecting the Fungi given as types for study. The first section is devoted to *Agaricus*, and a capital study of the structure and histology of the common mushroom is given. Then follows an equally good account of the Æcidiomycetes. Of Ascomycetes, we have *Peziza*, *Parmelia*, *Claviceps*, and *Eurotium*, as types of the chief great groups. A word as to *Peziza*. It is an excellent type, and certain forms can be cultivated, and we hope that in a second edition the author will see his way to introducing a fuller account of some one species. At the same time we are not sure that *Ascobolus* is not a better form for the present purpose: it can be easily cultivated, and its small size is an advantage, since perfect sections can be obtained across the whole plant. Another excellent type is also introduced in the study of the Peronosporeæ. English students are only now becoming aware of the theoretical importance of this group, and we are very glad to see Dr. Bower's section on *Pythium de Baryanum*: it cannot be too well understood that *Pythium* is one of the few parasitic Fungi which may be easily cultivated and followed through all its phases of development in the laboratory. For our own part, we regard it as the best of all Fungi for study, and its life-history and simple structure ought to be thoroughly investigated in every botanical course. It has the additional advantage of being also a saprophyte, and can be cultivated on dead organisms. The Mucorineæ are exemplified by *Mucor* and *Sporodinia*. No type of the Ustilagineæ is given.

Enough has been said to show that the volume pretends to no more than it can fairly claim, and we regard it with confidence as a praiseworthy and successful attempt to record for the benefit of a wide class of students the methods of teaching so well introduced and so thoroughly carried out in the laboratory at South Kensington, the birth-place of the modern English school of morphological botany. It now remains for one of our competent younger botanists to prepare a course of practical instruction in the physiology of plants, introducing the experiments employed in our best laboratories; and there are signs that such a volume will meet with a hearty welcome from students of botany in this country. The importance of the subject needs no comment.

OUR BOOK SHELF.

A Chapter in the History of Meteorites. By the late Walter Flight, D.Sc., F.R.S. (London: Dulau and Co., 1887.)

THIS work, though left incomplete by the early death of its author, will be found of great service by all who are interested in meteoric studies. The first 144 pages were printed off twelve years ago, and were thus safely beyond revision. The rest of the work has been revised, and the whole has been prepared for press, by editors who, perhaps wisely, have chosen to be anonymous: their part of the task we may dismiss with the remark that it appears to have been executed with at least ordinary care. The task of the author has been to give a brief summary of the memoirs which have been published relative to meteorites since the year 1868, and thus to furnish an appendix to the work of Buchner. To collectors of meteorites such a convenient summary of memoirs, themselves scattered over a wide range of periodicals, chiefly foreign, is invaluable. There are seven plates and six woodcuts: the frontispiece is an excellent engraving of Chladni, who did so much to compel men of science to recognize the reality of meteoric falls. There is also a hand-painted picture of the wonderful meteorite of Busti, in which two minerals new to terrestrial mineralogy were discovered by Maskelyne. In an introduction there is a short sketch of the life and work of the author. Only 240 copies have been printed; the proceeds of their sale are to be added to the Flight Memorial Fund, which at present amounts to £317.

A Hand-book for Steam Users. By M. Powis Bale, M.I.M.E., A.M.I.C.E. (London: Longmans, 1887.)

MR. BALE'S little hand-book supplies a want long felt by steam users. Its contents are entirely of a practical nature, and the technical terms used are very properly those of the ordinary mechanic. The book embraces the whole of the many duties of the engine-driver and fireman, and explains to them what to do, and what not to do, under varying circumstances. The arrangement of the information is simple and effective, the writer evidently knowing how to get at the understanding of those for whom the book is written.

The information and rules given are eminently practical, and will prove very useful to those steam users who do not pretend to be engineers. In the preface we are told that the author has for many years urged the necessity of a compulsory system of boiler inspection, and of granting certificates of competency to those having boilers under their charge. In this we entirely agree, and we trust the time is not far distant when Parliament will establish a system of examination similar to that of marine engineers, under the control of the Board of Trade for all who have charge of stationary boilers and engines, as well as locomotives. Michael Reynolds, the author of several books on the practical working of steam-engines, has long advocated the introduction of certificates of competency for locomotive drivers and firemen. Their duties are as arduous and responsible as those of the marine engineer, and yet this fine class of men is entirely recruited from the lower grades employed in the locomotive running sheds and works, and their promotion generally depends on years of service on the footplate.

Students of steam and mechanical engineering will here find information which, although not generally taught in the lecture-rooms, will indicate some of the many points an ordinary engine-driver has to be thoroughly acquainted with. N. J. L.

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

THE special characteristic of this work is that the compilers have tried to make it combine some of the advantages of an encyclopædia with all the advantages of a dictionary. The result, upon the whole, is very satisfactory. The information given in the encyclopædic part of the work is not, of course, sufficient for students; but it will meet the wants of readers who may wish to obtain a concise and trustworthy account of any subject in which they happen to be interested. Special attention is devoted to the various branches of science, and scientific terms are very carefully defined and explained. So far as we have been able to test the volume of which this is the second part, we have found it in all respects equal to the preceding volumes.

A Treatise on the Principle of Sufficient Reason: a Psychological Theory of Reasoning, showing the Relativity of Thought to the Thinker, of Recognition to Cognition, the Identity of Presentation and Representation, of Perception and Apperception. By Mrs. P. F. Fitzgerald. (London: Thomas Laurie, 1887.)

THIS is neither a treatise nor has it anything particularly to do with the principle of the sufficient reason, or with the philosophical views mentioned in the second title. It is rather a kaleidoscope of phrases, original and otherwise, that have apparently from time to time touched the author's fancy, and are now vaguely but gratefully remembered to have once possessed a meaning for her. Quotations from Ouida, Plato, Lord Dundreary, and other philosophical authorities, are tossed together impartially, without apparent purpose except to fill 400 pages; and though some reference is made occasionally to opinions said to be held by the author, such reference is nearly always too vague to show what the opinions really are. Only the hard-hearted can find even amusement in the book.

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.*]

"Infusorial Earth."

THE following letter, addressed to the Secretary of the Royal Society, has been forwarded to us for publication:—

Foreign Office, October 27, 1887.

SIR,—I am directed by the Marquess of Salisbury to state to you, for the information of the President and Fellows of the

Royal Society, that Her Majesty's Consul-General at Christiania has reported that a considerable number of pits of "infusorial earth" containing 85 to 95 per cent. of silica are said to have been discovered in the neigbourhood of Stavanger.

Capital is being sought for the purpose of working the deposits, which are estimated to be capable of yielding 400,000 cubic metres of that rare product. It is affirmed that whilst the similar deposits at Lüneburg, in Hanover, are mixed with sand and gravel, those now discovered are so pure in quality as to be available for most purposes merely after desiccation.

As this discovery may possibly have a scientific interest as well as a commercial value, I am directed to convey the above information to the Royal Society.

I am, Sir, your most obedient humble servant,

T. V. LISTER.

The Secretary, Royal Society, Burlington House.

The Electrical Condition of the Peak of Teneriffe.

THE limited number of observations on atmospheric electricity which have been already made all point, with one exception, to a normal positive difference of potential between a point some few feet above the earth and the ground itself. The only notable exception to this law was found in some observations which were made on the Peak of Teneriffe about thirty years ago. Then it appeared that the condition of the Peak was constantly resinous or negative. These observations were, however, taken with a gold-leaf electrometer, and some doubt has been expressed as to whether the sign of the electricity was correctly obtained.

I therefore thought, when taking a short trip to Teneriffe, that it would be useful to examine this question by means of the improved electrical instruments now available.

Through the courtesy of the Meteorological Office I obtained the loan of a Thomson's portable electrometer, and, through the kindness of Mr. Whipple, received at Kew all necessary instruction in the use of the instrument, and special caution as to the possible difficulty of getting a good "earth" on sun-burnt lava. Any success the observations may have had is entirely due to his care and forethought.

I was only able to stay about a fortnight on the island, but the results obtained were so uniform that there can be no doubt as to their accuracy.

The height of the electrometer fuse was always about 5 feet 6 inches above the ground. At the Port of Orotava, at the base of the Peak, and about 50 feet above sea-level, the mean of eight sets of observations—each set usually consisting of six determinations—gave a potential of 138 volts. The highest was 193, and the lowest 98 volts. These, and all I obtained in Teneriffe, were uniformly positive.

One day I took a skirmishing expedition to the rock of Gayga, a portion of the rim of the old crater, 7100 feet above the sea. On the way up, while on the pretty uniform slope of the mountain, at 3800 feet, the potential was only + 99 volts, while on the rock itself, tension rose to 257 volts. The rock is a long sharp, narrow edge, perhaps half a mile long, with a precipitous cliff of 500 feet on one side. The rock was composed of dry lava, and I thought a little damp, but still the earth observations were not quite so accordant as usual.

A few days later, therefore, when starting for the top of the Peak, I took, as suggested by Mr. Whipple, an ordinary 66-foot iron surveyor's chain to be laid along the ground and connected with the instrument. The readings at different heights, on the way up, were as follows:—

At 5600 feet, on the slope of the mountain, 111 volts.

On the Cañadas, or rough flattish ground that forms the bottom of the old crater, at 5800 feet, 139 volts. The ground here was pumice and pumice dust, so I tried running out the chain to see if the earth-readings would be altered. There was not however the slightest change, and to show the character of the observations five out of the six earth-readings gave the same number.

At the *Estancia de los Ingleses*, 10,500 feet, situated on the slope of the main peak, the potential fell to 118 volts. The sun was setting, and dew falling so fast that the top of the electrometer box was covered with wet. There could be no doubt then of obtaining a good earth.

On the top of the Peak, 12,200 feet, the potential actually rose to no less than 549 volts. This was at 8 o'clock in the morning of October 24. The wind was blowing at the rate of about 10 miles an hour from the north-east, while the dry and wet bulb thermometers marked 31° and 26° respectively. There was a little white frost on the ground, and the earth-readings, without the chain, were remarkably uniform, only differing by the 11-100th of a turn of the screw.

The results of all the observations points unmistakably to the conclusion that during this month of October *the electrical condition of the Peak of Teneriffe were the same as in every other part of the world. The potential was moderately positive at the same distance from the ground even at considerable altitudes, but the tension rose enormously round a sharp point, and a projecting edge of rock.*

It is well known that there are very few thunderstorms in Teneriffe, though one passed near us at Orotava without affecting the indications of the electrometer. Would it not be interesting to measure the potential on the summit of a mountain like Kina Balu in Borneo, which is about the same height as the Peak of Teneriffe, but situated in the heart of the equatorial zone of the constant electrical discharge?

We had one day of very heavy rain, when possibly some negative indications might have been obtained; but I did not think it expedient to let the instrument get drenched.

But, besides obtaining these decisive electrical results, I was also very fortunate in some other observations during the short stay in Teneriffe.

We saw from the *Estancia* the shadow of the Peak at sunset gradually creep along the land and surrounding sea, and then stand up in the air like another peak rising above the horizon. This is what is so often seen from Adam's Peak in Ceylon, and from Pike's Peak in Colorado.

Then our observations confirmed not only the important discovery made by P. Smyth, that cloud is not formed at the junction of a south-west current flowing over a north-east trade, but the even more important fact that there is no such thing as the supposed simple return current from the equator. At Teneriffe, as in every other part of the world I have ever visited, the general circulation of the air is on a complicated screw system, the practical effect of which is that as you ascend, the wind always comes more and more from your left hand as you stand with your back to the wind. You do not come abruptly to a south-west wind over a north-east trade, but pass successively as you rise from the surface from north-east through south to south-west, and then probably to west, or even north-west.

I also made some very important observations on the local formation of halo-forming sky, and got an excellent photograph of the genesis of a cirrus cloud from a moist current rising over the Peak, but space will not allow me to explain the results in this place. RALPH ABERCROMBY.

21 Chapel Street, London, November 7.

"Toeing" and "Heeling" at Golf.

I FEAR that "P. G. T.'s" reply to my letter on the above subject has left us very much in the same position as before. This is regrettable, as I hoped that further light would have been shed on this interesting mechanical problem. Before complying with the invitation to "think over the result of the impulsive rotation of the club-head," I considered it would be well to get some trustworthy observations on which to reason. With this object our professional, Mr. David Lowe, made twenty-seven tee shots with the driver, while I noted the effect. My instructions to him were, whether striking off the toe or the heel, to drive as truly as he could in the direction of an object selected for that purpose. The effects were as follows:—When the ball went off the heel of the club, the ball in its flight curved to the right, even though its direction commenced obliquely to the left; to this there was no exception. The opposite curve, or to the left, with only one exception, was produced by hitting off the toe. Care was taken to ascertain in each case the point of impact of the ball on the club-face.

I now instructed him to try and curve the ball to the left, striking with the heel of the club, or to "toe it off the heel," in "P. G. T.'s" words. This feat he was unable to perform, and he gave it as his opinion that it could not be done.

Now for my explanation of "toeing" and "heeling" in reply to the invitation of "P. G. T."

Everyone who has played golf is aware that the ball when cleanly struck leaves a round mark upon the face of a new club of about five-eighths of an inch in diameter. This is the measure of the elastic distortion that takes place in the ball by the impact. The ball is *flattened* against the club-face, and is for the time prevented from revolving. To assist the grip of the club on the ball, lines are scored over the surface of the ball. Now consider the effect of the rotation of the club-head round the centre of percussion when the ball goes off the heel or the toe.

The following diagrams of a "toed" ball will best explain my meaning—

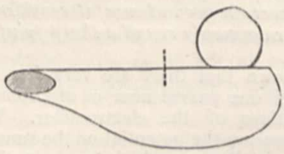
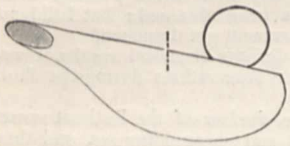


Fig. 1.



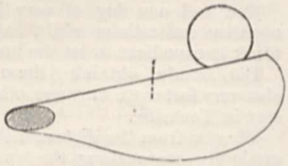


Fig. 2. Fig. 3.

Fig. 1 shows the club-head and ball on first meeting.
Fig. 2 shows the backward revolution of the club-head due to the impact of the ball on the "toe" of the club.
Fig. 3 shows the club-head on the recovery before the ball leaves the club-face.

It is quite evident that during the movement from the position shown in Fig. 2 to that in Fig. 3 the ball, though adherent to the club-face, is revolving to the left on its own axis at the same rate as the club-head on its axis. This is the direction of spin that curves the ball to the left, or "toes" it. The opposite happens in a "heeled" ball. This rotary movement is necessarily intensified by the involuntary reaction of the wrists, which brings the club-head further round than the elastic recovery of the shaft alone would do.

I venture to think that this is the true explanation of "heeling" and "toeing." The same effects can be produced in other ways; "heeling" may be imitated by "slicing," but that does none the more make it "heeling," nor must we generalize from what happens in bad play, for then—as I know to my cost—all things are possible. T. Mellard Reade.

Park Corner, Blundellsands, October 22.

The Ffynnon Beuno and Cae Gwyn Caves.

The letter from Mr. Worthington G. Smith in the last number of Nature (p. 7) affords a remarkable instance of rushing into print and giving an opinion on a subject with which the writer is unacquainted. Speaking of the deposits in the caves, he states that all he knows about the matter has been derived from reading a very short abstract of a paper read by Dr. Hicks at the recent meeting of the British Association, in which the caves are referred to. Now, so much has been written and published on the Ffynnon Beuno and Cae Gwyn Caves in Nature and other scientific publications, that it is extraordinary that anyone should venture to offer an opinion without previously reading up the literature of the subject. Mr. Worthington G. Smith states that he has visited the caves, and is fairly well acquainted with the Glacial deposits of North Wales and with Palæolithic implements in general, and that his "unbiased opinion is, and will so remain—unless" he gets "very convincing proof to the contrary—that the drift at the caves has been without doubt relaid." We may be thankful for Mr. Smith's opinion, but unfortunately it is not worth anything, as his letter conclusively proves. Although his opinion is of no consequence, I think it should not pass unnoticed, and it affords me an opportunity of stating that during the last month the drift about the entrance of the Cae Gwyn Cave has been again carefully examined, and that the Reports of the British Association Committee have been fully confirmed. G. H. Morton.

Liverpool.

THE VICTORIA UNIVERSITY.

We are glad to observe that the application of the Yorkshire College for admission to the Victoria University has been successful. Doubt was expressed by some members of the Court as to whether the Faculty of Arts in the Leeds institution was strong enough to justify its claim to share in the privileges enjoyed by Manchester and Liverpool. This doubt was overruled. The Charter requires that the provision for teaching both arts and sciences in a College must be "reasonably sufficient" before it can be admitted to the University. It is not, however, intended that it must be equally developed in both directions. The Yorkshire College is no doubt stronger on the scientific side, and was indeed originally called the "Yorkshire College of Science." The name was changed, and the limitation it implied removed, two years after its foundation, when the Council formally took over the classes in literature and history previously carried on by the Cambridge University Extension.

The subjects of a curriculum in Arts are now taught, though the number of Professors engaged in the task is less than could be wished. The Professor of Classics is Principal, and representative of his scientific as of his Arts colleagues on the Council. There is a Professor of English Literature and History, and there are Lecturers in French, German, Italian, and some Oriental languages. An institution which provides a staff competent to teach these subjects, and places its Professor of Classics at its head, cannot be accused of an undue preference for science, and is, we think, fully qualified under the terms of the Charter.

One of the advantages of the federation of local Colleges in a University is that members of their governing bodies will be brought together in its management, and will thus learn practically what is being done in other institutions. Leeds will no doubt be stimulated to attempt to bring its Arts Faculty to the level attained by Manchester. Manchester may learn that combined classes for both sexes are practicable, and that the addition of a Faculty of Technology to those of Arts and Science may be of advantage to all concerned.

The Victoria University is now fairly started on its career, and its constituent Colleges have their future in their own hands. Manchester, Liverpool, and Leeds can confer degrees on students in their principal educational institutions untrammelled by the requirements of any external authority. We believe that this experiment is more promising than an attempt to subordinate local Colleges to our older Universities. Oxford and Cambridge have traditions and peculiarities which those who know them best would wish to survive amid the changes which are from time to time necessary to bring them into harmony with the spirit of the age. Had a close union been formed between these Universities and the local Colleges, it is probable that the Colleges would gradually have destroyed much that in its place in the Universities is useful, or that the Universities would have checked the growth of the Colleges by insisting on the attempt to fulfil conditions which in a manufacturing town are unattainable.

However this may be, it is certain that the most successful provincial Colleges have achieved success without direct connection with Oxford or Cambridge, though from the fact that graduates of these Universities are always to be found on the Professorial Staff they have exercised an indirect and no doubt useful influence.

If the Victoria University succeeds in combining the love of knowledge for its own sake with a readiness to meet the practical requirements of an age in which success in commerce and in learning are closely related, it may acquire a prestige and an authority second to that of no other educational institution in the country.

THERMO-MAGNETIC MACHINES.

IT would seem that at the present time there is being developed in the United States a new kind of engine, capable, at least in theory, of turning, by a magnetic method, the latent energy contained in fuel either into mechanical work or into the energy of electric currents. In this kind of machine the variations produced in the magnetic power of metals, such as iron and nickel, by heating and cooling them, are made the means of generating in the one case electric currents, in the other mechanical motion. The latter application was the earliest to be suggested. In the columns of NATURE (vol. xix. p. 397) will be found a note, extracted from the Journal of the Franklin Institute, upon a thermo-magnetic motor devised by Prof. E. J. Houston and Prof. E. Thomson, of Philadelphia. In this curious apparatus a disk or ring of thin steel is mounted on a vertical axis so as to be quite free to move, with its edges opposite the poles of a horse-shoe magnet. This wheel becomes of course magnetized by induction. When, however, heat is applied at a point on the circumference, the change thereby produced in the magnetic susceptibility of that part causes the disk to move round so as always to bring into line with the poles those portions of the disk which are for the time being the most susceptible to magnetization. Hence if the heating is continuous there will be a continuous rotation; the parts of the disk cooling as they leave the source of heat, and again becoming heated as they pass through the place where heat is being applied. The very same kind of thermo-magnetic motor was re-invented, in 1886, by Prof. Schwedoff, of Odessa, who, in a paper in the *Journal de Physique*, pointed out that this was a genuine case of conversion of heat into work, and gave the theory of the transformation and the cycle of operations from the thermo-dynamic point of view.

The next stage of invention in point of time, though it has only just been made public, is the suggestion by Mr. E. Berliner, of Washington, to use these thermo-magnetic variations in iron for the purpose of generating electric currents. In June 1885 Mr. Berliner filed an application for a patent for an "electric furnace generator," of which the following are the underlying principles:—"If," he says, "I take a magnet and provide it with a coil around its pole or poles, and place before this magnet and in proximity to the coil a piece of iron heated to bright red, nothing will occur to disturb the magnetic field; but the instant the iron cools down to a dull red, the magnetism becomes excited, and a momentary current of electricity is produced in the coil. I may go a step further and have a series of such magnet coils and iron armatures, and by connecting the coils into the same circuit, and cooling the armatures in rotation one after the other, a number of electrical impulses will be produced, which, when they follow one another rapidly, will approximate to a continuous electric current. . . . The current thereby produced might be utilized to charge another coil surrounding the magnet and reinforce the field; and in that case the magnet might be substituted by a tubular core of iron, . . . or a series of coils and magnets might be placed toward one larger armature disk, forming a common armature, heated by one furnace."

The most recent suggestions in this line come from Mr. T. A. Edison, who, independently of Mr. Berliner, has devised an almost identical generator, to which he has given the name of a "pyro-magnetic dynamo." At the recent meeting of the American Association of Science, a paper by Mr. Edison, giving an account of his machines, was read, and has been largely noticed in the non-technical press, as though it were an absolutely new departure in electric science. The famous inventor may certainly lay claim to having worked out in greater detail the practical problems of construction. In the generator there are eight double-pole electro-magnets arranged radially. At the top the eight poles converge toward a central space; and about a foot below the other eight poles converge toward a second central space. In these central spaces lie two soft iron disks, forming the cheeks of the armature, and pierced with eight large holes, each to receive eight vertical armature cores, each of which consists of a roll of corrugated sheet-iron surrounded with a coil of wire insulated with asbestos. The eight wire coils are connected up together and joined to a commutator, just like the coils in the armature of Niaudet's dynamo. This armature stands over a furnace, the heated gases of which are led up through the interstices of the eight rolls of sheet-iron. By the use, however, of a revolving screen of fire-clay the ascending hot gases are cut off successively from some of these tubular cores so that they are alternately heated and cooled, giving rise to electric currents in the coils, which currents are collected above by the action of the commutator. The arrangement appears to have been constructed with Mr. Edison's well-known ingenuity. The inventor has also constructed a pyro-magnetic motor, which consists essentially of a powerful field-magnet (independently excited) having between its poles as a rotating armature a bundle of small vertical tubes of very thin iron, which are packed in a convenient drum-like form and mounted on a vertical spindle. From a furnace underneath rise currents of heated air, and pass through the iron tubes; but, by a screen placed in a suitable position below, the heated air is prevented from rising through some of the tubes, and instead thereof a blast of cool air is blown down these: the cooled tubes, becoming more highly magnetic, are more powerfully attracted by the poles of the field-magnet, and move forward, only to be afresh heated, whilst a new set of tubes comes into position to be cooled and attracted. Mr. Edison states that already a speed of 120 revolutions per minute is practicable; and he is building one of these motors calculated to work at 3 horse-power. Whether the sanguine hopes which he expresses as to the economic working of such motors and generators, as compared with existing engines and dynamos, will be fulfilled in the future is as yet a matter of speculation. But the practical problem, even though it is surrounded by many obvious difficulties, is of so tempting a nature, and the attempt to solve it is so daring, that we must wish to our Transatlantic friends the utmost success in their efforts to supersede the present wasteful methods of utilizing the latent energy of fuel.

NOTES.

THE following is the list of names recommended by the President and Council of the Royal Society for election into the Council for the year 1888, at the forthcoming anniversary meeting on the 30th inst.:—President: Prof. George Gabriel Stokes. Treasurer: Dr. John Evans. Secretaries: Prof. Michael Foster, the Lord Rayleigh. Foreign Secretary: Prof. Alexander William Williamson. Other members of the Council: Sir William Bowman, Bart., Henry Bowman Brady, Prof. Arthur Cayley, W. T. Thiselton Dyer, Prof. David Ferrier, Dr. Edward Frankland, Dr. Arthur Gamgee, Prof. Joseph Henry Gilbert, Prof. John W. Judd, Prof. Herbert McLeod, Dr. William Pole, William Henry Preece, Admiral Sir George Henry Richards, K.C.B., Prof. Arthur William Rücker, the Earl of Rosse, and Sir Bernhard Samuelson, Bart.

MR. F. J. JACKSON has presented to the Natural History Museum an interesting set of animals collected by him during his three years' residence in East Africa. The birds are particularly valuable, and contain many species new to the Museum collection. Mr. Jackson resided for some time in the Kilima N'jaro district, and procured several rare species hitherto only known from the late Dr. Fischer's collections in the Berlin

Museum. From Lamu and Manda Island the additions to the Museum collection are numerous, and supply many desiderata to the series of bird-skins.

THE remains of the great naturalist, Audubon, lie in an obscure and little-visited portion of Trinity Cemetery, New York City, and his tomb is not marked by any distinguishing monument. A movement has been started for the erection of a suitable monument. At the first autumn meeting of the New York Academy of Sciences a Committee was appointed to collect funds and make all necessary arrangements. This Committee, of which Dr. Britten is Secretary and Treasurer, is now ready to receive subscriptions, which will be properly acknowledged. It is estimated that from 6000 to 10,000 dollars will be required. While confident that this amount might be collected in America, the Committee are anxious that interest should be taken in the project by men of science in all departments in all parts of the world.

MR. EDWIN LEES, who died lately at Worcester at the age of eighty-seven, had a considerable reputation as a naturalist. Among his writings are "The Botany of the Malvern Hills," "Pictures of Nature among the Malvern Hills and Vale of Severn," "The Botany of Worcestershire," and "The Forest and Chace of Malvern." He was one of the founders of the Worcestershire Natural History Society, and of the Worcestershire Naturalists' Field Club.

MR. THOMAS BOLTON, of the Microscopists' and Naturalists' Studio, Birmingham, died on Monday. He was in his fifty-seventh year. About a year ago a Civil List pension of £50 per annum was granted to Mr. Bolton in recognition of his services as a naturalist and microscopist. The memorial setting forth his claims, discoveries, and special circumstances was signed by Sir J. W. Dawson and many other eminent men of science.

A CONFERENCE on Technical Education, in which working men took a prominent part, was held last Saturday evening at the Finsbury Technical College. There was a large attendance of students and others. Mr. James Rowlands, M.P., occupied the chair, and Prof. Silvanus P. Thompson read an address on "The Present Position of the Technical Instruction Question." Prof. Thompson urged that the most essential of all the conditions for the organization of an adequate system of technical instruction is the creation of "a real Education Department under a real Minister of Education."

AT the annual meeting of the delegates of the Union of Lancashire and Cheshire Institutes at Crewe on Monday, Lord Derby delivered an excellent address on education. In the course of his remarks he pointed out that the "Institutes of fifty years ago for the most part failed because of the want of good primary schools to feed them. "You have the schools now," he continued, "and what we have to do is to provide the means of carrying on the instruction of those who are willing to learn after the time when they are clear of school, and free to follow their own devices when the day's work is over." Speaking of technical instruction, Lord Derby said :—"We are fighting for the markets of the world ; we have held our own hitherto, but the struggle is sharper than ever, and we cannot afford to throw away any advantage which is possessed by other countries. It may be that, as often happens, we shall find out that we have overrated the benefit of technical teaching, that it can do less for us than we now expect ; but we are not the less bound to try, and to deserve success, whether we get it or not."

SOME electric balloon signalling experiments were carried on at Berchem, in the fortifications outside Antwerp on Wednesday evening, October 26. The system used was known as the Bruce system, and the inventor, Mr. Eric Stuart Bruce, himself superintended the experiments at the invitation of the Belgian War Minister. The balloon used, which had just been purchased of Mr. Bruce by the Belgian Government, was a small one, being only 15 feet in diameter. It had been designed for hydrogen, but though it was filled with very dense coal-gas it lifted 500 feet of electric cable besides its captive rope. This special cable was an improvement on what was formerly used by Mr. Bruce, being now lighter though of the same current capacity. The Bruce key also, which gave great satisfaction, has been lately considerably modified, and can carry any current, the contacts being of carbon, which can easily be renewed on wearing away. The Minister of War, General Pontus, General Wauwermans, Inspector-General of Fortifications at Antwerp, and various other distinguished officers were present, including special delegates from Russia, Holland, &c., &c. The first telegram sent was : "Porte d'Herenthals de Berchem. Voyez vous distinctement signaux Bruce, répétez la dépêche par téléphone. (Signé) Général Wauwermans." This was distinctly read and telephoned back. Also the second, sent by the Minister of War : "Envoyez un bataillon au fort I. (Signé) Ministre Guerre Pontus." A third telegram sent to the Caserne of Telegraphists was equally successful. There were six lights in the balloon giving about twenty candle-power each. The telephonic stations of Rehls were comparatively near, being only at a distance of from 4 to 5 kilometres ; the object that night being to test at once the distinctness of the signals, by placing the observing-stations on the existing telephonic circuits ; but the night was an ideal one for signalling, and it is understood that the balloon was seen to an enormous distance. A company was also on the look-out at the top of the tower of Notre Dame, at Antwerp (4 kilometres), and they distinctly read all the messages sent.

CONSIDERABLE uncertainty has, up to the present time, existed as to the number and composition of the compounds of gold with sulphur. For years it was supposed that there were three sulphides of gold—Au_2S, Au_2S_2, and Au_2S_3 ; but Schrötter and Pruvoznik, in 1874, came to the conclusion that no sulphides of gold were to be obtained in a pure state, thus leaving the subject in greater darkness than ever. Happily, however, this deplorable uncertainty has at length been completely dispelled by Drs. Hoffmann and Krüss, of Munich, who have abandoned the methods of Berzelius, Levol, and Schrötter and Pruvoznik, for more fruitful ones of their own. The lowest sulphide of gold, Au_2S, was obtained by the addition of hydrochloric acid to a solution of the double cyanide of gold and potassium saturated with sulphuretted hydrogen. The last traces of admixed sulphur were removed by washing with sulphuretted hydrogen solution, alcohol, ether, carbon disulphide, and finally again with ether. After drying over phosphoric oxide, pure Au_2S was obtained as a dark-brown powder, yielding theoretical numbers on analysis. When freshly precipitated it is remarkably soluble in water, indicating a close relationship to the metals of the alkalies, whose sulphides are also soluble in water, and thus asserting its position in the first vertical series of the periodic system. With polysulphides of the alkalies it forms green sulpho-salts. It decomposes at 240°, leaving a residue of pure gold, and, if warmed in a stream of oxygen, takes fire, forming SO_2, and again leaving its gold in the metallic state. In a second communication in the current number of the *Berichte*, Hoffmann and Krüss describe how they have succeeded in preparing Au_2S_2. A cold neutral solution of gold chloride was precipitated by sulphuretted hydrogen until the supernatant liquid became colourless. Admixed sulphur was removed from the precipitate in a manner similar to that employed in case of Au_2S, and finally pure Au_2S_2 isolated as a deep black substance, decomposed by heat similarly to Au_2S. It is distinguished from the latter sulphide by being decomposed by caustic potash with formation of potassium oxy- and sulpho-salts and separation of a little metallic gold. Au_2S_3 of Berzelius was found not to exist, being merely a mixture of Au_2S_2 and sulphur, for the former substance was completely extracted by a solution of potassium cyanide, leaving an emulsion of finely-divided sulphur.

THE November Bulletin of Miscellaneous Information, issued from the Royal Gardens, Kew, is the first of a series of papers in which information will be given as to the capabilities of our colonies to grow and export fruit. The authorities of Kew have little doubt that, if proper arrangements were made for packing and shipping, large quantities of fruit might be exported from Cape Colony, Natal, the Australian colonies, and New Zealand. It is thought that much of this, arriving in England during the winter and early spring months, would be readily bought to supply the wants of the community, and that the prices paid for such fruit as an article of luxury would be sufficiently high to cover the cost of bringing it from the southern hemisphere. Much interest was taken in the fruit shown from all parts of the Empire at the late Colonial and Indian Exhibition. An effort, therefore, has been made at Kew to collect information on the subject, and excellent service, no doubt, will be done by the publication of the facts which have been brought together. In the present Bulletin a full account is given of Canadian fruits.

THE fifth part (just issued) of the Transactions of the Leicester Literary and Philosophical Society contains an interesting paper, by Mr. F. T. Mott, on foreign fruits available for acclimatization in England. Among the plants to which he calls attention is the *Zizyphus vulgaris*, which produces a yellow fruit of pleasant flavour, the size of a small gooseberry. These fruits are usually dried and sold under the name of jujubes, the gelatine jujubes of our shops being named after them. "It is probable," says Mr. Mott, "that no species of *Zizyphus* in its present condition would ripen its fruit in English gardens, but the art of cultivation consists in so modifying the natural habits of plants as to adapt them to man's needs in various climates. This is accomplished by selection, propagation by seed, changes of soil, and gradual exposure. The first step would probably be to obtain a hardy variety of the *Zizyphus vulgaris* regardless of the quality of the fruit. A tree should be selected in the most elevated and exposed situation in which it naturally ripens its fruit. Seeds from this tree should be grown in a slightly colder climate, and if any of them can be got to ripen fruit, the seeds of these shou'd be again reared still further north. In this manner the tree might gradually be acclimatized in our southern counties. Having once obtained a sufficiently hardy stock, the next process would be to improve the fruit. This would be done by selection of seed with reference to the fruit rather than to the hardiness of the plant, by crossing with Indian or Chinese species, and by careful study of soil and general treatment. The process of thus producing a new hardy fruit would be tedious, because fruiting trees can scarcely be brought to such a state of maturity as to show their true characters in less than eight or ten years from the sowing of the seed, and five or six generations at least might be required to produce any useful result. But the experiment would be interesting in all its stages, and the object if ultimately attained would be of great value."

WE have received the General Report on the operations of the Survey of India Department, administered under the Government of India, during 1885-86. The Report has been prepared under the direction of Colonel H. R. Thuillier, R.E., officiating Surveyor-General of India. It is divided into three parts. Part I. is introductory; Part II. contains a summary of the operations of the trigonometrical, topographical, and revenue survey parties; in Part III. there is an account of the operations of the several head-quarter offices. Extracts from narrative reports are presented in an appendix. Among the "general remarks" in Part I. there is a paragraph in which some dissatisfaction is expressed with existing arrangements. "The large demands," says the writer, "that have been made on the Survey Department for officers required to accompany political missions and military expeditions, and for other special work, combined with the circumstance of a larger percentage than usual being absent on medical leave, has rendered the efficient prosecution of the regular work of the Department peculiarly difficult. This has been the subject of remark in the Annual Reports for the past two years, and during the year under review the paucity of officers has been still more seriously felt. There has been absolutely no reserve of trained officers, and the administration of the Department has consequently been a task of considerable anxiety. It is necessary to record that the working machinery of the Department has been limited to a dangerous extent."

IT is stated that the Government of the Straits Settlements are about to undertake a systematic survey, on the Indian plan, of their territory and of that of the neighbouring "protected" States. Colonel Burrow, of the Indian Survey Department, was recently appointed to advise the Colonial Government on the subject, with the result here stated.

THE Asiatic Society of Japan has, we are glad to observe, published a General Index to its Transactions. There are now thirty-six parts, or fifteen volumes, of the latter, and as almost every foreign scholar in Japan has been a contributor to the Society's Proceedings for fourteen or fifteen years past, it was necessary that an index should be published. About two years ago we noticed the publication of an index to the Proceedings of the Society's friendly rival, the German Society.

MR. HENRY SEEBOHM is about to issue a work on the Geographical Distribution of the *Charadriidæ* (Plovers, Sandpipers, and Snipes, &c.). The unrivalled collection of Wading Birds in Mr. Seebohm's possession supplies the material for this work, and the volume will undoubtedly be one of great interest to ornithologists. Mr. Seebohm's ideas on nomenclature, the influence of the Glacial epoch on the migration of birds, and other kindred subjects, are always original, and this new work of his will open, according to the prospectus, with an introduction setting forth his latest opinions. There is also to be given "a complete synonymy from 1776 to the present time," a rather appalling announcement, and one involving a vast change in ornithological nomenclature, as it will preclude the use of Linnean names.

A TRANSLATION, by Miss Margaret K. Smith, of Seidel's "Industrial Instruction" is about to be issued in America by Messrs. D. C. Heath and Co. The author presents an exposition of "the principles underlying the claims of hand labour to a place on the school programme."

"THE Shell-Collector's Hand-book for the Field," by Dr. J. W. Williams, the editor of *The Naturalist's Monthly*, will be published immediately by Messrs. Roper and Drowley. It will give full directions as to the collecting and preserving of British land and fresh-water shells, and will describe the habitat of each. Every genus, species, and variety known to the Conchological Society up to date of publication will be noted.

MR. T. A. WALKER's "History of the Making of the Severn Tunnel" is, we understand, likely to appear about Christmas. In addition to portraits on steel of some of the more prominent engineers concerned in the enterprise, there will be numerous plans and sections showing the gradual progress of the work, and diagrams of the large pumping-engines, &c. Messrs. Bentley and Son will be the publishers.

SIR JAMES PAGET's address to the medical students at Owens College, delivered at the opening of the session 1887-88, has been published. The subject is, the utility of scientific work in the practice of medicine and surgery.

THE new number of the Journal of the Anthropological Institute contains a striking paper by Dr. George Harley, in which he attempts to show that the tendency of civilization is decidedly to lower the bodily recuperative powers of human beings. Another interesting paper—by Mr. G. L. Gomme—is on the evidence for Mr. McLennan's theory of the primitive human horde.

MESSRS. S. WIGG AND SON, Adelaide, are issuing a work on "Common Native Insects of South Australia," by Mr. J. G. O. Tepper. It is intended to serve as a popular guide to South Australian entomology. Part I. relates to Coleoptera.

A PAPER containing a list of the mammals of Manitoba, by Mr. Ernest E. Thompson, has been reprinted from the Transactions of the Manitoba Scientific and Historical Society. It consists chiefly of the author's field notes.

A CORRESPONDENT writes from St. Petersburg that tigers have been encountered this autumn in parts of Asiatic and European Russia where they have never been found before. Some time ago one of these beasts was captured near Wladiwostock, in Siberia, and another in the government of the Caucasus, close to the Black Sea. Both animals have been conveyed to St. Petersburg alive.

A NORWEGIAN astronomer has collected seventeen reports from various parts of Norway respecting the great meteor seen in that country on the evening of September 18, no doubt the largest meteor seen in Norway in recent times. These reports show that the meteor was seen as far north as Hamar, in Central Norway, and as far south as the towns of Fredrikshald and Skien, on opposite sides of the Christiania Fjord, the capital and neighbourhood appearing to be in the centre of its track. Its light was everywhere magnificent, having the appearance of a sudden blaze of electric light. The reports from Drammen and neighbourhood, as well as those from the province of Smaalenene, on the opposite side of the Christiania Fjord, maintain that the bursting of the meteor, which took place within this area, was accompanied by a loud report; but the astronomer in question is of opinion that this belief is due to some freak of the imagination, as the track of the meteor, covering such a vast area of land, must have lain too high in the atmosphere for any sound to be heard. He calculates from the reports to hand that the bursting of the meteor occurred at an altitude of about 6000 feet, and he thinks that even this figure may be safely doubled, as no doubt the meteor was seen far north and south of the places whence reports have been received.

THE Aino idea of an eclipse is described by the well-known student of Aino language and manners, Mr. Bachelor, in a recent number of the *Japan Weekly Mail*. Mr. Bachelor specially observed the conduct of the Ainos during the recent eclipse. The Aino, he says, is a very matter-of-fact person, and is not usually carried away by the imagination. On being shown the eclipse through a smoked glass, the Aino cried out that the sun was fainting away and dying. A silence then ensued, and from time to time an exclamation of surprise or fear was to be heard; it was evident the fear was that the sun would die away and never revive. They brought water and sprinkled it upwards towards the sun (as they would do if a human being were expiring), crying at the same time, "O god, we revive thee! O god, we revive thee!" Some squirted the water upwards with their mouths, others threw it with their hands, others, again, used the common besom or willow-branches, the latter being supposed to be specially efficacious. A few, especially women and girls, sat down with their heads hidden between their knees, as if silently expecting some dreadful calamity to suddenly befall them. They have no theories with regard to eclipses, but their traditions run like this:—"When my father was a child, he heard his old grandfather say that his grandfather saw a total eclipse of the sun. The earth became quite dark, and shadows could not be seen; the birds went to roost, and the dogs began to howl. The black, dead sun shot out tongues of fire and lightning from its sides, and the stars shone brightly. Then the sun began to return to life, and the faces of the people wore an aspect of death; and, as the sun gradually came to life, then men began to live again."

THE first meeting of the one hundred and thirty-fourth session of the Society of Arts will be held on Wednesday, November 16, when the opening address will be delivered by Sir Douglas Galton, Chairman of the Council. Previous to Christmas there will be four ordinary meetings, in addition to the opening meeting. For these meetings the following arrangements have been made:—November 23, Prof. Silvanus P. Thompson, "The Mercurial Air-pump;" November 30, Mr. J. B. Hannay, "Economical Illumination from Waste Oils;" December 7, Mr. P. L. Simmonds, "The Chemistry, Commerce, and Uses of Eggs of Various Kinds;" December 14, Sir Philip Magnus, "Commercial Education." During the session there will be six courses of Cantor Lectures—"The Elements of Architectural Design," by Mr. H. H. Statham; "Yeast, its Morphology and Culture," by Mr. A. Gordon Salamon; "The Modern Microscope" (being a continuation of the recent course of Cantor Lectures on the "Microscope"), by Mr. John Mayall, Jun.; "Alloys," by Prof. W. Chandler Roberts-Austen, F.R.S.; "Milk Supply and Butter and Cheese Making," by Mr. Richard Bannister; "The Decoration and Illustration of Books," by Mr. Walter Crane. Two juvenile lectures on "The Application of Electricity to Lighting and Working," by Mr. William Henry Preece, F.R.S., will be given during the Christmas holidays.

THE additions to the Zoological Society's Gardens during the past week include a Campbell's Monkey (*Cercopithecus campbelli*) from West Africa, presented by Mr. E. B. Mitford; a Weeper Capuchin (*Cebus capucinus*) from Brazil, presented by Mr. C. N. Skeffington; a Raccoon-like Dog (*Canis procynides*) from China, presented by Mr. W. T. Manger; an Indian Antelope (*Antilope cervicapra*) from India, presented by Mrs. M. V. Charrington; a Leopard (*Felis pardus*) from Ceylon, presented by the Dissawe of Tamankadua Dulewa Adijur; a Common Squirrel (*Sciurus vulgaris*), British, presented by Mr. A. Townsend; a Naked-footed Owlet (*Athene noctua*), European, presented by Mr. R. E. Holding; a Laughing Kingfisher (*Dacelo gigantea*) from Australia, presented by Mr. G. E. Frodsham; two Larger Hill-Mynahs (*Gracula intermedia*) from Northern India, presented respectively by Mr. J. M. Cook and Mrs. J. S. Beale; a Gray-headed Porphyrio (*Porphyrio poliocephalus*) from India, presented by Lady Morshed; a West African Python (*Python sebæ*) from West Africa, a Common Boa (*Boa constrictor*) from South America, two Testaceous Snakes (*Ptyas testacea*), an Alleghany Snake (*Coluber alleghaniensis*) from North America, deposited; six Mocassin Snakes (*Tripidonotus fasciatus*) born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE VARIABLE STAR U OPHIUCHI.—Mr. S. C. Chandler, Jun., who first determined the true period of this star, of all variables the one with shortest period and most rapid fluctuations of light, has brought together, in No. 161 of *Gould's Astronomical Journal*, all the observations of magnitude of this star available. Of these, one made by Schjellerup on June 7, 1863, is of special value, as it was evidently made near the time of minimum, and at an interval of nearly 8000 periods from the principal epoch; whilst a series made at Cordoba in 1871 and 1872 has proved of very high importance. The discussion of these various observations show that it is exceedingly probable that the period has undergone a slight shortening; all the data being well reconciled by the assumption that each period is shorter than the preceding one by 0·0004s. The corrected elements of the star will therefore be as follows:—

1884 January 1, 0h. 54m. 43·6s. Paris M.T. + 20h. 7m. 41·6s. (E – 1070) – 0·0002s. E.

THE NEW ALGOL-VARIABLE, Y CYGNI.—In the same number of *Gould's Astronomical Journal* Mr. Sawyer states that he has obtained observations of this star which render it probable that the true period is 1d. 12h. ±, or half the period which Mr. Chandler had adopted for it (see NATURE, vol. xxxvi. p. 377).

OLBERS' COMET, 1887.—The following ephemeris is in continuation of that given in NATURE, vol. xxxvi. p. 588:—

Ephemeris for Berlin Midnight.

1887.	R.A. h. m. s.	Decl. ° ′	Log *r*.	Log Δ.	Brightness.
Nov. 11	14 24 15	13 59·0 N.	0·1152	0·3037	1·20
13	14 31 8	13 15·0			
15	14 37 51	12 31·6	0·1232	0·3098	1·12
17	14 44 25	11 48·9			
19	14 50 51	11 6·7	0·1317	0·3162	1·05
21	14 57 9	10 25·3			
23	15 3 18	9 44·7	0·1406	0·3226	0·98
25	15 9 20	9 50·0			
27	15 15 12	8 26·0 N.	0·1499	0·3291	0·91

The brightness on August 27 is taken as unity.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 *NOVEMBER* 13–19.

(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 November 13

Sun rises, 7h. 16m.; souths, 11h. 44m. 23·6s.; sets, 16h. 12m.: right asc. on meridian, 15h. 13·5m.; decl. 17° 58′ S. Sidereal Time at Sunset, 19h. 42m.

Moon (New on November 15, 8h.) rises, 4h. 13m.; souths, 10h. 6m.; sets, 15h. 46m.: right asc. on meridian, 13h. 34·4m.; decl. 4° 48′ S.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. on meridian. h. m.	Declination on meridian. ° ′
Mercury	8 16	12 23	16 30	15 52·4	21 13 S.
Venus	2 56	8 52	14 48	12 20·9	1 39 S.
Mars	1 12	7 48	14 24	11 16·3	6 30 N.
Jupiter	6 52	11 31	16 10	15 0·5	16 10 S.
Saturn	21 21*	5 8	12 55	8 36·0	18 59 N.
Uranus	3 52	9 28	15 4	12 56·8	5 23 S.
Neptune	16 40*	0 21	8 2	3 48·3	18 13 N.

* Indicates that the rising is that of the preceding evening.

Occultations of Stars by the Moon (visible at Greenwich).

Nov.	Star.	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image. ° °
18	33 Sagittarii	5	16 23	16 50	38 1
18	ξ^2 Sagittarii	4	18 2	19 5	103 330

Nov.	h.	
17	19	Mercury in inferior conjunction with the Sun.
18	7	Saturn stationary.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·3	81 16 N.	Nov. 17,	2 8	*m*
Algol	3 0·8	40 31 N.	,, 16,	1 3	*m*
			,, 18,	21 52	*m*
S Cancri	8 37·5	19 26 N.	,, 14,	1 26	*m*
R Virginis	12 32·8	7 37 N.	,, 14,		*M*
U Ophiuchi	17 10·8	1 20 N.	,, 13,	0 3	*m*
		and at intervals of		20 8	
β Lyræ	18 45·9	33 14 N.	Nov. 15,	19 0	m_2
			,, 19,	0 0	*M*
R Lyræ	18 51·9	43 48 N.	,, 16,		*m*
δ Cephei	22 25·0	57 50 N.	,, 13,	21 0	*m*

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

Meteor-Showers.

	R.A. °	Decl. °	
From Lynx	125	40 N.	Swift; streaks.
Near κ Leonis	142	27 N.	Very swift.
Near θ Ursæ Majoris.	143	49 N.	Very swift.
The Leonids	149	22 N.	Swift; streaks.
Near ξ Ursæ Majoris.	166	32 N.	Swift; streaks.

GEOGRAPHICAL NOTES.

THE November number of the *Scottish Geographical Magazine* contains an admirable paper by Mr. John Murray, on "Some Recent Deep-sea Observations in the Indian Ocean." Mr. W. W. Blair, C.E., contributes a useful paper on the "Cold Lakes of New Zealand." Prof. Mohn sends a list of the highest peaks in Northern Europe, with their heights from the latest determinations. They are, with heights in feet:—Galdhoppigen, South Norway, 8399; Glitter Tind, 8379; Snehætten, 7566; Oræfajökull, 6427; Sulitelma, Northern Norway, 6178; Petermann's Spitze, East Greenland, 11,418; Beerenberg, Jan Mayen, 8350; Mount Misery, Bear Island, 1785; Hornsund Tind, Spitzbergen, 4560; Richthofen Mount, Franz Josef Land, 5184. Of these mountains two are volcanic, Oræfajökull and Beerenberg.

THE new number (9) of the *Mittheilungen* of the Vienna Geographical Society contains a summary of our knowledge of the physical geography of the East Asiatic waters (the Western Pacific and its offshoots)—currents, temperatures, &c.—by Lieut. Adolf Glockner.

IN the September number of the *Bulletin* of the American Geographical Society, Mr. R. E. Peary gives a detailed account of his journey, in the summer and autumn of last year, into the interior of Greenland. He entered in the neighbourhood of Disco Island, considerably further north than the starting-point chosen by Nordenskjöld for his expedition. Mr. Peary's experiences were somewhat similar to those of Nordenskjöld. His course throughout the journey was due east. He only reached 100 miles from the edge of the ice-blink or interior ice, his highest elevation being 7525 feet. Mr. Peary sums up his observations of the character of the interior ice. The coast-line shows a great diversity of features, dependent upon the altitude, the season, and the elevation and configuration of the adjacent mountains. Whenever the ice projects down a valley in a long tongue or stream, the edges contract and shrink away from the warmer rocks on each side, leaving a deep cañon between, usually occupied by a glacier; and the upper surfaces, disintegrated by the reflected heat from the mountains above, and shattered by the daily change of temperature more perhaps than by the forward flow, presents a chaotic labyrinth of crevasses, gullies, and rugged pinnacles, increasing in magnitude in direct proportion to the length of the tongue and its approach to the sea-level. As to the features of the interior beyond the coast-line, the surface of the "ice-blink" near the margin is a succession of rounded hummocks, steepest and highest on their landward sides, which are sometimes precipitous. Further in these hummocks merge into long flat swells, which in turn decrease in height towards the interior, until at last a flat gently rising plain is reached, which doubtless becomes ultimately level. In passing from the margin of the ice-blink to the remote interior, from one to five distinct zones may be noted, the number and width varying with the season, the latitude, and the elevation. In winter the entire surface is undoubtedly covered with a deep unbroken layer of fine dry snow. Late in the spring the warmth of the sun at midday softens the surface of the snow, along the land borders of the ice, and this freezes at night, forming a light crust. Gradually this crust extends up the interior, and with the advance of the season the snow along the border of the "ice-blink" becomes saturated with water. A little later the zone of slush follows the zone of crust into the interior, the snow along the border of the ice-blink melts entirely, forming pools in the depressions, and streams which cut deep gullies in the ice; water-cavities form; old crevasses open, and new ones appear. This zone rapidly widens, and extends into the interior in the footsteps of the others, and behind it the immediate border of the ice gets ragged and soiled; pebbles, boulders, and moraines crop out of its melting surface, and by the end of the Arctic summer it is disintegrated and shattered by the heat, and eroded by the streams, into impassable roughness. Mr. Peary gives some useful hints as to the best modes of travel over the ice, which, if followed, he believes would without any difficulty take the explorer to the east coast.

In Heft 3 of this year's *Deutsche Geographische Blätter* will be found the first part of a detailed study of the Schwarzwald by Prof. Platz, of Carlsruhe. It deals with the orography and geology.

The Portuguese explorer, Josè Anchieta, is at present in the Quinsumbo region of the Portuguese West African territory, on his way to Bihé. He intends to investigate the flora of the region, which has never been adequately studied.

In the Danish Budget for 1888–89 a sum of 68,000 kroner has been allotted for research in Icelandic waters. Several large fjords of great commercial importance are entirely unexplored, and are therefore full of danger to navigation. The fishery grounds around the various islands will also be investigated. This exploration will have great interest for science, as it is likely to accumulate much valuable information in oceanography, as well as zoology and meteorology. The work will be carried on freely from May to August, and it is hoped will be completed in five or six years.

The Roman Catholic missionaries on Yule Island have been exploring the region of New Guinea opposite their station. They found that the Ethel and Helida are insignificant streams; but they discovered a new river, the St. Joseph, which rises at the foot of Mount Yule in 8° 15′ S. lat. and 146° 40′ E., and which flows in a southerly direction. The land on both sides is highly fertile and the natives peaceful. They visited fifteen villages, several with a population of over 2000.

In a paper in the last-issued *Bulletin* (vol. ii. No. 6) of the Californian Academy of Sciences, Mr. George Davidson gives some interesting information on submarine valleys off the Pacific coast of the United States. He points out that within 40 or 50 miles of the coast to the south of Cape Mendocino the plateau of the Pacific reaches a depth of 2000 to 2400 fathoms. Generally there is a marginal plateau for 10 miles out to the 100-fathom curve, and then the descent is sharp to 500 or 600 fathoms. In this marginal plateau there has been discovered by the Coast Survey several remarkable submarine valleys. Notably that in Monterey Bay, heading to the low lands at the great bend of Salinas River; and that off Point Hueneme at the eastern entrance of the Santa Barbara Channel, and heading into the low coast at the wide opening of the Santa Clara Valley. Then there are one or two off the southern point of Carmel Bay, while the deepest one enters far into the bay. The latest discovered submarine valleys are near the high bold coast under Cape Mendocino. Just north of a submarine ridge extending from Point Delgada to Shelter Cove is a deep valley which breaks through the marginal plateau and runs sharply into the immediate coast-line under the culminating point of the crest-line of mountains. The head of this submarine valley is 100 fathoms deep at 1¼ mile from shore; when it breaks through the 100-fathom line of the marginal plateau it reaches a depth of 400 fathoms. The slopes of the valley are very steep. Midway between this and Point Garda there is another valley 300 to 150 fathoms deep. The opening of this valley through the outer edge of the 100-fathom plateau is 520 fathoms deep. Between Point Garda and Cape Mendocino is another valley, which, 6½ miles south-west by south from the cape, is 450 fathoms deep. This is a wide valley, the bottom of which is green mud, though in two places, at depths of 320 fathoms, broken shells were brought up with gravel.

By the latest communication from Mr. Stanley's expedition it is evident that, unless some unexpected disaster has happened, he reached Emin Pasha some time in August. He found the Mabodi country, through which the Aruwimi flows, densely inhabited, while that river on the borders of the Mabodi country bends south, and again becomes navigable. This seems clearly to show that the Aruwimi can have no connection with the Wellé system.

The last number of the *Izvestia* of the Russian Geographical Society (1887, 3rd fascicule) will be most welcome to geographers. It contains a preliminary map (70 miles to an inch) of the eastern parts of East Turkestan, Tsaidam, and the upper parts of the Yellow and Blue Rivers, embodying the results of the fourth journey of General Przewalski in Central Asia. The most interesting feature of the map is that it shows that the depression of the Lob-nor must not be confounded with the Eastern Gobi. This last is more elevated, and falls by a steep terrace towards the depression of the Lob nor, which has in the east of the lake a width of only 80 miles, and terminates at Lake Tchin-jen-he, where the desert reaches altitudes of 3700 and 4800 feet above the sea. The Tarim depression is thus well limited in the east, and the doubts which arose among geographers as to the possibility of embodying the Eastern Gobi and the Tarim depression under the same denomination of Hang-hai, as proposed by Richthofen, are thus settled. The well-known difference of characters of the two regions depends upon the differences of their orographical structures, and the Tarim region appears as a depression of the high plateau of East Asia, limited in the east as well as in the north, the west, and the south. Geographers will find on the map the series of chains named after Colombus, Marco Polo, Humboldt, and Ritter, discovered by General Przewalski; the high range to which the Russian Geographical Society gave the name of its Russian discoverer; the Burkhanbuda range; the lakes Jarin and Orin, 14,000 feet high, of the upper Hoang-ho; and all those minor features which, when mentioned in M. Przewalski's letters, excited so much interest among geographers. A list of sixteen places, the latitudes and partly the longitudes of which have been determined, and a list of ninety-five altitudes, accompany the map.

In a short note accompanying the above map, General Przewalski mentions certain facts brought to light during the last three months of his journey. The Khotan-daria of East Turkestan does not make a bend towards the west, as shown on several recent maps. It flows due north through a sandy desert, and its course on Klaproth's and D'Anville's maps was more in accordance with reality than the indications on more modern maps. Its water reaches the Tarim only during the summer. A new oasis, Tavek-kel, grew up some fifty years ago on the Yurun-kash; its population numbers about 500 families. The lake Yashil-kul does not exist where it is shown on our maps. The most important statement is, however, the following. By the beginning of October 1885—that is, at low water—the Tarim had, at the confluence of the Yarkand and Khotan Rivers, a depth of 3 to 5 feet, and a width of about 185 yards. In the summer, according to information obtained from the natives, and confirmed by the state of the river-bed, the depth and width of the Tarim are thrice the above. Taking into consideration the fact that the lower Tarim, followed by M. Przewalski in 1876 and 1877, has throughout a depth of no less than 14 feet, it may be maintained, M. Przewalski writes, that the Tarim is navigable for steamers on its whole length from the above junction to the Lob-nor. It seems probable also that steamers may be able to ascend a short distance up the Aksu River and further up the Yarkand-daria.

The same number of the *Izvestia* contains an elaborate paper by M. A. Eliséeff embodying the ethnological results of his journeys in Asia Minor since 1881. In this paper there are able descriptions of the various populations of Asia Minor—the Turks, the Armenians, the Kurds, the Kurmanjis, the Greeks, the Arabs, the Chaldæans, the Tsiganes, and the Jews. The numerous anthropological measurements and other observations which the author made during his journeys in the interior of the country will be published separately in full. Two papers, on the Manych and the steppes of Northern Caucasus, by D. Ivanoff, and on the vegetation and geology of the same, by W. Fausek, are valuable contributions towards a better knowledge of the nature of this interesting region.

METEOROLOGICAL NOTES.

Symons's Monthly Meteorological Magazine for October contains a fifth annual table of the climate of the British Empire, giving a summary of the daily observations at sixteen stations, distributed over the globe, for the year 1886. The extremes show some very interesting facts, from which we select the following:—Adelaide has the highest maximum temperature in the shade, viz. 112°·4; the highest temperature in the sun, 174°·5; the least rainfall, 14·42 inches; and the lowest humidity, 56 per cent. Winnipeg has the lowest shade temperature, −44°·6; the greatest annual range, 147°·6; and the lowest mean daily temperature, 33°·2. Colombo (Ceylon) has the highest mean daily temperature, 81°·0. Bombay has the greatest rainfall, 99·74 inches. London occupies the unenviable position of the dampest station, 80 per cent. The same magazine contains a discussion of the severe thunderstorm which visited London on

August 17. The greatest rainfall on this occasion was 2·08 inches at Wimbledon, and the least at Hackney, 0·27 inch. In connection with the climatology of the British Empire, it may not be generally known that the Annual Reports of the Army Medical Department contain meteorological summaries for a number of stations mostly in the northern hemisphere, *e.g.* the Mediterranean, Africa (including Egypt), and the East and West Indies. The last Report published is for the year 1885, and contains the results of observations and the extremes from nineteen stations.

It is stated in the *Meteorologische Zeitschrift* for October that a new edition of Prof. H. Mohn's "Grundzüge der Meteorologie" has just been published by Reimer and Co., of Berlin. The fact that the work has reached a fourth edition in twelve years shows the favour with which it has been generally received. The plan remains the same as before, but both the text and the plates have been corrected to correspond to the recent progress of the science.

Mr. H. Allen Hazen has contributed an article to the *American Journal of Science* for October on the relation between wind-velocity and pressure, giving a summary of the better class of experiments, the methods employed, and the results arrived at, from those of Borda, in 1763, to the present time. The methods of investigation generally adopted are (1) carrying a plate either in a straight line or in a circle; and (2) allowing a current of air to impinge normally upon the plate. The results of Borda's observations are expressed in the formula—

$$p = (\cdot 0031 + \cdot 00035c)sv^2,$$

in which p = pressure in pounds; c = contour of plate in feet; s = surface in square feet; and v = velocity in miles per hour. In some careful experiments made at Washington in 1866, the formula obtained, viz.

$$p = (\cdot 0032 + \cdot 00034c)sv^2,$$

shows a remarkable and unexpected coincidence with Borda's results, with an entirely different apparatus. By far the most careful experiments with a whirling machine were those of Hagen, in 1873, with plates varying in size from 4 to 40 square inches in area. His formula is—

$$p = (\cdot 0029 + \cdot 00014c)sv^2;$$

and these results have been used by Prof. W. Ferrel in his recent discussion of this question. Various other experiments are discussed, including those lately made in France on a train running at increasing velocities, which give the formula—

$$p = \cdot 000535sv^2.$$

The author expresses the opinion that further experiments are much needed, with larger plates than 2 feet square, and with high velocities with a straight-line motion. In connection with this subject it may be mentioned that the Royal Meteorological Society have appointed a Wind-Force Committee to consider the relation existing between velocity and pressure, together with other anemometrical questions, and a preliminary report was read in the spring of this year.

The publications of the Swedish Meteorological Office are somewhat in arrear, the volume recently published being for the year 1882. It contains observations *in extenso* from eighteen stations of the second order, and monthly and yearly results of 117 stations, among which are seventy-nine for temperature only and several that have been established in the interest of forestry. The Central Office has no station of the first order, but publishes the observations of the Upsala Observatory, which is an independent institution. From this Observatory we have very complete observations from 1855 to 1886, in addition to very valuable works on the classification of clouds and the movements of cirrus clouds, by Dr. Hildebrandsson. The Central Office publishes, however, a monthly weather report, in the service of agriculture, which is brought out to date. The Swedish network of stations was established in 1856, by the Royal Academy of Sciences of Stockholm, and in 1873 the present Office was founded, with Dr. R. Rubenson as Director. The Office for Marine Meteorology, established in 1877, is also an independent institution; the logs used are those of the English Meteorological Office, with the addition of the headings in Swedish. By mutual agreement, Sweden deals specially with the Baltic, while Norway takes the North Sea, the data collected being exchanged by the respective countries.

The Report of the Meteorological Service of the Dominion of Canada for the year 1884, just issued by Mr. Carpmael, shows satisfactory progress in the various departments. Several new stations have been added, and the number for which monthly and yearly averages are given amounts to 136. Eighty-three per cent. of the storm warnings issued during the year have been verified; weather predictions have also been disseminated throughout portions of the country by means of large disks attached to the railway cars. These disks have the image of the sun, representing fine weather, the crescent moon, for showery weather, and a star, for wet weather, painted on them, in addition to words. The percentage of verification of these predictions is also very satisfactory. The climatological tables show that the highest mean annual temperature was 47°·81 at Windsor (Ontario), and the lowest at Fort Chipewan (North-West Territory), 26°·65. The records for Hudson's Bay Territory are not complete, but would probably have shown a lower mean. The maximum shade temperature was 100° at Chaplin (North-West Territory) in June, and the lowest at St. Andrews (Manitoba), −53°·3, in January; with one slight exception this station had also the largest mean daily range, viz. 24°·75. Sunshine-recorders are erected in five provinces only; in these Winnipeg has the maximum sunshine, 45 per cent., and Pembroke (Ontario) the least, 30 per cent., of the possible amount. The greatest mean rainfall in any whole province was 48·46 inches in Newfoundland, and the least, 9·90 inches, in North-West Territory on 48·6 days. The greatest average of rainy days was 151·5 in Prince Edward's Island. The distribution of rainfall in Ontario is also represented by maps for each quarter and for the year. With a view to enhancing the value of the tables, we suggest the desirability of arranging them according to the international scheme, instead of in the present form; or at least of printing the extreme values in thick type, as is usually done in other countries.

The chief feature of the United States *Monthly Weather Review* for July last is the unusually high mean temperature over the central and northern parts of the country; in some portions it averaged from 4° to 7° above the normal values, and was the warmest that has occurred since the establishment of the Signal Service stations. This fact is interesting in connection with the weather experienced in some parts of this country, where there was an excess of 2° to 5° in all districts. Descriptions of the storms which occurred over the North Atlantic are given; the average number of areas of low pressure for July during the last fourteen years is nine, for July 1887 the paths of seven such areas are traced, being two less than the average. The storm of the 26th is the one in which the high wave struck the s.s. *Umbria* (see Nature, vol. xxxvi. p. 508). This depression was first charted in N. 55°, W. 25°, on the 25th, and its presence was indicated northwards of the British Isles during the 27th and 28th. The *Review* also contains a discussion of the North Atlantic storms during 1885; of sixty storms which advanced over the ocean from the American continent, twenty-eight were traced to European waters. Fifty-nine storms first appeared over the ocean, of which about 65 per cent. were traced to the west coast of Europe. A table is given showing the positions of centres of areas of mean high and low barometer for each month, and explains why in March and October the storm areas moved northward before reaching European waters, and that in August the depressions did not move eastward owing to unusually high pressure along the middle latitudes. Attention is drawn to the fact that, as a rule, the storms which do traverse the ocean leave the coast north of the fortieth parallel; only a very small number of the storms which advance from southern latitudes cross to the northward of the trans-Atlantic ship routes.

A series of very interesting articles, from the pen of Dr. Oscar Doering, on the inter-diurnal variability of temperature at places in the Argentine Republic and South America generally, are being published in the *Boletin de la Academia Nacional de Ciencias* of Córdoba. Investigations of this kind have been very seldom undertaken, although Dr. Hann and Dr. Supan have pointed out that the variability of temperature is a factor of eminent importance, affecting the habits and character of mankind, and also partially the distribution of plants. Dr. Hann, in his elaborate paper upon this subject presented to the Vienna Academy on April 15, 1875, and based upon such observations as were then available, defines the variability of temperature as the differences of temperature of two immediately succeeding intervals of time which do not belong to the daily and yearly period; or, in other words, as the differences of temperature between two short intervals that lie within the daily or yearly period, *minus* the amount of the periodical (or normal) variation. In part 4, vol. ix., of the above-mentioned Bulletin, Dr. Doering has calculated the variability for Concordia (lat. 31° 25′ S., long. 58° 4′ W.), but for three years only. The month of October has the maximum value, 4°·6, and April the minimum, 2°·8. The variability during spring is greatest, viz. 3°·9, and least during autumn, viz. 3°·0, and the mean for the year is 3°·6, or about 0°·4 above that for Buenos Ayres. The hourly observations published by the Meteorological Council, with the daily means ready calculated, afford excellent materials for similar investigations. The preceding number of the Bulletin contains the meteorological observations made at Córdoba during the year 1885. The absolute maximum shade temperature was 100°·9 in December, and the minimum 14°·9 in June, giving an annual range of 86°·0. The maximum solar temperature was 147°·4, in February. The mean relative humidity ranged between 81·7 per cent. in March and 61·1 per cent. in August. The rainfall amounted to 24·26 inches; the wettest month was March, 5·96 inches, and the driest, May, 0·04 inch. Rain fell on 71 days, and snow on one day. The times of rain at the moment of observation, an element much recommended by Dr. Köppen, are also quoted.

THE WORK OF THE INTERNATIONAL CONGRESS OF GEOLOGISTS.[1]

II.

My only remaining subject is the representation of terranes on maps by means of colours. At present no two organizations and scarcely two individuals use colours in the same way; and it is probably true that every organization and individual publishing many geologic maps has at different times employed the same colour for different terranes, and different colours for the same terrane. It results that the map user can gain no information from the distribution of colours until he has studied the legend; before he can read a new atlas he must learn a new alphabet. The advantage to be gained by substituting a universal language for this confusion of tongues is manifest and great, and has justified the application of much time and attention by the Congress and its Committees. By a series of resolutions a partial scheme has been selected, one colour at a time, and the completion of the plan has been left to the Committee on the Map of Europe. That Committee has prepared a colour legend which is accessible to American geologists in the volume of information published by the American Committee. It is understood in a general way that the Congress reserves final action, and the published legend not only belongs specifically to the map of Europe, but is provisional; still, as this map, if generally approved, will unquestionably be declared by the Congress an authoritative pattern for the guidance of map makers, the plan should be freely criticized at its present stage. The selection of uniform colours is a far more delicate and important matter than the arrangement of taxonomic terms; for while ill-chosen words may quickly fit themselves to new uses, the adoption of an ill-arranged colour scheme must entail continual loss.

In my judgment the scheme provisionally chosen is defective in several particulars, to which I shall presently call attention; but it is necessary to introduce the discussion by a statement of the conditions to be satisfied by a standard colour scheme and a statement of the practical means available. The following are the principal conditions, arranged in an order embodying my estimate of their relative importance:—

(1) The map must be clearly and easily legible. Each colour must be so distinct from each other colour that it can be identified, whatever its surroundings; and all other conventions must be readily discriminated.

(2) The cartographic scheme must be adjustable to the geologic facts; it must not require that the facts be adjusted to it.

(3) The same scheme should serve both for general maps—as, for example, those representing only systems—and for detail maps, representing numerous smaller divisions.

(4) Undue expense should be avoided. The amount and consequent utility of colour cartography is largely limited by its cost.

(5) It should be easily fixed and retained in the mind. This is best accomplished by making it orderly.

(6) Other considerations permitting, the map should please the eye. Since the arrangement of colour areas cannot be foretold, this can only be accomplished by admitting a certain range of choice. If allowed sufficient latitude in the selection of tones, an expert colourist can ameliorate an offensive combination of hues.

(7) Other considerations permitting, the establishment of a universal system should involve the least possible inconvenience. But as the inconvenience of change is temporary, while the inconvenience of a bad system is lasting, this consideration should yield to every other.

The art of mapping geologic terranes by means of colour is well developed, and its methods, viewed from the geologist's stand-point, admit of easy characterization. Colour may be varied in two distinct ways—in hue and in tone. Hues differ in quality, as yellowish-green and bluish-green. Tones differ in strength, as pale green and dark green. A colour is printed either solid or broken; it is said to be broken when applied in a pattern, as in lines or dots, or when it is interrupted by a pattern. The difference between solid and broken colours is a difference of texture. The primary discriminations in mapping are through hue, tone, and texture.

The map engraver produces texture in three ways. In the first way a single impression is made with the broken colour. The white of the paper, displayed where the colour is interrupted, combines with the colour in the general effect, producing a paler tone of the same hue. In the second way two impressions are made, one with solid colour, the other with broken, and the two impressions have the same hue; they may or may not differ in tone. This is monochromatic over-printing, and its general effect agrees in hue with the single impression, but differs in tone, being darker. In the third way two impressions are made, one solid, one broken, and their colours differ in hue. This is bichromatic over-printing, and its general effect differs in hue as well as tone from each of the colours combined in it. The first and second ways produce texture monochromatically, and do not yield a new hue; the third way produces texture bichromatically, and yields a new hue. It is practically impossible to obtain a texture effect without modifying the original tone.

The natural gradation from hue to hue is absolutely continuous, and the number of hues is infinite; the number of tones of each hue is likewise infinite. The number of hues and tones the eye can discriminate is finite, but very great; it is stated that 1000 hues have been distinguished in the solar spectrum. But the number of hues and tones that can be combined in a map is small. As a matter of perception, every colour is modified by the colours adjacent to it. The same hue affords different sensations when differently surrounded, and different hues may afford the same sensation. The same is true of tones; and there is a certain interdependence of hues and tones in this respect. In a geologic map each colour is liable to fall into various combinations, and two colours little differentiated occasion confusion. There is therefore a somewhat narrow limit to the employment of hues and tones. The matter has not been fully worked out, but it is probable that twenty is as large a number of hues as can safely be employed in connection with tones. Texture admits of very great variation. The various colour schemes submitted to the Congress and printed in the report of the Bologna meeting afford, with their manifest permutations, about 200 distinct textures, and I am satisfied from a study of these and others that as many as 100 can be chosen that are not subject to confusion. It follows that a map or atlas expressing few distinctions need use only hues, or only hues and tones, but where numerous distinctions are to be made, recourse must be had to textures.

The printing of a large number of textures of the same hue produces a greater number of tones than can be discriminated, and its effect is to confuse and nullify any distinctions (within the range of that hue) based purely on tone. The printing of a large number of bichromatic textures causes the same result, and it also produces a greater number of hues than can be discriminated. Its effect is to confuse and nullify distinctions based purely on tone, or on hue, or on tone and hue together.

In the colour scheme prepared for the map of Europe, thirty-eight distinctions are made. There are twenty-four hues, and

[1] Vice-Presidential Address read to Section E of the American Association for the Advancement of Science, August 10, 1887, by Mr. G. K. Gilbert. Continued from p. 22.

the remaining fourteen distinctions are accomplished by variations of tone. While it may be possible to select twenty-four hues available for indiscriminate combination, there can be no question that those provisionally printed by the Committee will fail to maintain their distinctness when variously combined upon a map. Under the influence of such chromatic environments as are sure to be encountered, the four yellow hues of the Tertiary cannot be discriminated, and the same difficulty will arise with the two hues of gray assigned to the Carboniferous, and with the hues of gray and brown assigned respectively to the Permian and the Devonian. Some of the tones likewise are not sufficiently distinguished. Two of the blues of the Jurassic, two of the browns of the Devonian, two of the rose tones of the Archæan, and the two violets of the Trias, are open to this criticism. A certain amount of adjustment can be made in the final selection of inks, and probably all the defects from tone can be thus remedied, but the confusion of hues is more difficult to eliminate, for the great number of the hues interferes with the separation of those that are too approximate. To strengthen one contrast is to weaken another.

In order to judge of the availability of the scheme for the production of detail maps, it is necessary to consider the resolutions of the Congress as well as the printed legend. A resolution provides that the subdivisions of a system shall be represented by shades of the colour adopted for the system, or by broken colour or other texture devices; and it is further provided that the shades, whether produced by solid colour or by texture, shall be so arranged that the darkest or strongest represent the lower divisions of the system. The resolution is in French, and the word I have translated shade (*nuance*) is one which applies popularly to either hue or tone, while in the scientific terminology of chromatics it applies to hue only. The Committee on the map has taken it in its popular sense, and has represented some subdivisions by hues, and others by tones; for example, Pliocene and Miocene are assigned two tones of the same hue, while Oligocene and Eocene have each a separate hue. The Upper Cretaceous and part of the Lower Cretaceous are assigned a green hue in two tones, while the Gault and the Wealden, classed as subdivisions of the Lower Cretaceous, have independent hues of green. Of the six reds assigned to volcanic rocks, two agree in hue and differ in tone, while the remainder have distinct hues. As the legend stands, both major and minor distinctions—that is to say, the discrimination of groups, the discrimination of systems, and the discrimination of divisions smaller than systems—are all accomplished by differences of hue; while the discrimination of minor divisions is accomplished indifferently by variation of hue and by variation of tone. The same means performs several functions, and the same function is performed by several means.

It is stating the same thing from another point of view to say that the Congress and its Committees have used the term colour in its popular rather than its scientific sense. Scientifically, a colour is a particular tone of a particular hue, and the number of colours is infinite. Popularly, a colour is an assemblage of contiguous hues and their tones, to which a name has been given. Each hue and tone within the range covered by the name is a shade of the colour. It is in this popular sense that the resolutions assign a colour to each system, and assign shades of the system-colour to the subdivisions of the system.

Now, if in the variation of a system-colour, by textures or otherwise, a single hue is adhered to, the system-colour remains distinct from other system-colours throughout all its modifications and their modifications; but if hues as well as tones are varied, the inevitable result is confusion, for some of the hues of one system-colour will approach too near to hues of other system-colours. With a multiplicity of minor distinctions the main distinction of system from system will be lost.

Another difficulty lies in the fact that the Quaternary and Devonian colours, while strongly contrasted in tone, are nearly identical in hue. This does not affect their use in a general map, but in a detail map the stronger tones of the Quaternary gray will approach too closely the paler tones of the Devonian brown.

These criticisms apply to those features of the scheme which affect its adoption for general and detail maps of European countries. There is one of equal or greater importance affecting its application in other continents. It is adjusted to the rock systems of Europe exclusively, and makes no provision whatever for the systems of other parts of the earth. The geologists of Wisconsin, for example, cannot use it without calling the Keweenawan either Cambrian or Archæan. If they were in doubt which division should hold it, but inclined a little one way or the other, they could express their qualified opinion in the notation provided by the Map Committee; but having attained an unqualified opinion that the terrane belongs to neither of these two categories, they find no means for expressing their conclusions. The scheme cannot be applied to the geology of India, of New Zealand, or of Australia, without misrepresentation. It is not universal but local, and this because it is founded on the fallacy of a world-wide unity of geologic systems.

So far as the geology of the world is concerned, it would be better to adopt no convention at all as regards map colours than to adopt one carrying with it and promulgating a vicious classification. Uniformity is not worth purchasing at the price of falsification. If the members of the Congress cannot agree upon a plan having the flexibility demanded by the geologic facts, it will be best to limit its action to the local problems involved in the map of Europe. I believe, however, that the necessary flexibility is attainable; and before proceeding to further criticism of the Committee's scheme, I will give the outlines of a plan which appears to me to combine the advantage of flexibility with a number of other desirable qualities.

The plan is founded on the universality of geologic time and the diversity of local geologic histories as expressed in rock systems. Geologic periods are arranged in linear order. Each one adjoins the next, and together they constitute continuous geologic time, which we may conceive as represented by a straight line. The stratigraphic systems of a country have likewise an order of succession, and their arrangement is linear. They are not always continuous one with another, but the history recorded by the systems and the breaks between them is continuous, and may be represented by a straight line, equal and parallel to that of geologic time. And so for each country. A colour scale which shall represent each and all of these parallel lines must be itself linear and continuous, and fortunately we have such a scale furnished us in the prismatic spectrum.

I propose, first, that the continuous prismatic spectrum be adopted as the standard universal scale for continuous geologic time. I propose, second, that the conventional time scale, based on the geologic history of Europe, be complemented by a colour scale, prismatic but discontinuous. I would assign to each period, not a certain portion or area of the spectrum, but a specific colour defined by its position in the spectrum. This colour scale will also apply to the geology of Europe. I propose, third, that the students of each geologic district shall assign to the stratigraphic systems of that district a set of prismatic colours so selected from the spectrum as to properly represent the relation of each system to the time scale, provided that relation is approximately known. Under this rule a system corresponding partly with the Cretaceous and partly with the Jurassic will receive a prismatic colour intermediate between those assigned to the Cretaceal and Jural divisions of the time scale. I propose, fourth, that systems whose relations to the standard time scale are not even approximately known be given tentative positions in the time scale and assigned the corresponding colours; and that such provisional colours be distinguished by a special device.

Of this device I will speak later, but before we leave this part of the subject the capability of the plan to express the facts should be more clearly characterized. Continuous geologic time being equated with the continuous spectral band of light, each period is theoretically equated with a segment of that band including all the hues between certain limits. But practically the period is represented in the colour scale only by the central hue of the segment, and there is nothing in the nature of this hue to indicate the length of the segment. Similarly each local system is represented only by the hue corresponding to the middle of the equivalent period, considered as a part of the continuous time scale, and this hue gives no information as to the magnitude of the system or the duration of the corresponding period. When a non-European system is represented on a map with the Devonal colour, all that is expressed is that the middle of its period coincides with the middle of the Devonal period; the whole period may equal the Devonal or may be shorter or may be longer. With this limitation the scheme is able to express the exact facts, or the exact state of opinion, in regard to correlation.

I propose, fifth, that the subdivisions of systems be represented, if their number is small, by distinct tones of the hue assigned to the system, and if their number is great, by monochromatic textures. It having been provided that systems shall be distinguished by means of hues, it is now provided that hues shall have no other function. This secures the integrity of the distinction between systems, whatever the minuteness of subdivision.

The idea of using the spectral colours in their proper order is not novel. It has entered into half the plans submitted to the Congress, but each author has introduced other colours also, or else has undertaken to use the spectrum colours more than once, under the impression that they do not afford the necessary range or variety. This impression is based largely upon the popular meaning of the word colour. It is indeed true that if we limit ourselves to those parts of the spectral series which have univocal names, we have only six or seven distinctions; and it is further true that if we have recourse to binomial designations, such as yellowish green and greenish yellow, we obtain rather indefinite conceptions; but to men of science there are better resources than those afforded by the language of every-day life. The spectrum has been elaborately studied, and the relations of its dark lines to its colours have been determined. Its wave-lengths have, moreover, been measured, and by such means as these we are furnished with three different scales, any one of which is adequate to the precise definition of any hue of the continuous series. What needs to be done is this. When the divisions of the time scale have been decided on, the spectrum must be studied to ascertain the best selection of hues. Their number must, of course, be that of the number of divisions of the time scale, and they must be so chosen that the degree of separateness of adjacent colours shall be everywhere the same, as judged by the normal human eye. Then define each hue by its wave-length or its position in the Kirchhoff scale, and define it also in terms of the best combination of pigments with which it can approximately be reproduced for practical use. It is, of course, impossible to copy the prismatic colours with accuracy, because the colours of pigments are impure, but this difficulty will not seriously interfere with the employment of the prismatic colours as a standard.

The practical question whether the spectrum will give a sufficient number of hues so far separated from each other as to be distinguishable in all the arrangements occurring on maps has received such consideration as I have been able to give it, and it is my judgment that the maximum number of hues that can safely be used falls somewhere between fifteen and twenty. There will certainly be no difficulty in thus constructing a standard colour scale with about a dozen terms.

The employment of the spectral colours in this manner leaves three groups of colours unassigned—the purples, the browns, and the grays. If the spectral colours be arranged on the circumference of a circle so that each diameter of the circle connects hues that are complementary, it is found that they occupy the greater part, but not quite all, of the circumference, and the colour needed to fill the vacant arc is purple. The hues of purple might then, if deemed necessary, be added to one end or the other of the spectrum, thus increasing the range from which to select colours for the time scale.

My sixth proposition is to assign the browns to volcanic rocks. I would leave the grays unassigned.

It will be observed that no intimation has been given as to whether the violet end of the spectrum should apply to the newest system of strata or the oldest. It must of course be definitely assigned to one or the other, but the particular assignment is a matter of indifference.

The main features of the proposed prismatic scheme have now been set forth, and you are fairly entitled to exemption from the minor features, but there is one detail that can hardly be omitted. In one of the main propositions it was provided that some special device should distinguish colours assigned to uncorrelated systems, and I feel it incumbent to show that a suitable device can be found. Of a number that have occurred to me as about equally available, I will mention but a single one—the over-printing, in small dots, widely separated, of the complementary colour. The complementary colour is selected because it does not disturb the relation of the system-colour to the colours of adjacent systems. Bichromatic over-printing produces a hue intermediate between the two hues combined, but the hue midway between a system-colour and its complementary colour is white or gray, and if only a small amount of the complementary colour is added, the system-colour merely becomes paler or duller, when viewed from such a distance that the colours blend.

The prismatic colour scheme, having been constructed for the express purpose of securing a degree of flexibility that will fit it for universal use, need not be further compared in that regard with the scheme published by the European Map Committee. Enough has also been said to show that its superior perspicuity is claimed both for general and for detail maps. A few words will suffice to compare the two systems in other respects.

As regards the expense incurred in the production of general maps, neither has any notable advantage, and they are not yet sufficiently developed to permit a comparison as regards the cost of detail maps. Their capability for the production of pleasant colour effects can best be judged when maps have been actually made, but it may be said in a general way that the Committee's scheme will afford more strong contrasts between adjacent colour areas than the prismatic. The maps coloured by the former will be relatively lively, those coloured by the latter relatively quiet. It is provided by the Committee that the volcanic colours shall be not merely red but strong. On a general map volcanic areas cover comparatively small spaces, and strong reds thus disposed will ordinarily add brilliancy; but the detail map of a volcanic district, thus coloured, will be disquietingly suggestive of active eruption.

The alphabet of colours for the prismatic scale will be the more easily learned of the two, because it is orderly, and because its order is already familiar in the spectrum. The Committee's scheme, however, has some old-fashioned mnemonic features which the prismatic lacks. The green of the Cretaceous is connected with greensand, the red of volcanic rocks with fire, and the rose of the Archæan with feldspar; and the gray of the Carboniferous mildly suggests the blackness of coal.

In respect to facility of introduction the Committee's scheme, being essentially a compromise of existing colour scales, has the advantage that to most users it is not entirely novel. The prismatic scheme on the other hand has the advantage of being orderly. It scientifically differentiates the functions of hues and tones, and though each one of its colours may be different from what the individual geologist has previously employed for the indication of the same system, the order of the colours is already familiar to him in another way.

This closes my review of the various works undertaken by the Congress. Some of these have been favoured, others opposed, and reasons have been given. But there is a general consideration or criterion applicable to all, which has nearly escaped mention, although it is of pre-eminent importance. When a matter is proposed for regulation by the Congress, the first question which should be asked is whether it falls within the legitimate purview of a convention of geologists. It manifestly does not if it belongs to some other science rather than to geology, and objection has on this ground been made against the regulation by our Geologic Congress of the nomenclatures of palæontology and mineralogy. But not all geologic matters even are properly subject to settlement by convention. This is peculiarly the case with geologic facts. Science is distinguished from the earlier philosophies of mankind by the peculiarity that it establishes its fundamental data by observation. The old philosophies were founded largely upon assumptions, and it was not deemed illogical—perhaps it was not illogical—to appeal to the authority of an assemblage of experts for the establishment of fundamental assumptions. But for science it is not merely illogical, it is suicidal, to establish facts in any other way than by observation. No vote of the most august scientific body can possibly establish a fact, and no vote can have any weight against a good observation.

Now the entire science of geology, using the phrase in a strict sense, is constituted by the aggregation and arrangement of facts, and none of its results can be rendered more true or be more firmly established, or be prevented from yielding to contradictory facts, by conventional agreement. A classification, if it has any value whatever, is merely a generalized expression of the facts of observation, and is outside the domain of the voter. If it comprises all the essential facts, its sufficiency will eventually be recognized, whether its authority is individual or collective. If it does not comprise them, it will inevitably be superseded, by whatever authority it may have been instituted. For this reason I am opposed to the classification by the Congress of the sedimentary formations, and likewise to the classification of volcanic rocks, and I also regard it as ill-advised that the Congress undertook the preparation of a map of Europe, for that—if more than a work of compilation—is a work of classification.

If we examine the other undertakings of the Congress—the definition and gradation of taxonomic terms, the systematization of terminations, the selection of a scale of colours for geologic maps, and the selection of other conventional signs for the graphic expression of geologic phenomena—we find that they all belong to the means of intercommunication of geologists. They affect only the verbal and graphic technical language of the science. Of the same nature is the arbitrary time scale whose preparation I favour—a conventional terminology for the facts of correlation. So we may say, in general, that the proper function of the Congress is the establishment of common means of expressing the facts of geology. It should not meddle with the facts themselves. It may regulate the art of the geologist, but it must not attempt to regulate his science. Its proper field of work lies in the determination of questions of technology; it is a trespasser if it undertakes the determination of questions of science. It may decree terms, but it must not decree opinions.

TECHNICAL EDUCATION.[1]

THE present century has witnessed a vast and almost incredible change in the great industries of the world, and in the progress of the arts and manufactures. The causes of this great change are various, though mutually dependent upon each other, such as the cessation of the great wars that had for so long ravaged the continent of Europe, which enabled many of the most vigorous minds to be turned to the arts of peace; the rapid growth of population, which rendered the wants of mankind more pressingly felt; and the more general spread of education, which caused the great discoveries that have enriched this period to be eagerly taken advantage of and adopted.

Among the many results which have ensued, is one which must be carefully studied, affecting as it does in a peculiar degree our own country at this time.

Since the latter half of the last century, when by the disappearance of forests in the iron-producing districts, resulting from the use of timber as fuel, maternal Necessity had brought forth an invention in the shape of the process of smelting iron ore with coal, progress in machinery and manufactures had steadily been made. The great natural advantages arising from the conjunction, not only of coal and iron in the same locality, but also their immediate proximity to the limestone required in iron-smelting operations, had greatly contributed to this advance, until this country, instead of importing four-fifths of the whole iron used from Sweden, as was the case in 1750, had become the greatest iron-producing country of the world. The invention of the steam-engine in conjunction with the power-loom and other important machines, greatly contributed to the growth of the factory system, the establishment of the cotton, linen, and woollen industries, and the rapid increase of manufactories in general. Owing to the insular position of Great Britain, and the prohibitive laws in force, until fifty years ago the nature of the machinery used in all these manufactures, as well as the technical knowledge and skill of the workman, was prevented from being carried abroad. Thus, as stated in the recent Report of the Commissioners on Technical Education:—

"When, less than half a century ago, Continental countries began to construct railways, and to erect modern mills and mechanical workshops, they found themselves face to face with a full-grown industrial organization in this country, which was almost a sealed book to those who could not obtain access to our factories."

This artificial state of things was not destined to last, for, on the one hand, these countries were keenly alive to the importance of possessing such manufactures, and were determined to obtain them at all costs; and, on the other, it was greatly to the immediate advantage of our manufacturers to sell freely in such a market as began to be opened to them. At the same time skilled artisans were easily found who were willing to accompany abroad machinery which had been constructed in this country, and thus to become the means of disseminating technical education of the most practical type amongst those who were quite as industrious and frequently better educated than the workmen at home.

The efforts of foreign nations to establish mills and workshops of their own did not cease here; for, recognizing the necessity of specially spreading technical knowledge by all possible means, technical schools, instituted and supported by the State, at which instruction could be obtained free, or at almost nominal cost, were established in numerous places all over the Continent. The larger number of these schools have been institutions at which the scientific principles underlying industrial and manufacturing operations, rather than the actual operations themselves, were taught, although there are also in lesser number special technical schools, such as the weaving schools of Chemnitz in Saxony, of Crefeld in Rhenish Prussia, of Basle in Switzerland. From these various schools, numbers of highly educated men have been sent out year by year, prepared, when becoming foremen, managers, or employers of labour, to take advantage of the latest discoveries and improvements in various branches of industry, and keenly alive to the fact that "knowledge is power."

Notwithstanding all this, an enormous increase of trade and prosperity was enjoyed by this country for many years, and notably was this the case after the first International Exhibition in Hyde Park, in 1851, which Exhibition revealed to visitors from all parts of the world much (some persons of the old school are to be found, who assert *too* much), concerning the perfection of our machinery and processes of manufacture which had been scarcely realized before, even by ourselves. This prosperity apparently reached a climax from ten to fifteen years ago, and, since then, trade has assumed a very different aspect. At first the change was felt in relation to countries whose resources were in some respects comparable with our own, and afterwards with others less favourably situated, and in place of supplying them with manufactured articles and machinery, they began to enter into competition, and in many cases successful competition, with this country, even in markets hitherto considered all our own. Indeed, a positive reflex action has actually occurred in some important branches of industry and foreign iron, machines, hardware, and textile goods are imported for home use. The result of this competition has been keenly felt, and the consequent struggle which has taken place in these times of peace has been, and now is, almost as determined and often as bitter as in an open war. That rather doubtful compliment once paid by a great general to the British soldier, that he never knew when he was beaten, could scarcely be applied to the British manufacturer, since there is a very speedy way of settling this point in a commercial transaction; but the question upon which knowledge has often been wanting and information sometimes too tardily sought, is rather as to the cause and its remedy. In some cases the cause is obviously due to the lower wages and longer hours for which foreign workmen will toil, and it may be mentioned, as pointing to what may be sometimes possible in this case, that in the neighbouring industry of wire-drawing at Warrington, which was threatened with extinction, the German competition was entirely met and overcome by the wire-workers voluntarily accepting a reduction in wages of 10 per cent., after four of their delegates had visited the Black Forest and ascertained for themselves full particulars as to the wire industry of that district.

But, on the other hand, there are branches of manufacture in which the state of foreign workmen and workwomen is so pitiable that no right-thinking person would desire to have increased trade in this country at such a price to our own people, though happily there is not much fear of this, since the movement is rather in the other direction. But the question of wages is only one of many causes, for it has been asserted by excellent authorities that it is not in those branches of industry in which foreign wages are lowest and hours longest that competition presses most heavily upon us. Thus, according to the recently published Consular Reports, we have still something to learn in several directions in the matter of finding out fresh markets and accommodating our productions to native wants, instead of trying to force goods of our own pattern and design where they are either not in accordance with native views and prejudices, or are unsuitable to the locality. Again, it is not only the Germans who stamp the words "best Sheffield steel" upon cast-iron axes and knife-blades: neither in the matter of shoddy-manufacturers can this country afford to throw stones at our foreign rivals.

It is not, however, the object of this address to enter into a discussion of the various causes of trade depression, and still less to presume to say how such an undesirable state of things may be met and overcome, but to consider a subject which has recently been very vigorously brought forward in connexion with this matter under the title of "Technical Education." No branch of education has of late attracted so much attention as this. It has formed not only the text of the Presidential Address of the British Association in 1885, and part of that at the recent

[1] Part of Inaugural Address of session of University College delivered at St. George's Hall, Liverpool, on October 1, 1887, by Prof. Hele Shaw, M.Inst.C.E., of the University College, Liverpool.

address at Manchester, but of innumerable other speeches, pamphlets, papers, and even books, one of the very earliest and most brilliant of which was a treatise from the pen of the late Mr. Scott Russell. It has been quite recently the subject of a special Government Bill, which was considered sufficiently urgent to be carried through almost to the last stage when other Bills were being dropped right and left, and then disappeared only with the full assurance of a revival in more vigorous form at an early period of next session; while only in last July there was formed "A National Association for the Promotion of Technical Education," which numbers as its President, Vice-Presidents, and Committee, many of the most able politicians, experienced men of business, and well-known men of science.

These facts are quite sufficient to show that there is now a very prevalent and wide-spread belief that the subject of technical education has become one of pressing national importance. There are, indeed, already not wanting persons who connect the subject with the terms "foreign competition" and "commercial depression," by a train of reasoning apparently somewhat as simple as the following:—

1st proposition.—Bad trade is the result of foreign competition.
2nd proposition.—Foreign competition derives its strength from superior foreign technical education.
Conclusion.—Therefore bad trade at home is due to superior technical education abroad.

This mode of reasoning is brief and conclusive enough to satisfy even the most superficial, it is easily portable, and has the advantage of admitting of illustration in certain special cases in which both propositions and conclusion are true, but it is nevertheless a striking example of the danger of arguing from the special to the general. Without, however, accepting such a sweeping generalization, it may be safely said that foreign countries have derived great benefit from their systematic encouraging of technical teaching, and we may proceed to consider briefly what progress we ourselves have made in this direction.

In the first place it may be well to ask what the term "technical education" really means? Most people have, no doubt, a general idea on the subject, but there are a great many who freely discuss the question, who would be woefully at a loss if asked for an exact definition; and if anyone doubts the truth of this, let him try the experiment on a few friends. The answer which will generally be given, with some hesitation, will probably have some not very distinct reference to instruction in the use of tools, backed by allusion to carpentering by way of illustration, or will, perhaps, be some mention of chemistry, or other branch of science, or, as a final resort, "something to meet the German competition." Now the fact is that the first of these may not be really technical instruction at all, but only manual training as part of a general education, as, for instance, is now given out of school hours in the working of wood to the boys at most of our Colleges, partly to keep them out of mischief and partly to train the hand and eye, but in which case there is not the slightest intention or idea that any of the boys shall actually become a carpenter. The last answer, however grotesque it may seem, is much nearer the truth, as it connects technical instruction with a special *object* in view. Now that this is really the idea of those who have thought most carefully over the subject is made clear by the terse and excellent statement of the aims of the Association for the Promotion of Technical Education, one of which is "to effect such reforms in our educational system as will develop in the best way the intelligence of those of all classes upon whom our industries depend," the Association itself being formed because of "the general expression of opinion throughout the country as to the necessity of a reform in our system of national education, with the object of giving it a more practical direction." Thus we may accept the following definition of a writer on the subject, that "by technical education is meant special instruction in some scientific, artistic, or mechanical process or handicraft as distinguished from purely literary instruction"; or that by another writer, who defines it as "special training for an industrial pursuit as distinguished from a general preparation for any calling hereafter to be chosen." Thus technical education will comprise a very wide range of subjects, not those merely taught with a view to manufacturing, mechanical, and artistic pursuits, but will comprise the instruction given in a medical school, in an agricultural college, and even commercial education, which last now forms a distinct feature of our own College, and the reform of which branch of education is one of the special objects of the Association above alluded to. It is therefore at first surprising to the uninitiated that we find the following definition in the recent Bill for Technical Education: "The expression technical instruction means instruction in the branches of science and art with respect to which grants are for the time being made by the Science and Art Department, or in any other subject which may for the time being be sanctioned by the Department." This definition is no doubt quite satisfactory to the authorities of the Department, although it savours strongly of the opinion attributed in a well-known series of rhymes to a certain eminent University don, who is made to assert—

> "I am the Master of this College,
> And what isn't taught here isn't knowledge."

And though this definition happens at present to exclude manual and w rkshop instruction, concerning which the mover of the Bill, Sir Wm. Hart Dyke, expatiated somewhat eloquently and at considerable length when moving the second reading of the Bill—but this is a trifling matter, as no doubt when the Science and Art Department has had time to go into the matter, and to study the subject, and has made arrangements for teaching and examining it, it will be "sanctioned" with the rest, and become technical instruction. It must, however, be recognized that the Science and Art Department is the most important institution in this country for the promotion and encouragement of technical education, and has done a work, especially in the direction of evening-class teaching to the artisan class, which must have proved of incalculable benefit, and it will be well to study the progress made in science instruction, as affording some index of our general progress in technical education. The following table gives the result of work during the last ten years, showing in three columns: (1) the amount of the grants given to teachers for successful candidates on the system of payment by examinational results; (2) the actual number of students under instruction in science classes fulfilling conditions which would enable a grant to be claimed; (3) the number of papers actually worked in different science subjects. The three columns are independent of each other in a certain sense, since a registered student may either take several papers, or may, on the other hand, possibly not come up for examination at all, or, coming up, may fail to secure a grant.

TABLE I.—*Results of Science and Art Department during the last Ten Years.*

Year.	Grants. (1)	Students under Instruction. (2)	Examination Papers actually Worked. (3)
	£		
1878	39,073	59,705	66,365
1879	41,036	56,752	70,248
1880	43,863	60,041	72,428
1881	47,231	61,180	75,735
1882	49,700	67,315	79,786
1883	50,967	71,164	83,387
1884	61,638	77,519	90,825
1885	69,113	81,491	101,275
1886	79,000	97,664	118,241
1887	88,000	103,362	131,896

The results are striking, but in order to reveal their significance more closely, the diagram, Fig. 1, is reproduced from a recent memorandum of expenditure and estimates of the Department, in which the height of the lines in each year from the base line gives the value of grant, number of students, or of worked paper.

The three curves represent at once to the eye the rapid progress which is being made. Indeed, the rate of increase is twice as great during the last two years as during previous years, and, so far from there being any want of appreciation of technical instruction, the results are such as might possibly cause the taxpayer some concern; on this point, however, the memorandum states:—"There is no reason to suppose that the expenditure will rise at the present rate; on the contrary, even without looking at the increased rate of rise of the last few years, as a sudden augmentation due to special causes, it is obvious that as the limit is approached the rate of rise must rapidly diminish. This limit, as far as it can be arrived at by calculation from population, &c., probably about 200,000 persons under instruction in science—there were last session 110,000 under instruction. Continuing the curve for science as it may reasonably be expected to run, we should arrive at about 110,000 in 1896." In any case there is no real cause for alarm, because the standard of work required to secure a grant can always be raised, and, as a matter of fact, appears to be steadily rising year by year, and, after all, the sum of even £101,175, which is the estimated expenditure for the current year in aid of science instruction, is a remarkably small annual expense for the instruction of 103,362 students all over the country.

There has been for several years at work another central agency, which promotes technical instruction in the same manner as the Science and Art Department, viz. by payment upon the results of examination. This body is known as the City and Guilds Institute of London. These examinations carried on by this body were originally established in 1873 by the Society of Arts—the subject that year being cotton manufacture, steel, and carriage building, the number of candidates being respectively one, two, and three, making a grand total of six. The next year, gas manufacture and agriculture were added, and the total rose to thirty-six. Subjects continued to be added, and the

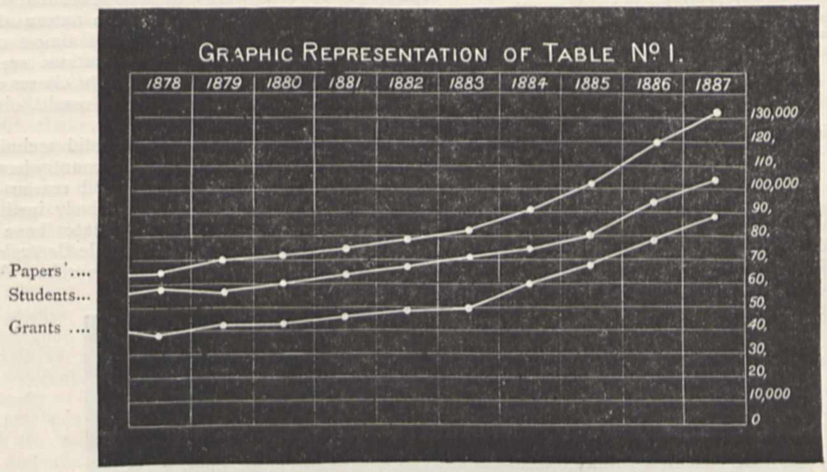


FIG. 1.—Science and Art Department.

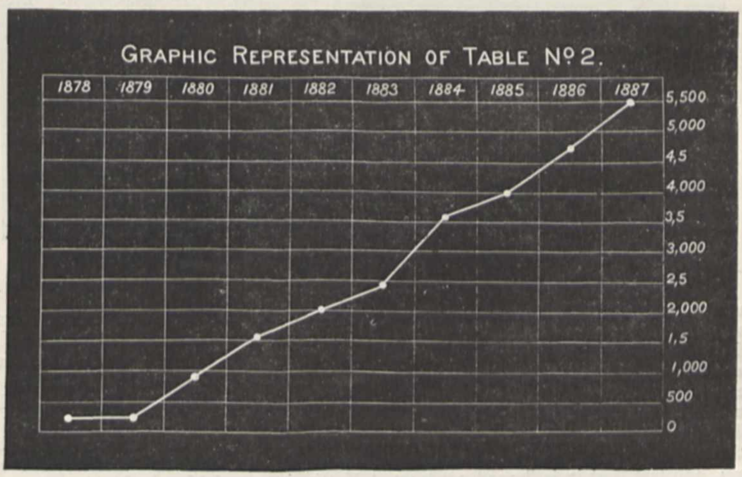


FIG. 2.—City and Guilds of London.

numbers to rise year by year, until ten years ago the latter had reached 184, since when the following table shows the progress made, the City and Guilds taking over the whole responsibility of the work in 1881.

TABLE II.—*Society of Arts and City and Guilds Examinations.*

Years.	1878	1879	1880	1881	1882	1883	1884	1885	1886	1887
Number of Candidates.	184	202	803	1563	1972	2397	3635	3968	4764	5508

I have plotted the above results in a similar manner to those of the Science and Art Department, and it will be seen (Fig. 2) that the rate of growth is far more rapid; and rich as are the worthy livery companies of grocers, fishmongers, tanners, spectacle makers, and others, who form the City and Guilds Institute, they too must have reason to confess that technical education, towards which they have recently contributed not less than a quarter of a million of money, is not quite at a standstill, for at the present rate of growth the number of candidates, large as it now is, will have doubled in the next seven years, though even this, with an assured income of £33,000 a year, may not give them cause for alarm. It may be well to explain that the examinational work of the City and Guilds, and that of the Science and Art Department, not only do not clash, but bear an important and valuable relation to each other. Thus the former is more distinctly technical, dealing with special details of trades and manufactures, and the term "technological examination" is always employed to emphasize this point, and before a full technological certificate is granted by the City and Guilds Institute in any subject, certificates in the elementary stage of certain specified theoretical examinations of the Science and Art Department must be produced. A comparison of a few of the subjects will at once make this clear, the numbers appended to the subjects in the following list being those attached to them in the syllabus of each examining body.

SCIENCE AND ART DEPARTMENT.	CITY AND GUILDS.
Subject II.—Machine Construction and Drawing.	(27) Tools. (*a*) Wood Working. (*b*) Metal Working.
Subject III.—Building Construction.	(34) Carpentry and Joinery. (35) Brickwork and Masonry.
Subject VI.—Theoretical Mechanics. Subject VII.—Applied Mechanics.	(28) Mechanical Engineering.
Subject IX.—Magnetism and Electricity.	(22) Electrical Engineering. (*a*) Telegraphy. (*b*) Electric Lighting. (*c*) Electrical Instrument Making.
Subject X.—Inorganic Chemistry. Subject XI.—Organic Chemistry.	(1) Alkali and Allied Branches. (4) Coal Tar Products. (7) Oils, Varnishes. (8) Oils and Fats. (9) Gas Manufacture.
Subject XIX.—Metallurgy.	(10) Iron and Steel Manufacture.

Practical examinations are held by the City and Guilds in weaving and pattern designing, in metal plate work, in carpentry and joinery, and in mine surveying, while last year, for the first time, an examination was held in typography. This latter was conducted in several printing works placed at the disposal of the Institute, and thirty-two out of the seventy-seven candidates succeeded in composing and printing the difficult manuscript supplied to them—sufficiently well to obtain a certificate.

There is nothing at all approaching our own system of payment by results in any country in Europe, and eminent foreign educationalists have frequently deplored the absence of such in their own respective countries. This system has given particular vitality to that most valuable kind of education—evening class instruction; and as an examiner for both the bodies above alluded to, and after an experience—not a very enjoyable experience, and not the experience that a rich man would continue to indulge in—of upwards of 6000 examination papers, I may be permitted to testify to the valuable nature of the work done by the students, and the possibility of almost complete prevention of "cram" when proper precautions are taken. Thus, though large numbers of technical night classes exist all over the Continent, it is very doubtful if the results obtained by them are superior or even equal to our own.

When it is considered what splendid technical training the workshops and manufactories of this country have afforded, there will, perhaps, appear to be very good reasons why, originally, technical schools were not so extensively instituted at home as abroad, where almost all foreign States have established and maintained technical schools, the École Centrale at Paris being almost the solitary exception to this rule. When, however

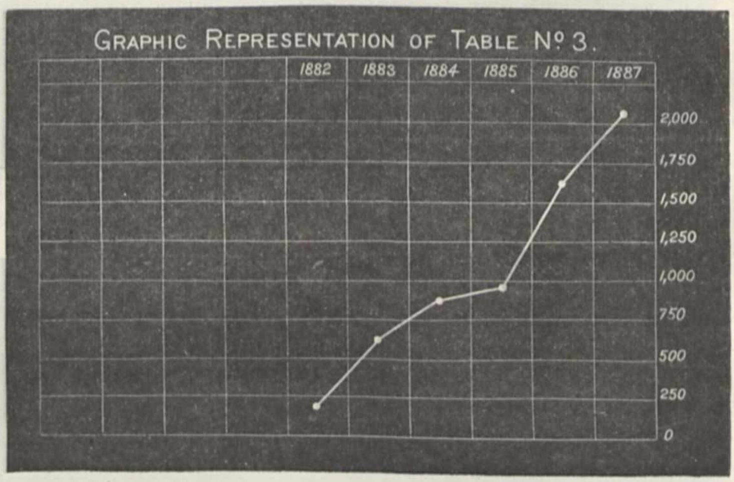


FIG. 3.—University College, Liverpool.

their need was felt, it was not left to the slowly-moving wheels of State to bring such schools on the scene. At first these schools took the form of lectureships and chairs in constructive science, for which the term "engineering" was conveniently adopted, the first of these being at London, Glasgow, and Manchester, and founded in connexion with the local Colleges. These have been gradually followed by Engineering Schools in the Colleges at Leeds, Sheffield, Nottingham, Dundee, Newcastle, Bristol, Birmingham, and last, but it is hoped not least, at Liverpool. These schools give instruction not merely in engineering subjects in a narrow sense of the word, but include in their courses of teaching the wide range of subjects necessary for laying a firm foundation for a successful career in any one of the constructive professions, and prepare a student to enter any of the particular branches into which engineering has become differentiated, and compare in this way with chemical teaching, which is given in places like this city—which may be specialized with a view to particular local industries. Besides these schools, others have arisen of a more special nature, due to liberal-minded men and public-spirited bodies, such as the Weaving and Dyeing Schools at Leeds, upon which the Worshipful Company of Clothworkers have spent between £20,000 and £30,000; the Technical Schools at Huddersfield, Bradford, Glasgow, Manchester, and other towns, some of which will bear comparison with the celebrated foreign schools of Chemnitz, Mulhouse, Verviers, Crefeld, and Vienna. The benefit of such schools has already been felt, for it is most encouraging to find amongst many similar opinions the testimony of the Technical Education Commissioners that—"In those textile manufactures in which other nations have hitherto excelled us, as in soft all-wool goods, we are gaining ground. We saw, at Bradford, merinos manufactured and finished in this country, which would bear comparison in texture and colour with the best of those of the French looms and dye-houses, and in the delicate fabrics of Nottingham and Macclesfield (thanks in great measure to their local Schools of Art) we no longer rely upon France for design."

The address, after pointing out that this country was, taken as a whole, after all not in such a deplorable state with regard to technical education, asserted that such education was of two kinds—general and special. General technical education may be said to be that necessary in all large centres of population, being the preparation for such callings as engineering, architecture, medical science, and other professions, which at any rate a certain percentage of the inhabitants will always follow, besides training of another kind suitable to the artisan class. Special technical education is that necessary in a locality where there are special industries, instances of which have already been given, and others will readily occur to the mind.

The remainder of the address was devoted to considering the educational work of Liverpool and its special technical requirements. A brief reference was made to the progress of University College, as shown by the following table of attendances in the day classes since its foundation in 1882.

TABLE III.—*Entries in Day Classes, University College.*

1882.	1883.	1884.	1885	1886.	1887.
189	625	883	944	1642	2063

These results are better shown graphically in Fig. 3.

During the last few months no less than £30,000 has been contributed to the Engineering Department alone, but the other professorships are all provided for upon an equally sound basis, and Prof. Hele Shaw thus concludes:—

"Hence, side by side with teaching, directed—sometimes perhaps only directed—to the practical purposes of life, we shall, thanks to the liberal endowment of chairs of language, of literature, and of art, always have the more liberal studies, and, as their exponents, scholars of the highest culture. Thus every individual professor thinking, as he ought to think, his subject to be the most important of all (a feeling I must, in common with the rest, confess to having myself), and so led to work for its due recognition, the happy mean will doubtless be maintained between mere idealism on the one hand, and mere routine on the other. Yet one word more. There is another motto prominent upon the College crest ('*Fiat lux*'), in the spirit of which work will always be true to the highest ideal. Our national life depends upon our national progress, and when we cease to advance, decay will speedily follow. Just as surely our College life, vigorous because growing, depends for its vitality upon the reality of the effort we make to carry forward the light of truth, and should never suffer because we strive to keep in touch with the requirements of practical life. Scientific investigation and philosophic research must have their proper place and support, and if allowed fair scope for development, will exercise the needful influence, and one that will be of untold value upon such narrowing tendencies as there may be in our various schemes of technical education."

SCIENTIFIC SERIALS.

American Journal of Science, October.—The relations between wind velocity and pressure, by H. Allen Hazen. A comparative study is made of the experiments carried out by Borda, Hagen, Piobert, Didion, Morin, and more recently at Washington, showing the great necessity there is for further research before absolutely trustworthy results can be obtained. Experiments are much needed, especially with larger plates than 2 feet square, with bodies of other forms than those hitherto employed and with high velocities by a straight-line motion.—Is there a Huronian Group? (continued), by R D. Irving. After establishing the existence of a true Huronian Group, the author proceeds to define its character, showing that many formations even in the Lakes Superior and Huron regions, have been wrongly referred to this type. The presence is clearly demonstrated of two entirely distinct and mutually discordant series in the Marquette, Penokee, and Menominee districts. In all these regions there are great discordances between a lower set of gneisses and other crystalline schists, intruded by granite, and an upper set of detrital rocks carrying iron. The so-called Animikè series is then considered, and referred with the older Penokee formations to the Huronian system.—Oxygen in the sun; contributions from the Physical Laboratory of Harvard University, by John Trowbridge and C. C. Hutchins. The experiments here described have been carried out in order to test the soundness of the conclusion generally drawn from Dr. Henry Draper's discovery of bright spaces in the solar spectrum apparently coincident with the bright lines of the spectrum of oxygen. This conclusion is shown to be at least premature, and in the numerous photographs taken of the solar spectrum by them the authors have failed to discover any line that could with certainty be pronounced brighter than its neighbours. The bright bands of Dr. H. Draper's spectrum are found to be occupied by numerous dark lines of various degrees of intensity; but the hypothesis of Prof. J. C. Draper that these are the true representatives of the oxygen lines is rendered untenable by the lack of any systematic connection between the two.—Bismutosphærite from Willimantic and Portland, Connecticut, by H. L. Wells. An analysis of two specimens of basic bismuth carbonate shows them to be apparently identical with Weisbach's bismutosphærite, the composition of which had been considered somewhat doubtful.—Note on some remarkable crystals of pyroxene from Orange County, New York, by George H. Williams. The lower back part of some of these specimens is exactly like the lower front quarter, but in a reversed position, so that the lower half is a twin as represented by Von Rath, while the upper half is apparently simple and of the usual habit.—The flow of solids, or liquefaction by pressure, by William Hallock. The experiments here described point at the conclusion that pressure alone cannot truly liquefy a solid—that is, diminish its rigidity; consequently neither can chemical or mineralogical changes be produced by pressure alone without a rise of temperature.—Analysis of some natural borates and borosilicates, by J. Edward Whitfield. The series of analyses here described have been undertaken to verify, if possible, the given formulæ, and correct errors caused by defective analytical methods of estimating the boric acid of natural borates. The percentages of boric acid as here determined by direct analysis do not differ greatly from the results of Stromeyer's and Marignac's methods.—The Texas section of the American Cretaceous, by Robert T. Hill. In this paper the author studies the true character of the deep marine Cretaceous strata already determined by him in Texas, at the same time explaining some new features of it, which throw much light on the various American chalk systems.—Notice of new fossil mammals, by O. C. Marsh. Descriptions are given of some new species of *Bison alticornis*, *Aceratherium acutum*, *Brontops robustus*, *Menops varians*, *Titanops elatus*, and *Allops serotinus*, recently received at the Yale Museum from the West.

Rivista Scientifico-Industriale, September 15.—On the pressure of mixtures of gases and vapours, and on Dalton's law, by Prof. G. Guglielmo and V. Musina. Regnault, while admitting that Dalton's law on the tensions of vapours in gases is not strictly verified, and that the maximum tensions are less in gases than in vacuum, concluded that the law was theoretically exact, and would even be verified in practice in a receptacle whose walls were formed of the liquid generating the vapour. The experiments here described have been carried out for the purpose of testing the accuracy of this view, with the result that the attraction of the walls for the vapour is far from sufficing to explain the discrepancies of the Daltonian law. Consequently this law is not even theoretically correct, at least so far as can be concluded from these researches, which, however, will require to be repeated with apparatus insuring greater precision than those here employed.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 31.—M. Janssen in the chair.—Observations of the minor planets made with the great meridian of the Paris Observatory during the second quarter of the year 1887, by M. Mouchez. The right ascension and Polar distance, with correction of the ephemerides, are given for Belisane, Athor, Asterope, Nausicaa, Vesta, Antiope, Amphitrite, Polana, Bellona, Hecuba, and Arethusa.—On the Observatory of Nice, by M. Faye. In connection with the Geodetic Conference just concluded at Nice, the author announced that the magnificent Observatory of that place, due to the munificence of M. Bischoffsheim, is now completely finished. This institution, he added, is entirely at the service of the astronomers of all nations who may wish to avail themselves of its exceptional advantages in the prosecution of their researches.—New fluorescences with well-defined spectral rays, by M. Lecoq de Boisbaudran. The results are described of spectral researches made with gallina and samarine ($Ga_2O_3 + \frac{1}{50}Sm_2O_3$) moderately calcined; the same very highly calcined; gallina and the earth $Z\alpha_2O_3$; gallina and the earth $Z\beta_2O_3$; and alumina with a small portion of the oxide of praseodyme (Pr_2O_3) highly calcined.—Observations of the new planet, Peters (270), made at the Observatory of Algiers with the 0·50m. telescope, by MM. Rambaud and Sy. The observations cover the period from October 14 to October 17.—Observations of the new planet, Knorre (271), made at the same Observatory by the same astronomers during the period from October 20 to October 24.—Magnetic declinations and inclinations observed in Tunis by the Hydrographic Mission of 1884-86, communicated by M. Bouquet de la Grye. The results of these observations are tabulated for twenty-one places, whose latitudes and longitudes are also accurately determined.—On the phosphites of ammonia, by M. L. Amat. The process is described by means of which the author has obtained the salt (PhO_3HO) NH_4O,HO, which has not hitherto been studied. It may be prepared very easily in beautiful crystals and in a perfectly pure state, which is rarely the case with phosphites.—On the production of the double carbonate of silver and potassium, by M. A. de Schulten. The carbonate of silver obtained by the action of an alkaline carbonate on the nitrate of silver is found to be sometimes yellow, sometimes white, while in most cases the white precipitate takes the yellow colour when washed with water. The experiments here described show that, as anticipated by the author, the white colour of the precipitates is due to a combination of the carbonate of silver with the alkaline carbonate, this combination being transformed by the water into a yellow carbonate by eliminating the alkaline carbonate.—On some salts of aniline, by M. A. Ditte. The salts here described are formed by metallic acids almost insoluble in water, or by energetic oxidants, and have been obtained by the process of double decomposition. They comprise a molybdate, a tungstate, a vanadate, an iodate, a chlorate, and a borate.—Formation of normal amylic alcohol in the fermentation of glycerine set up by *Bacillus butylicus*, by M. Ed. Charles Morin. Fitz has shown that, under certain conditions of temperature and environment, this Bacillus transforms glycerine into alcohols, glycol, and acids. To the normal ethylic and propylic alcohols determined in the products of the fermentation must now be added normal amylic alcohol, which may be easily extracted by distillation.—On a remarkable variety of mineral wax, by MM. G. Dollfus and Stanislas Meunier. The specimens here described came from Sloboda Rungorska, near Kolomea, in Austrian Galicia, where petroleum wells have recently been sunk. A rough analysis yields $H = 15, C = 85$, corresponding to the formula CH, with density 0·60.

BERLIN.

Physical Society, October 28.—Prof. von Helmholtz, President, in the chair.—The President gave a heart-felt address in memory of the late Prof. Kirchhoff, who was Vice-President of the Society.—Dr. Robert von Helmholtz showed and explained before the Society the experiments on vapour currents, of which he has recently given an account in *Weidemann's Annalen*. In his earlier experiments on the formation of mist he arrived at the same results that had been obtained by Aitken—namely, that the condensation of supersaturated aqueous vapour, as it forms a mist, takes place only at some nucleus which is provided ordinarily by the particles of dust in the air. His observations on vapour currents have, however, now shown that other conditions have an influence on the condensation. When a platinum wire heated red-hot by an electric current is brought near a current of vapour, the colour of the latter changes owing to an increased condensation. A similar result was obtained when the following agents were employed instead of the red-hot platinum wire, viz. the gases evolved from a hydrogen flame; the gases which rise from a glowing wire gauze; a metallic point from which electricity is making its exit; an electric spark; the vapours which rise from sulphuric acid; sal-ammoniac when formed in the current of vapour by the interaction of hydrochloric acid gas and ammonia. In all these last-named cases, where the condensation is facilitated, it is impossible to speak of any "nuclear" action. The speaker was of opinion that a supersaturated vapour, just as is the case with water cooled below its freezing-point, or a supersaturated solution of any salt, can be made to pass from its condition of unstable equilibrium by two means, either by some "nuclear" action or by a sudden vibration. Mist formation is the result of a "nuclear" action in those cases in which the atmospheric dust induces a condensation in the supersaturated vapour. The condensation must be regarded as the result of the sudden vibration in the other cases mentioned above. Although in these cases no truly mechanical vibration takes place, still the chemical processes involved in the production of the gases evolved by the flame, in the evaporation of the sulphuric acid, in the formation of the sal-ammoniac, at the point from which the electricity is making its exit, and in the electric spark, are to be regarded as so many sources of molecular tremors which upset the unstable equilibrium of the supersaturated vapour.—Dr. Dieterici gave an account of his experiments on the determination of the mechanical equivalent of heat by the indirect electrical method. He made this choice of method on account of the exactness with which electrical values can now be determined in absolute units. The speaker described the general arrangement of his experiments and gave a detailed account of the ice calorimeter which he used, as specially modified by himself. As the result of his series of measurements he obtained closely agreeing values for the mechanical equivalent of heat, namely 424·4 and 424·2 as the mean of each series, the highest and lowest values obtained differing but little from the mean of the determinations. When making his calculations the speaker took as the specific heat of water, the mean of the determinations made between 0° C. and 100° C. The statements which have been made respecting changes in the specific heat of water as dependent on changes of temperature differ so greatly with different observers that the mean values based on their results provide no constant factor; the speaker's determinations would have been considerably different had he taken as his basis any other value of the specific heat of water. He next compared the results of his experiments with those of earlier observers, and discussed the very marked differences in the values given for the specific heat of water at various temperatures. He thinks that the specific heat of water may best be determined by the electrical measurement of the mechanical equivalent of heat, and intends to investigate this question more fully at a later date.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Pen and Pencil in Asia Minor: W. Cochran (Low).—An Elementary Treatise on Light and Heat: Rev. F. W. Aveling (Relfe).—British and Irish Salmonidæ: F. Day (Williams and Norgate).—*Vega* Expeditionens, 2 vols.: A. E. Nordenskjöld (Beigers, Stockholm).—L'Atmosphère et Météorologie Populaire: C. Flammarion (Hachette, Paris).—Spezial Karte von Afrika, 2, 3, 4, 5 Lief. (Perthes, Gotha).—Guatemala; the Land of the Quetzal: W. T. Brigham (Unwin).—The Microscope in Theory and Practice, translated from the German of Prof. Carl Naegeli and Prof. S. Schwendener (Sonnenschein).—Reynolds's Experimental Chemistry, Part 4, Organic (Longmans).—Klima und Gestaltung der Erdoberfläche: Dr. J. Probst (Schweizerbart'sche, Stuttgart).—Beiträge zur Geophysik, i. Band: Prof. Dr. Georg Gerland (Schweizerbart'sche, Stuttgart).—Die Japanischen Seeigel, 1 Theil: Dr. L. Döderlein (Schweizerbart'sche, Stuttgart).—The Lake Age in Ohio: E. W. Claypole (Maclachlan and Stewart).—Gold-fields of Victoria, Reports of the Mining Registrars for Quarter ended June 30, 1887 (Melbourne).—Report on the Progress and Condition of the Government Botanical Gardens at Saharanpur and Mussoorie for Year ending March 31, 1887 (Allahabad).—Coleoptera; or, Beetles of South Australia: J. G. O. Tepper (Wigg, Adelaide).—The Answer to the Universal Question, What is an Earthquake?—Journal of Anatomy and Physiology, October (Williams and Norgate).—Journal of the National Fish-Culture Association, October.—Journal of the Chemical Society, November (Gurney and Jackson).

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