Nature

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

VOLUME LIX
NOVEMBER 1898 to APRIL 1899

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—Wordsworth

London
MACMILLAN AND CO., Limited
NEW YORK: THE MACMILLAN COMPANY

RICHARD CLAY AND SONS, LIMITED,
LONDON AND BUNGAY.

INDEX

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A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

THURSDAY, NOVEMBER 3, 1898.

ANALYTICAL CHEMISTRY.

A Manual of Chemical Analysis, Qualitative and Quantitative. By G. S. Newth. Pp. 462. (London: Longmans, Green, and Co., 1898.)

A Laboratory Guide in Qualitative Chemical Analysis. By H. L. Wells, M.A. Pp. 180. (New York: Wiley and Sons. London: Chapman and Hall, Ltd., 1898.)

A Short Course in Inorganic Qualitative Analysis. By J. S. C. Wells, Ph.D. (New York: Wiley and Sons. London: Chapman and Hall, Ltd., 1898.)

IT is now becoming generally recognised that chemical analysis is a subject that may be looked at, taught, and practised in two ways—as an art, or as a science. No doubt it should be both, and always has been both with chemists properly so-called; but it is sad to think of the time, trouble and money that have been expended during the last thirty years in disseminating a smattering of the analytical art on the supposition that education and even British industry would be thereby furthered.

The demand for a practical chemistry that could be easily scheduled, that should not be too elaborate, and that could be examined and controlled by sending out packets of powders and getting back packets of papers, has contributed, doubtless, more than anything else to the degradation of chemical analysis. At the same time it must be admitted that chemical analysis as a science suffered seriously by the abolition of the ideas and notation of the dualistic theory. Before then the current names and formulae were at least consistent, and the writing of equations could be conducted on comparatively simple general principles. Even now there are probably few chemists who would calculate the oxidising value of potassium permanganate in reference to ferrous sulphate, otherwise than by dualistic conceptions and formulae. The hopeless confusion arising over the old terms *acid*, *base* and *salt*, and especially *basic salt*, in their modern use, must be known to every teacher.

To those who in recent years have protested against chemical analysis as an introduction to practical science it has been objected that analysis, when properly taught, is a highly educative subject. But this has never been disputed; the point is that analysis is far too high a science and too difficult an art for young boys, and that a little proficiency in the art of "taking a solution through the chart" has, practically speaking, been the only attainable outcome of a positive kind, whilst the habits of mind and manipulation usually engendered have been lamentable.

The tide is happily with the reformers, and the improvement that has taken place within the last ten years in school science is one of the most remarkable and gratifying of the numerous signs now evident that a more rational and humane spirit is pervading British education.

For those who wish to make a serious study of chemistry, chemical analysis has still to be taught, and how to teach it best, is a question which may perplex the most thoughtful teacher. The fundamental difficulty is that there appears to be no thin end to the wedge. If the subject is to be taught scientifically—that is to say, if the reactions on which analysis is based are to be elucidated as they arise—the student is at once thrust into a thicket of ramifying facts in which he will find his way with difficulty. Suppose he begin with the reactions of the silver group, he is at once among the mercuramines; should he begin at the other end, there are the platinichlorides and acid tartrates. The student, in fact, who is to learn analysis scientifically at the first attempt, requires a fair knowledge of chemistry to begin with. The choice lies between devising some extended practical work, beyond the mere preparation of gases, as a preliminary to analysis, or making the student, as he might put it, "do analysis" more than once. In the last case, the analytical operations are not comprehended to their inmost parts in first traversing the course, but a preliminary survey is obtained, and the student learns something, at least, about a great many substances and reactions. It is, after all, something to know the mere outside of things in chemistry. The difficulty, however, is to secure the *da capo* or cud-chewing process which is essential to the success of this scheme. It is not easy to convince the half-informed of their ignorance. No doubt, the best way to approach analysis is through preliminary practical work in which typical substances are prepared by typical reactions, and subjected to a careful qualitative and quantitative study; but no one has yet given a really good lead in this direction, though several books of inorganic preparations have appeared in recent years.

Sooner or later the serious student of chemistry must enter upon the systematic study of analysis, and the selection of a good handbook becomes an important matter. It has been the habit for writers on analysis to confine themselves almost entirely to the technique of the subject, and among the scores of books written a fair number might be named as trustworthy guides in the processes of qualitative and quantitative analysis. At the head of these stands the well-known work of Fresenius—a monument of industry and care. It must be recognised, however, that Fresenius' book is essentially an analytical dictionary. If it be an object in the teaching of analysis—and it is surely, for the general student, the chief object—to make the learner familiar with the philosophy of the subject, the use of Fresenius and the smaller versions of Fresenius must be supplemented by something else, either in the way of oral teaching or literature. The circumstances of few laboratories permit of the constant personal supervision which is necessary to keep an analytical student straight on the theoretical side of his work, and thus the possession of a book which really grapples with the chemistry of analytical reactions becomes indispensable. It is, however, only recently that a book adequately fulfilling this purpose has appeared in the English language, though a little-known manual published by the late Prof. Dittmar, in 1876, deserves respectful mention. In Germany (and doubtless in Russia) for many years Menschutkin's book has occupied the place in question. Menschutkin does not pretend to be an exhaustive compendium of analytical processes; it contains no tables; it lays down no laws for the treatment of a solution containing a limited number of acids or bases; yet Menschutkin has the stamp of individuality and real science, which make it not unworthy of companionship with Mendélejeff's Principles. It was the only book on analysis which Bunsen, who had a horror of the analytical "Bradshaw," would allow to appear in his laboratory. It is to be hoped that through its English translation the book has become better known in this country.

One more type of work on analysis, and only one, can be mentioned. Ostwald's "Scientific Foundations of Analytical Chemistry" is a book *sui generis*. The view taken of this book will depend entirely on whether the reader finds the preamble proven. If the ionic theory of solution be accepted, there can be no doubt of the remarkable coherence and symmetry of Prof. Ostwald's adaptation of it to the facts and processes of analysis. The book is well worth the attention of any one who may have lightly taken up a mere prejudice against the ionic theory.

Of the books at present before us, two are of considerable interest as being out of the common style. Mr. Newth, who is well known as the author of a book of lecture experiments, and one on inorganic chemistry, both characterised by many excellent features, has now produced a manual of analysis which is no less satisfactory. It is written much in the style of Menschutkin, that is to say, it is thoroughly explanatory. At the same time there is no lack of plain practical directions for the conduct of analytical work. The book gives evidence throughout of having been written by a skilled analyst and a thoughtful chemist, whilst the frequent asides—sometimes beseeching, sometimes scornful—show that the author has tasted the sorrows of a teacher of analysis. Beginning with a chapter of preliminary manipulative exercises, the book proceeds to detail and explain the reactions of the metals in the order of the analytical groups. Two chapters follow on the conduct of a qualitative analysis and the statement of results. The second part of the book deals with quantitative analysis, including electrolytic analysis, gas analysis and organic analysis, concluding with a section on miscellaneous physico-chemical determinations. This brief summary of contents will, of course, give little idea of the real character of the book, yet it is impossible to enter minutely into either explanation or criticism of a work so full of details. The least satisfactory part is the first chapter dealing with the important matter of manipulation. In the first place it must be remarked that the essentials of manipulation should have been learned long before the systematic study of analysis is commenced, and a student who is at all ready to enter upon the second chapter of Mr. Newth's book will very probably resent the instruction to mix hydrochloric acid and charcoal in order to see how the charcoal may be filtered off and washed. Such elementary instructions are doubtless useful in their place; but their juxtaposition with chapters on systematic analysis only tends to confirm the practice of plunging students of practical chemistry prematurely into analytical work. It would at least have been better if this intention had been disclaimed. The instructions themselves also call for some comment. No recommendation is made of the filter-pump for qualitative analysis, an omission which, in the opinion of the present writer, is very regrettable. It is true that in the hands of a careless and uncontrolled student a vigorous filter-pump is a source of moral degradation, but, in other hands, it is, with limited exhaustion, perhaps the chief aid to dispatch, neatness, and even accuracy. The instructions given by Mr. Newth for evaporation, neutralisation, the use of borax beads, and the removal of precipitates seem to show that many of Bunsen's helpful artifices are still unknown in England. Other useful things which do not seem to be described by Mr. Newth, are the Gooch crucible and the perforated disc porcelain funnel. The writer would also here recommend the process of separating barium, strontium and calcium by means of nitric acid, described by Dr. S. G. Rawson in the number of the *Journal* of the Society of Chemical Industry for last February.

An addition that may well be made to a future edition is a plain statement about the rational use of figures in quantitative analysis. It is astonishing how little attention is paid by chemists to the significance of figures in the statement of an analytical result, and how seldom students are taught to let their recorded numbers bear a proper relation to the accuracy attainable, even with perfect manipulation, in any given process. It is the commonest thing to find a pretension to accuracy of 1 part in 1000 where 1 in 50 would hardly be justified.

Mr. Newth does not introduce the ionic theory into his explanations of analytical reactions. It is not difficult to understand reluctance to embrace a theory which is still young and still the object of adverse criticism. At the same time it seems a great pity that a writer on analysis should leave the student in ignorance of what, according to a large number of eminent chemists, is the real key to the chemistry of analysis. The ionic theory need not have been woven into the fabric of the book; but it, at least, deserved a chapter and a fair hearing.

Whilst a few defects are to be noticed in the book, it is right to add that the merits are much more conspicuous; and it may be said, on the whole, that Mr. Newth's account of analysis is wide in scope, exact in detail, and particularly luminous in exposition. If it is used conscientiously by duly prepared students, it will teach them a great deal of chemistry.

Prof. Wells's book is written on somewhat different lines, yet is characterised, like Mr. Newth's, by the attention paid to the explanation rather than the mere description of reactions. Prof. Wells, who has charge of the teaching of analytical chemistry and metallurgy in the Sheffield Scientific School of the Yale University, is evidently deeply impressed with the feeling that students tend to do their analytical work in a mechanical way, taking merely marching orders from their text-books. Instead, therefore, of telling the student anything about the metallic chlorides, the author contrives that the facts shall be *discovered* by such instructions as:

"Find by experiment which of the twenty-seven solutions give precipitates when a few drops of hydrochloric acid, HCl, are added to 1 or 2 cc. in a test-tube. Write the equations of the reactions and remember the facts observed in this experiment as well as in those that follow. Why are no precipitates produced in the solutions containing chlorides?"

The directions continue in the same strain. It must be observed that the student does not proceed on a natural voyage of discovery. At every port he opens another sealed order, and takes the directed course wherever it may lead. The value of this method of teaching analysis is open to serious doubt. The student is asked to perform twenty-seven experiments, of which all but three are, practically speaking, blanks. The present writer's experience is that operations of this kind pall intolerably upon a self-respecting student. We surely have here a case where a wrong sacrifice is made to pedagogic theory. In the early stages of education it is no doubt hardly possible to pay too much attention to method. Whilst habits of mind are being formed, and pupils are young and docile, much may be permitted in the name of method; but a period arrives when the leading strings must be relaxed. As soon as a system of teaching is felt by the pupil to be a system, it is apt to lose its value, and to engender the resentment which every one feels on discovering that he is being manoeuvred. The present writer has had experience of the unintelligent student of practical chemistry, and has tried Prof. Wells's device, among others. The result has not been at all encouraging. The fact is, that by the time a student is fit to begin the study of analytical chemistry he should be fit to avail himself of straightforward explanations. If he is not fit, strategy will do but little to mend matters. Prof. Wells, however, thinks differently after fourteen years' teaching and it may be that things are different in America.

Whilst offering this general criticism of Prof. Wells's system, it is right to add that the book is wholly good in its scientific tendency, and that it contains abundant evidence of the writer's experience and grasp of analytical chemistry. The injunction that the student is to construct his own tables of separations is much to be commended. The second part of the book deals with theory; it embraces the ionic theory, and explains the phenomena of analysis from that point of view. The explanations are, it is to be feared, too brief and sketchy to be of much use. They have a somewhat high-sounding logical form, but do not always convey much substance.

"There is a direct connection between the formation of precipitates and insolubility. A compound which is readily soluble in the liquid that is present *cannot* form a precipitate in the presence of a sufficient amount of that liquid."

This surely was unnecessary.

The chapter on equations is clear and useful. The third part of the book gives an account of the properties of the inorganic radicals in alphabetical order, and does not purport to be more than a condensation of Fresenius. It contains a summarised statement of what the student is meant to have learned for himself by working through Part i.

Two "appendixes" to the book, consisting of eighteen pages of labels, seem very unnecessary.

The third book before us is also of American origin. It is intended for engineering students, though there is no evidence of this special destination in the text. In so far as the reactions are explained with fair completeness, it is in advance of the customary analysis book. The distinctive feature is to be found in a number of large tables plotting an outline of reactions which occur in the separation of the members of a group. By reference to the tables it is possible to see what is the maximum number of substances in any particular precipitate or filtrate. Thus precipitate 35 may contain $BaCO_3$, $SrCO_3$, $CaCO_3$, whilst filtrate 35 may contain $MgCl_2$ NH_4Cl, $NaCl$, KCl, $BaCl_2$ and $CaCl_2$ in traces, NH_4OH, $(NH_4)_2CO_3$. The author states that these tables have been found of much benefit to the student.

In the beginning of the book we find the statement that "in inorganic chemistry the bases comprise the metals, and the acids the non-metallic elements (with a few exceptions)"; a little later—"all acids contain hydrogen, which hydrogen is replaceable by a base"; and lastly—"bases have properties just the reverse of acids. Among the inorganic compounds they usually consist of hydroxyl in combination with a metal. Their chief characteristic is their power of uniting with acids to form neutral compounds." Could any better justification be found for the remark, made early in this article in reference to the dire effects of lingering dualistic terminology?

ARTHUR SMITHELLS.

RESEARCHES ON MEDUSAE.

The Cubomedusae. By Franklin Story Conant. (Memoirs from the Biological Laboratory of the Johns Hopkins University, vol. iv. No. 1.) Pp. xvi + 61, and plates. (Baltimore: Johns Hopkins Press, 1898.)

IT is one of the characteristics of some of the more important American Universities that they advance knowledge, employ the best of their young graduates, and at the same time add to the treasures of their museums by equipping expeditions to explore unknown regions, both of sea and land. In this way the archaeology, ethnology, geology, palaeontology, and marine zoology of Central and North America have all benefited largely; and the results of these College expeditions are to be seen in several of the Transatlantic Museums and Universities.

Last year (1897) was unfortunately most disastrous to the marine biological expeditions of two of the leading American Universities: Columbia at New York, and the Johns Hopkins at Baltimore. The Columbia University Expedition to Alaska was wrecked on the return voyage by running on the West Devil rock in Dixon entrance, the steamer sinking almost at once in deep water, and the party barely escaping with their lives (one of them, young Mr. B. B. Griffin, has unfortunately died since), while all their collections, notes, drawings, theses, and other property were lost. The Johns Hopkins Expedition to Port Antonio, in Jamaica, had even a more tragic termination. Prof. Humphrey, the leader of the expedition, died of yellow fever after a few hours' illness the day (August 17) they were to have sailed for home. Dr. Conant, the second in command, and Dr. Clark considered it their duty, under the circumstances, not to leave. Clark was then taken ill and recovered; but when they eventually sailed from Port Antonio, on September 6, Conant became ill on the second day at sea, and died on September 13 in Boston.

The present volume consists of Dr. Conant's researches on the Cubomedusae completed, and accepted by the Johns Hopkins University as a dissertation for the degree of Doctor of Philosophy, just before the author sailed on the fatal expedition to Port Antonio, and now published as a memorial by his friends, fellow-students and instructors at the University. Dr. Conant had been with the Johns Hopkins marine laboratory party at Jamaica in June 1896, and the discovery then of two new species of Cubomedusae in Kingston Harbour led him to the further study of the group. Cubomedusae are comparatively rare jelly-fish, and are of morphological interest because of the relatively high degree of development attained by their nervous system and sense-organs. After a systematic review of the position of his new species (one of them the type of a new family), Dr. Conant gives an excellent account of the anatomy and histology, with a specially full description of the nervous system and of the highly-developed eyes and associated sense-organs. Eight clearly drawn plates, nearly all the figures being from drawings by the author, illustrate satisfactorily this monograph, which is of special interest, first as giving an account of a rare group of medusae, and secondly because of its sad associations. Dr. Conant was a talented and high-souled young zoologist, who seems to have sacrificed his life to a sense of duty and devotion to others.

During this last stay in Jamaica, Conant seems to have been working largely on physiological problems especially of the sense-organs, such as the action of retinal pigment-cells under the influence of light and darkness; and also on the embryology of the Cubomedusae. We are glad to learn from Prof. W. K. Brooks, that Conant's notes are so full and so advanced that he hopes to be able to have them completed and published before long.

W. A. H.

OUR BOOK SHELF.

Special Report on the Beet-Sugar Industry in the United States. Pp. 240. (Washington: Government Printing Office, 1898.)

FOR some time the United States Department of Agriculture has been instituting and directing experiments to ascertain where sugar-producing plants can be grown most profitably. The present volume contains the results of this investigation so far as concerns the beet-sugar industry. It is divided into two parts, one part consisting of the report of the chemist of the Department, Dr. H. W. Wiley, while the other consists of the report of the field agent, Mr. C. F. Saylor, who has personally visited and examined the plantations and factories concerned in the beet-sugar industry in a large number of districts.

The facts and figures presented in the volume justify the attention which the Department of Agriculture has given to the development of this important industry. How widespread is the interest taken in the subject may be judged by the fact that 150,000 copies of a farmers' bulletin upon sugar-beet were applied for last year, and 60,000 copies of the present report have been printed for distribution.

Numerous packets of sugar-beet seed were sent to different parts of the United States last year with the object of obtaining information as to the regions in which the sugar industry is most likely to succeed. There are, however, such great differences in soils and climatic conditions in the United States, that seeds which are suitable for one locality may not succeed in another. Dr. Wiley therefore points out that the experiments which the Department of Agriculture has conducted for several years in the analysis of beets, and the delimination of areas suited to beet culture, require now to be supplemented by a more rigid scientific attempt to develop beets of characteristics best suited to the various localities.

The opinion of Mr. Saylor upon the industry is decidedly optimistic. He says: "There is no doubt that the United States has a wide and varied extent of land that will successfully grow high-grade beets, that the enterprise of the people of this country will appreciate this fact, and that in a short time all the sugar consumed in this country will be furnished by our own people." Whether this prediction will be fulfilled during the next few years remains to be proved; but, in any case, the Department of Agriculture is doing its best to educate and assist the farmers who cultivate lands upon which the sugar-beet can be successfully grown.

Traité d'Algèbre Supérieure. Par Henri Weber. Traduit de l'allemand sur la deuxième édition par J. Griess. Pp. 764. (Paris: Gauthier-Villars, 1898.)

THIS is a translation of the first volume of the second edition of Prof. Weber's "Lehrbuch der Algebra," and will doubtless be welcome to those who are more familiar with French than with German. The translation appears to be trustworthy, although a few misprints have crept in here and there which are not in the original; thus on pp. 71, 72, the indices $a_1, a_2 \ldots a_m$ should be replaced by

$\mu_1, \mu_2 \ldots \mu_m$, and on p. 150 $f(x)$ has been printed instead of $f'(x)$. On p. 73 the phrase "en outre" is an imperfect equivalent for "wir setzen noch," and is likely to make the reader suppose that the symbol $\Phi\ (x, \xi)$ has been already defined. The handsome appearance of the volume, and the excellence of the printing, fully maintain M. Gauthier-Villars' high reputation.

The first edition of the "Lehrbuch" was reviewed in this journal at considerable length, so that it is unnecessary to give here any detailed account of the contents of this volume. Prof. Weber has introduced various improvements in detail, and added, amongst other things, an account of Lagrange's interpolation formula, and of Hurwitz's very interesting researches on Sturm's theorem. The extreme value and originality of the treatise become more evident the more carefully it is studied; the appearance of this translation, as well as that of the second edition at home, indicates that its great merits are being duly appreciated. G. B. M.

A Manual of the Grasses of New South Wales. By J. H. Maiden. (Sydney: Gullick, 1898.)

BROUGHT out under the authority of the Minister for Mines and Agriculture for New South Wales, the Government botanist publishes a very useful account of the grasses of the Colony. The number of species indigenous to the Colony is stated at 196, comprised in 56 genera. These numbers may be compared with the 95 species belonging to 48 genera reckoned by Hooker as natives of these islands. Under each species, in addition to the technical diagnosis, the vernacular names are given, with a reference to the published figures; the habitat and range of the species, and an account of its value for fodder and for other purposes. Then follows a key to the genera, and under each genus a key to the species. In the case of a number of the more useful or more common species, full-page illustrations are given. The volume is a very useful and valuable one; but, considering its purpose, it strikes us that its practical value woûld be increased by either a general description of the flower of grasses, or a glossary of technical terms; unless indeed, Australian farmers are much better acquainted than our own with botanical terminology.

Manuel de l'Explorateur. By E. Blim and Rollet de l'Isle. Pp. vii + 260. (Paris: Gauthier-Villars, 1899.)

THE object of this volume is to provide travellers in little-known regions with information which will enable them to record particulars of service to geography concerning the land traversed. In the first chapter the methods are described for determining and representing approximately the route followed and the details of the surface, using a prismatic compass and an aneroid. The astronomical observations required to define positions along the route are then explained, and it is shown how the combination of these observations with the rough survey enables an approximately accurate representation of the journey to be laid down. The determination of heights and distances by levelling and triangulation are described in the third chapter, for the instruction of explorers who wish to make a detailed study of particular districts. The two remaining chapters deal with systems of projection for the conversion of the observations to maps, and the choice and transport of the instruments referred to in the text. The sextant is not included among the instruments, the astronomical observations being made with the theodolite instead. No instructions are given as to what to observe in natural history, geology, anthropology, or other sciences; hence, the volume is not to be compared in value with the "Hints to Travellers" published by the Royal Geographical Society. Nevertheless, as a clear and very elementary manual on surveying and practical astronomy for travellers who explore without having received a preliminary scientific training, the book may prove of service.

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 intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Heredity and Fertility.

As Prof. Karl Pearson in his paper "On the Law of Ancestral Heredity," published in the *Proceedings* of the Royal Society, alludes to an investigation which he has apparently commenced into the inheritance of fertility in man, it may be of interest now to publish one which I completed some years ago, but which for various reasons has not appeared in print.

The problem to be solved was:—Do marriages of heiresses prove more or less fertile than ordinary marriages? The first desideratum was of course to get a practically homogeneous class from which to obtain the necessary data. The families enrolled in "Burke's Peerage and Baronetage" sufficed. Taking the volume for 1892—just published when this investigation was commenced—there were in it of the present generation 265 ordinary or non-heiress marriages which had produced an average of 3·8 children per marriage, forty-eight of which, or 18·5 per cent., were absolutely sterile.

Now an heiress, so called in "Burke," may be considered of the same class as an only child. Hence, taking care that both parents lived long enough after the birth of their first child to have had others, I extracted all the marriages of heiresses and female only children that occurred in "Burke" for the present generation, with the addition of a considerable number from the past generation contained in "The Lineage." There resulted:—243 marriages, averaging 3·74 children per marriage and 11·9 per cent. marriages absolutely sterile. These figures show that there is practically no difference in the fertility of ordinary marriages—3·8 per marriage—and the 3·74 fertility of heiresses and only children: the small difference of six-hundredths per cent., on so small a number as 250 marriages, being well within the ordinary limits of error. It implies that with greater numbers the results would probably be similar. Not so, however, when we come to consider the number of marriages which are absolutely sterile, for these are so much fewer with the only children marriages—6·6 per cent.—that we must say when they are fertile they are more fertile than the others.

But the problem may be attacked from the other side. If female members of the smallest families possible tend to bear fewer children than the female members of families of ordinary size, the female members of large families would tend to bear large families. Is this so? With a much greater amount of labour than would be imagined, I extracted from the same work some marriages of ladies who were members of families of five or more, *i.e.* had in each case four or more brothers or sisters, with the result that 250 marriages averaged 4·25 per marriage with 13·6 marriages quite sterile.

Summarising, we get then ladies of small families average 4·06 children per marriage, 11·1 per cent. marriages being quite sterile.

Ladies of ordinary families average 3·8 per marriage, 18·5 quite sterile.

Ladies of large families average 4·25 per marriage, 13·6 quite sterile.

This shows that the more contrasted the ladies are as regards number of brothers and sisters, the more nearly allied are the numbers of their children and the relative amount of absolute sterility. A conclusion tending to show that the cause under investigation is not a *vera causa*.

Does the female influence show itself in a change in the proportion of male to female children, assuming of course a chance distribution of the husbands as being members of small, ordinary, and large families?

	Sons.	Daughters.	Total	S. to 100 D.	Sterile.
243 heiress and only-child marriages	492	414	906	107 sons	11
265 ordinary marriages ...	514	528	1042	97 sons	18·5
250 large family marriages	553	510	1063	108 sons	13·6

The same result as before—the most contrasted classes give the most similar results.

If heredity has anything to do with this matter, which so far seems improbable, it may arise from the other side—the father's. Hence I extracted marriages of only sons, of sons of ordinary marriages, and of sons who had four or more brothers or sisters, and found that :—

	Children per marriage.	Sons to 100 Daughters.	Sterile.
191 only sons	4·09	116 sons	8·4 per cent.
265 sons of ordinary families	3·8	97 sons	18·5 ,,
500 sons of large families..	3·8	110 sons	12·4 ,,

These results point rather to the conclusion that could have been surmised: only sons being usually better off, have no reason to restrict the size of their families, as is so often necessary where a fortune has to be divided among many, and hence they have larger families.

Adding the three separate parental classes together, we have :—

	Sons.	Daughters.	Total.	Per marr.	Sons to 100 Daughters.
434 F. and M. only children	912	776	1688	3·89	117
265 F. and M. ordi- families	514	528	1042	3·9	97
750 F. and M. large families	1558	1424	2982	3·98	109
			5712		

Which shows that the number of children per marriage is so nearly similar that with a larger number of marriages to deal with they would probably be the same. Comparing the figures in the last column brings forth the most curious result of the investigation, that the marriages of members of ordinary sized families have a smaller proportion of sons to daughters than in the case of the other marriages.

The size of the families of the various classes dealt with may prove of interest, although nothing of great importance can apparently be drawn from the figures. The table contains the percentage of children per hundred marriages :—

Number of family.	Sterile. 0	1, 2	3, 4	5, 6	7, 8	9 & over.
Marriages of—						
Only female child ...	11	26	26	24	9	4
Only male	9	30	25	15	12	9
Ordinary	18	19	24	18	11	10
Daughter of large families	14	23	16	19	12	14
Son of large families ...	12	26	25	18	10	8
Total	64	123	117	95	54	42
Average	12·3	10·2	9·7	8	4·5	3·5

And, now, what are the final results to be drawn from the foregoing analysis? That, as a matter of fact, there is in no case a difference of sufficient magnitude to enable us to say that the fertility of either male or female in the human race is in any way correlated to the fertility of their fathers or mothers, and *a fortiori* correlated to the fertility of their grandparents.

Churchfield, Edgbaston. F. HOWARD COLLINS.

"A Short History of Scientific Education."

IN Sir Norman Lockyer's address, under the above title, reprinted in NATURE of October 13, he is reported to have said : "Before the Reformation the universities were priestly institutions, and derived their authority from the Popes. The universities were for the few ; the education of the people, except in the various crafts, was unprovided for. The idea of a general education in secular subjects at the expense of the State or of communities is coeval with the Reformation. In Germany, even before the time of Luther, it was undreamt of, or rather, perhaps, one should say, the question was decided in the negative." . . . "With the Reformation this idea spread to France."

The whole passage seems to have been taken from that travesty of "The History of Pedagogy" compiled by Dr. Gabriel Compayré (compare pp. 114–115 and 120), and it is unfortunate that Sir Norman Lockyer should have followed so untrustworthy a guide.

For the statements contained in the above-quoted sentences are in direct opposition to the facts as ascertained by the best authorities in the matter. It is quite true that education owes much to the bishops and monks of the centuries before the Reformation, for it was in the episcopal seminaries, which formed a part of the bishop's own household, and in the great monastic schools, such as those of Cluny, Bec, St. Gall, and numerous others, that the torch of learning was kept alight in the troublous times when the laity were mostly fighting to resist the incursions of barbarians, or warring one with the other.

The priestly influence was therefore an influence for good. More than this, such Popes as Innocent III., Honorius III., Benedict XII., Gregory IX., Urban IV., to name no others, deserve the gratitude of mankind of all ages for their persevering efforts to improve the state of learning in the schools and universities of their times. Sir Norman Lockyer tells us that the "universities were for the few." How is this statement to be reconciled with the fact that students flocked to the universities in the days before the Reformation in multitudes so great, that we find it reported, that in the thirteenth century some ten thousand scholars attended the classes of the University of Bologna at one time, with another forty thousand at Paris, and thirty thousand at Oxford, while at Bordeaux a single college boasted of upwards of two thousand scholars. Even allowing that the numbers are exaggerated, it is indisputable that in this century the universities were crowded with students. Nor were these scholars all clerics, nor yet the sons of the nobles and well-to-do citizens, but mostly poor men—a scholar and a poor man being almost synonymous terms. Does not our own Chaucer describe the Clerk of Oxenford as "full hollow and threadbare?" And this, too, at a period when printed books were either altogether wanting or were a rarity. The number of universities founded in Europe in pre-Reformation days has been reckoned as sixty-six.

And what is true of universities is true also of elementary and grammar schools. In this connection, the first essay of John Charles Tarver's collection, "Debateable Claims," is worth referring to. "Fifty years ago," he writes, "the Reformation was popularly regarded as the very first beginning of enlightenment. Up to that time a crass and brutish ignorance was supposed to have prevailed . . . Since the middle of this century this view of our history has been considerably modified . . . How were the middle classes taught before the Reformation? The popular view is that they were not taught at all till Henry VIII. and his children, especially Edward VI., reserved something from the spoils of the Church endowments for grammar schools. A more enlightened view holds that incidentally the monasteries themselves were teaching establishments, and especially that the friars were not only preachers, but teachers . . . we should hardly have expected to find that the period of the Reformation was a period of indifference to schools; it was more than that, it was a period when schools were suppressed" And further on: "Again, the Reformation in its later stages was distinctly an upheaval of ignorance: the value of the old methods of teaching was not understood; 'the baser sort,' armed with the text of the Bible, thought all other learning superfluous; they regarded it, as classical learning is regarded by the scientific smatterer of to-day, as antiquated and superstitious. In Germany, according to Dr. Scherer, this attitude of mind contributed to the Counter-reformation; for contempt of learning having destroyed the teachers, when in the fulness of time the want of them was felt, the Jesuits were ready to take their place." In Mr. Leach's "English Schools at the Reformation," we learn that in England about the year 1546 there was one grammar school for every 8000 people, instead of one for every 23,000, as was the case in 1865; so that, at least in England, it is not correct to state "that the education of the people was unprovided for."

And what is true of England is true of other countries. As a set-off to the reference made by Sir Norman Lockyer to Luther's laudable endeavours in the cause of free education for the people, let us take the following quotation from a decree drawn up in the days of the Anglo-Saxons. "Mass-priests shall always have in their houses a school of learners; and if any good man will trust his little ones to them for lore, they shall right gladly receive and kindly teach them. . . . They shall not, however, for such lore, demand anything of the parents, besides that which the latter may give of their own will." This decree first appears in the Council of Vaison, and re-appears in the acts of several Councils of England, France, and Italy: for instance, in the Carlovingian Council of Orleans, and in the Constitutions of Vercelli. The request of the States General of Orleans in 1560 to Francis II., quoted by Sir Norman Lockyer, is therefore nothing new in the matter of free education. In addition to the Constitutions of Vercelli, those of Dado of Verden, and Heraclius of Liege, ordain the establishment of "little" or parochial schools, wherein poor children of both sexes, about the age of seven years, are to be taught gratis. That free schools existed in England before the Reformation, as for instance those at Wisbech, Week St. Mary, Wimborne, Darlington, and Chipping Campden, appears from Mr. Leach's researches before referred to (pp. 110-114). In fact, the very idea of receiving payment for teaching was scouted until the introduction of secular teachers about the beginning of the eleventh century.

And yet Sir Norman Lockyer speaks of "the iron heel of priestcraft"—an ugly word—as arresting the "new spirit" presumably of free education of the people. Nor is his uncomplimentary reference to the Jesuits in France more according to facts. However what the Society of Jesus has effected for the cause of education, both literary and scientific, is too patent to any unbiassed student of the history of education to need discussion. Moreover, I should be needlessly occupying space in this journal. A. L. CORTIE.

Stonyhurst College, October 23.

Organic Variations and their Interpretation.

I HOPE you will allow me to correct two serious errors in Prof. Weldon's reply to my criticisms.

I was never foolish enough to assert, as he implies that I did, that the theory of natural selection attempts to answer the question whether modifications originate accidentally or not. I said that this was the question between the adherents of the theory and its opponents. I quite agree with Prof. Weldon that the theory of natural selection does not involve a theory of the origin of variations. For that reason it is not by itself a theory of evolution.

Prof. Weldon asserts that I said there was no evidence of the entrance of fine mud into the gill-chambers of crabs during life. I said, or wrote, nothing of the kind. He found china clay in the gill-chambers of the individuals which died in his experiments, and I pointed out that this was no proof that the crabs had died because their branchial apparatus was unable to keep out the particles of clay. The clay was not found in the gills of the survivors, and he inferred that they owed their survival to more efficient filtration, due to their relatively narrower frontal breadths. I merely pointed out that the inference was not valid because the dead crabs had been in the muddy water after death, while the survivors were killed after removal.

I do not admit that Prof. Weldon has successfully vindicated his evidence or his conclusions against my criticisms; but as you, Sir, are unable to allow me any more space, I must thank you for printing my first letter, and leave further discussion of the matter for some other opportunity.

Penzance, October 22. J. T. CUNNINGHAM.

SCIENTIFIC EDUCATION IN RURAL DISTRICTS.

AMONG the problems of technical education which County Councils have had to face, the most difficult is the bringing home of the importance of scientific training to those engaged in agriculture and in rural industries generally. A study of the results achieved in the various counties very clearly brings out the fact that while considerable progress has been made in manufacturing centres where the practical bearing of science is more or less obvious, the agricultural counties have hitherto failed to show a similar progress as the outcome of their efforts to improve the rural industries. Many causes are contributing in this country to check advancement in rural technical education. The general depression of agriculture, the conservatism and apathy of farmers and landowners, the high cost of carriage of farm produce, and the incompetence of technical instruction committees are among these causes; but it would be out of place to discuss such matters in the columns of a scientific journal, and we are content in admitting that the technical committees in agricultural districts have had a far more difficult task imposed upon them than the committees of urban manufacturing centres have ever been called upon to perform.

In bringing under the notice of the readers of NATURE an educational movement which we are firmly persuaded is a movement in the right direction, we have primarily in view the fact—obvious to men of science, but, unfortunately, not so obvious to those more immediately concerned—that agriculture in its widest sense is as much dependent upon scientific research for its advancement as any other industry. The great importance attached to agricultural stations in the United States and Canada, and on the continent, and the splendid results in the way of agronomic research which are being achieved at these stations, amply testify that other countries are alive to their agricultural welfare. All that has been done in this country by those great pioneers, Lawes and Gilbert, has been the result of private munificence.[1]

In view of the fact that the results of scientific research are bound with the progress of time to make themselves more and more felt in all kinds of rural industries, and bearing in mind also the slow rate of development in this direction in our country, we are convinced that the best chance of enabling our agricultural population to appreciate the importance of research and to meet competition is to give the rising generation an opportunity of acquiring some knowledge of sound scientific principles as a part of their early training. If the present generation of farmers and landowners cannot or will not bend to the inevitable, and endeavour to cope with difficulties by scientific method, then, at any rate, let facilities be given to their children for the acquisition of such scientific habits of mind as will enable them, without actually becoming experts in any particular science, to realise exactly how they are situated with respect to their competitors. It is hardly necessary to point out in these columns that in all rational schemes of technical education this principle is recognised as sound. It is remarkable, in view of this acknowledged principle, that so many technical instruction committees should have attempted to begin their work at the wrong end, and should have expended large sums in encouraging sporadic teaching by specialists to adults who, for lack of proper training, are totally unprepared for specialisation in any direction. In most cases a critical analysis of the results obtained under this system shows that unintelligent manual dexterity is the utmost that can be achieved. This, in our view, does not constitute technical education; certainly, so far as agricultural industry is concerned, this kind of instruction is not likely to be of any permanent value.

The agricultural industries may be regarded as furnishing a rallying point round which several distinct branches of science meet. To insure success in such occupations when all the resources of science are being utilised by our competitors, it is becoming more and more imperative that the education of the farmer should, at any rate, be placed on a scientific foundation. We cannot, unfortunately, look at present to the elementary schools for any help in this matter. The children leave too early in life, and such science teaching as they receive (if any) is quite inadequate. The sporadic system encouraged by some County Councils has already been condemned. Still more unfortunate appears to us to be the frittering down policy of administering the technical education grant in the form of doles to districts in proportion to the number of the inhabitants. The few want educating in the thinly populated agricultural districts quite as much, or even more, than the many in the towns. It is more costly to educate the few than the many; therefore the rural districts require more financial aid proportionally than the towns. Under the system referred to, the country districts get less. If an "intelligent foreigner," who came over to inquire into our educational systems since the passing of the Technical Instruction Act, were told that the degree and quality of the education given to a boy or girl had been made dependent on the number of inhabitants per square mile

[1] The fructicultural station established by the Duke of Bedford and Prof. Pickering at Ridgmount also comes under this heading.

in which the child happened to reside, he would be justified in passing on with a smile and a shrug.

Owing to the insufficiency of the educational machinery in country districts, and the disproportionate assistance given to urban centres under the decentralising policy, another evil has arisen which threatens to cripple still more seriously the already languishing rural industries. By the examinational selection of pupils for scholarships the best intellectual products of the country districts are gradually being weeded out, and all the skill and intelligence for which the land is thirsting is being diverted into other channels. This process, if allowed to go on, can only have one result: there will be left such an inferior residue that some future Minister of Education will have to deplore, even more emphatically than did Sir John Gorst in his memorable speech in the House of Commons last June, the barrenness of the outlook with respect to rural education. Still louder will go up the cry of the economist, that while the land is lying barren for want of skilled attention, and the villages are becoming depopulated, the towns are becoming overcrowded to the starvation point of competition.

In order to counteract these evils, it is desirable that the resources of science should be made as available to the inhabitants of the country as to the dwellers in towns. A long acquaintance with the habit of mind of the average British farmer has convinced us that the only chance of salvation in the future is to bring the educational machinery into his neighbourhood. It is useless to tell him that he must send his children to some distant school or college where science teaching forms part of the curriculum. He knows nothing and cares nothing about science. He looks upon learning as a dangerous thing, and associates chemistry with bogus fertilisers. An experiment which leads to no practical issue causes a chuckle, and if a downright failure is the result, he is rather pleased than otherwise. The so-called "agriculture" of the certificated schoolmaster, which was let loose in some counties in the early days of the technical education movement, is very largely responsible for hardening the scepticism of the practical farmer towards science.

Perhaps we are over-sanguine in the belief that the agricultural salvation of our country depends on the scientific education of the coming generation. At any rate the belief has taken practical form, and a school of science has been founded at Bigods, near Dunmow in Essex, by one of the writers (F. E. W.), which it is hoped will set an example throughout the country. No claim is made for any particular educational originality in this venture. The *raison d'être* of the school is that it serves a thinly populated agricultural district where there is no organised science school in existence. There are districts of a similar kind all over the country, and there is a distinct need for such schools in these districts. The Essex County Council has extended some aid towards the Bigods school, and it is to be hoped that other County Councils will follow suit in their own districts. Certainly no better use of the "whisky money" can be made in agricultural districts than in establishing schools of science where the children can receive a sound training, extending over the three or four years between their leaving the elementary school and their entry into life as bread-winners. In some cases it might be possible to develop existing schools in the desired direction; but, on the whole, a fresh start would seem to be the preferable course. The average country grammar school is generally too much hampered by ancient tradition to meet modern requirements; the education in such foundations has not a sufficiently scientific bias, and the particular class of students whom it is our desire to see catered for, do not take kindly to the grammar school curriculum, apart from the question of cost, which is more than the small farmer or proprietor can afford.

With respect to the curriculum at Bigods, we have at present adopted that laid down for schools of science by the Science and Art Department. In most respects this scheme seems adaptable to our requirements, which may be described briefly as an education which, while allowing a certain amount of time for literary subjects, gives also a general scientific training with some manual training. No specialisation will be allowed till the pupils have passed through the elementary stage, and in the advanced course the sciences bearing on agriculture will be given extra prominence. A large mansion has been placed at the disposal of the school as a residence for the principal and for boarders who reside too far off to come to the classes daily. There is plenty of land about the establishment for experiment plots, apiaries and poultry runs, and a farm adjoining the estate is available for field demonstrations. For the advanced classes the services of the County Council Staff Instructors, who are experts in their various departments, will be requisitioned. The school has made a start with some forty pupils, of whom about twenty-three are considered qualified to go through the school of science; while the remainder are in course of training for this curriculum. One especial feature of the scheme is the mixed education of boys and girls together in the same class. This system has been found to work admirably in other schools, both in this country and elsewhere, and it is intended to give it a fair trial in Essex. So far as experimental science is concerned, girls certainly are quite as keen and do just as well as boys if they are properly taught. The only point of difference in the education of the sexes is that the girls sacrifice some portion of the manual training and science in favour of domestic subjects, such as cookery, needlework, and domestic economy. Chemical and physical laboratories, a workshop and well-equipped laundry are, of course, essential parts of the institution.

The educational experiment which has been inaugurated in Essex is one which we venture to think is worthy of success and encouragement. The main difficulty with which we shall have to contend will no doubt be that of persuading the parents to allow their children to remain long enough at the school to complete their education. At any rate, the chance has now been placed in the way of the inhabitants of a district which has hitherto been devoid of institutions for carrying on any systematic scheme of secondary education. The firm belief that such establishments will do more permanent good to the agricultural welfare of this country than any amount of sporadic teaching or evening courses to people already mentally and bodily weary with a long day's work, has prompted the expenditure of money, time and thought, which have been necessary to found this school. Of equal weight has been the conviction that the mental discipline imparted by sound instruction in the principles of such sciences as are taught under the curriculum, is the best of all equipments that can be given to the agriculturist on his entry into active life. In order that would-be benefactors of rural education need not be alarmed, it may be pointed out that large institutions are not essential. At Bigods the laboratories of the school of science are available for about twenty-five pupils. We shall be satisfied if for some years this department of the school can be maintained at this number in the elementary and advanced stages. The great desideratum of the time is the establishment of numerous small but thoroughly efficient secondary and technical schools in appropriate centres, so that all the rural districts may be catered for. The general level of intelligence in the neglected country districts is bound to be raised in the long run by such means—not only by the direct effect of the training, but indirectly by reacting upon the elementary schools and compelling them to increase the efficiency of their teaching.

FRANCES EVELYN WARWICK.
RAPHAEL MELDOLA.

IN THE FORBIDDEN LAND.[1]

AMONGST the many travellers who wander to and fro in the untrodden parts of the world there has lately been a marked development of the journalistic class.

Ever since the days when the *New York Herald* achieved such a grand success with Mr. Stanley, and was instrumental in the discovery not only of the lost Livingstone, but of a vast new world for future enterprise, we have had from time to time new schemes for exploration initiated and supported by leading exponents of popular literature. The difference between the special correspondent and these emissaries of what we may call geographical journalistic enterprise lies chiefly in this; the special correspondent finds the subject-matter of his correspondence ready made for him; he has but to record the sequence of events as they pass before his eyes; over them he has no control, and his success depends largely on the chances and accidents of a campaign or political mission. The journalistic geographer, on the other hand, has to make his own straw before he can produce his bricks; and if startling sensation and thrilling incident are necessary to his success, he must find them for himself. There can be no reasonable objection to this form of enterprise, although the dangers that beset it (both moral and physical) are obvious. Haply the traveller who starts in search of a sensation may discover much that is of real value to science, and may prove to be a sound geographer. But his *métier* should not be confounded with that of the true geographer, the seeker after scientific truths, whose aim is the enrichment of the world's store of exact knowledge, and who will, in the pursuit of his object, avoid rather than court those situations which may peril the safety of his mission and impede his purpose, even if they may add picturesque detail to his narrative.

Mr. H. S. Landor is an adventurous traveller who possesses by heredity the eye of a poet, and a great power of graphic description. His book is interesting all through, but we must not take him too seriously as a great geographer. A journey through the Kumaon district (which constitutes a great part of his book) is but the periodic experience of every official Englishman who is appointed to the administration of that corner of the North-west Provinces, and even a visit to the Mansarawar Lake has not proved to be beyond the powers of several sportsmen lately, who have been more fortunate than Mr. Landor in their relations with the frontier Tibetan authorities. But beyond the Mansarawar Lakes, on the direct route to Lhassa, it has been known for many years that no European has a chance of penetrating far. It is a most jealously guarded route, and those travellers who have studied the subject of traversing Tibet beforehand, and who have lately succeeded in crossing the great northern plateau from west to east, have entered Tibetan territory at points less exposed to the hostile and unrelaxed vigilance of the Tibetan officials. It is true that the region of the Mansarawar Lakes, and, indeed, the whole route to Lhassa has been pretty thoroughly explored and surveyed under conditions of much less difficulty than those experienced by Mr. Landor; but this has been accomplished by trained employés of the Indian Survey department, who, being either residents of Kumaon or educated Tibetans, have been able to identify themselves with the people of the country, and have experienced no particular difficulty in reaching Lhassa, and describing it in comprehensive

FIG. 1.—Escaping in a snowstorm.

[1] By A. Henry Savage Landor. Two vols. Pp. xx + 320, and xvi + 263. (London: W. Heinemann, 1898.)

official reports. Mr. Landor's map differs in no essential particular from that of the Indian Survey, except that he shows an error in longitude. His separation of the Rakas Tal from the Mansarawar Lake by a dividing ridge of some elevation cannot be accepted as a final determination of the real nature of that division, the continuity of which probably depends on the amount of water in the two lakes. Evidence of their connection exists, and in face of the fact that Mr. Landor only partially traversed the dividing ridge, this evidence cannot fairly be set aside.

It speaks much for Mr. Landor's pluck and endurance that he should have succeeded, with two followers only, in penetrating some 200 miles along the high road to Lhassa. Here a forcible conclusion was put to his journey, and his opportunities as a geographical observer came to an end. But what was wanting in opportunity for scientific research was evaded the Tibetan outpost by escaping from his camp into the mountains during a severe snowstorm, and wandered amongst the hills for some days before he regained the direct road to Lhassa. So constant were his encounters with bands of dacoits on this much-traversed route, as to lead to a suspicion that these dacoits must gain a precarious livelihood by robbing each other. Their cowardice was, however, phenomenal (and in this trait of Tibetan character all travellers agree), and the simplest demonstration of resistance was enough to put them to flight. Gradually reduced to two followers, with two yaks to carry his small equipment, Mr. Landor still pressed on eastwards until he lost half his baggage in crossing a river. He was driven to a Tibetan encampment for food and for the purchase of ponies, and it was whilst negotiating the latter that he and his two companions were treacherously overpowered and cruelly bound, under the direction of a

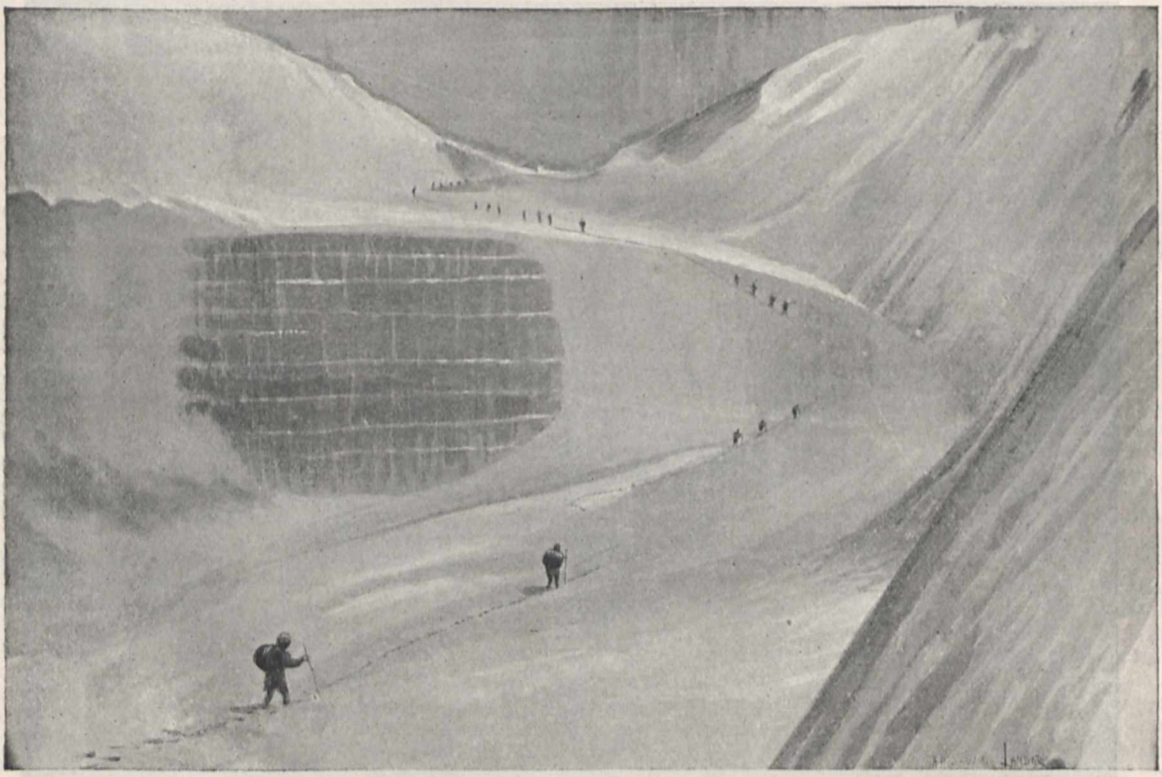

FIG. 2.—Crossing the "divide" between the sources of the Indus and the Brahmaputra.

more than balanced by the excitement (unexpected and most unpleasant) of thrilling personal adventure in the hands of the Tibetans; and it is this which gives such strong interest to Mr. Landor's narrative. He crossed the frontier by the Lampiya pass after a preliminary ascent of the Mangshan mountain. After reaching the top of the mountain (22,000 feet) at night, and recording his observations by the light of the moon, he witnessed some extraordinary optical phenomena; and then collapsed under the pressure of sensations such as few travellers have experienced, and from which we may venture to say that none before have ever recovered. High altitudes, no doubt, produce curious effects on the powers of vision. On another similar occasion Mr. Landor observed all the planets and stars oscillating in the sky with something of the motion of a swinging pendulum.

From the Mansarawar Lake eastwards his journey was one of constant difficulty and danger. He Tibetan official, who had probably been despatched from Lhassa to prevent his further progress. If Mr. Landor was in search of a sensation, he certainly found it now.

The rest of his book is a lively description of his sufferings and those of his faithful retainers during their forcible removal from Tibetan territory. One hardly knows which to admire most—the supreme contempt for his captors that Mr. Landor never failed to evince even under the most harrowing circumstances; the pluck and nerve which he showed when face to face with death; or his extraordinary athletic powers, as proved by his clinging to the saddle with his knees when his hands were tied behind him, and a heavy-weight Tibetan was pulling him backwards with a rope tied round his neck; or when, triced up by hands and feet (as illustrated by himself), he was able to liberate one hand and loose the ropes which bound his servant's feet, whilst he still remained suspended by the other.

With Mr. Landor's illustrations, two of which accompany this notice, we have no fault to find. The photographs are excellent, and his own drawings are powerfully descriptive of the impressions which remained in his mind after his adventures were over. The Kumaon hill track where he climbs round the face of the cliff is indeed a perilous path; but anything is possible in a region where the habitations of the natives can cling to the face of a wall in apparent defiance of all laws of gravity, as they do in the illustration which faces p. 159 of vol. ii. But with Mr. Landor's system of spelling we cannot agree. It is *not* the "geographical" system, and it is at first a little difficult to recognise well-known Hindustani words in the guise in which Mr. Landor clothes them. The words "Acha giao" (achcha jao) would not in the mouth of a Pahari gypsy mean "Go well" so much as "All right, clear out."

And there is one other subject which we think requires further investigation. The habits and manners of Tibetans have often been described, sometimes by themselves, sometimes by scientific observers. But Tibetans have never so far been classed amongst cannibals. The revolting details which Mr. Landor gives of the practices of the Lamas in connection with the last rites of a dead Tibetan are too horrible to be admitted without question. It should be remembered that Mr. Landor deals with a section of the Tibetan community which is directly connected with the great religious centres at Lhassa. It happens that it is about these centres that we possess the fullest information. No Lama in the neighbourhood of Darjiling would admit for an instant that such practices were common; nor will the reports of educated native travellers to Lhassa support the accusation. Mr. Landor carries his search for sensation just a little too far when he accepts in all good faith accusations such as this without an appeal to the best authorities.

With reference to the appendix to Mr. Landor's book, and the report of Mr. Larkin, the Deputy Commissioner of Almorah, the following extract from the *Pioneer Mail* of October 14 will be interesting.

"We have the best authority for stating, as we did the other day, that Mr. Landor was told that this report was confidential, that no copy was given him, and that he was not authorised to publish any Government report." The certified copies of depositions made in Mr. Larkin's Court should not be mistaken for Mr. Larkin's report.

T. H. H.

BODE'S LAW AND WITT'S PLANET DQ.

In comparing the distances of the planets from the sun, it was early thought that there might be some law which would connect these distances together and allow us to calculate them correctly or even approximately. Kepler, as long ago as the beginning of the seventeenth century, thought that he had discovered such a law; but as he could not account for the anomalous space between the orbits of Jupiter and Mars, he abandoned the idea "of reconciling the *actual* state of the planetary system with any theory he could form respecting it, and hazarded the assertion that a planet really existed between the orbits of Mars and Jupiter, and that its smallness alone prevented it from being visible to astronomers." In the year 1772 Prof. Bode announced a law which gave a curious approximate relation between these distances, although it seems certain that Titius of Wittenberg discovered and formulated it some years previously, pointing out "the existence of a remarkable symmetry in the disposition of the bodies constituting the solar system." This law was very simple, and amounted to this: If to each of the planets, beginning with the one nearest the sun, the number 4 be given, and to the second, third, fourth, &c., the numbers 3, 6, 12, &c., respectively, be added, then the resulting numbers, divided by ten, approximately give the values for the mean distances of each planet from the sun in terms of the radius of the earth's orbit.

The first six numbers calculated by this law gave with fair accuracy the relative distances of the planets; but there was one exception, namely the number 2·8, which represented the distance of a planet when there was no body known: this exception was the same that puzzled Kepler in the formation of his law. Prof. Bode supposed, however, a hypothetical planet to fill up this gap, which probably was absent simply because it had not then been discovered. We may mention that at that time Uranus and Neptune had not been found, so that the discrepancy with regard to the latter planet, in which this law utterly breaks down, could not then have been noticed. As this one feature in the law could not otherwise be explained, namely the number which accounted for the distance of a planet between Mars and Jupiter, a planet which had never been observed, it was decided to make a thorough search and try to pick up this missing member. The discovery of Uranus in 1781, and its distance agreeing with the value as given by Bode's law, set many astronomers thinking, with the result that it was decided to make a systematic search in the heavens for this unknown planet. Although all those who undertook this search worked diligently to pick up this supposed body, it was left for Piazzi, the Sicilian astronomer at the observatory of the University of Palermo, to make the discovery of the first (Ceres) of those now numerous small bodies known as planetoids, asteroids, or minor planets, which make their journey round the sun between Mars and Jupiter.

Piazzi, it may be remarked, was at the time constructing a star catalogue, and discovered this small body in his usual course of work, thinking at first it was a new kind of comet.

This was the first of a series of discoveries which now followed one another, and, up to the beginning of this year, no less than 425 of these planetoids have been discovered. The question then was asked, Did Bode's law still hold good? Were these small bodies, which vary in size from 100 to 10 miles in diameter, remnants of one large planet which originally revolved between Jupiter and Mars at a distance approximately the same as that represented by Bode's number 2·8?

Taking the distance of the mean minor planet, namely 2·650, and comparing it with the computed value from Bode's law, namely 2·8, the agreement was found to be sufficiently satisfactory for such an approximate law. In the case of Saturn, the difference between the mean distance and that given by Bode's law is nearly three times that for the minor planet above mentioned, so that the law may be said to approximately hold good.

In the case of Neptune, which was discovered in 1846, the value of the mean distance, according to Bode's law, is far from the true one, so that the law in this case may be said to completely break down.

Quite recently another planet, not a member of the minor planet family, as far as we know, but one revolving by itself, in an orbit between Mars and the Earth, has been added to the members of the solar system. Does Bode's law account for this? Before answering this question, let us, first of all, confine our attention for a moment to the manner in which this body was discovered, and what we as yet know about it.

In the early days of minor planet discovery, the task of finding one of these heavenly wanderers was by no means a light one; for the watcher had not only to be provided with an excellent star map of the region of the sky he was studying at the time (he nearly always constructed one himself), but to make measurements of each of the bright points in his field of view, night after night, to see if he could detect any relative motion between them. Considering the number of stars in the region under investigation, and the improbability of there being a minor planet in that region at that time, it can be quite well understood that such discoveries were the result of an immense amount of labour. By the use of the photographic method, all these difficulties are at once swept on one side; for, since the presence of one of these bodies can only be detected by its own motion relative to the stars around it, the photographic plate can at once indicate this. Further, by using a fairly wide angle lens, a far greater portion of the sky can be examined at one time than was previously the case, and therefore the chance of finding these bodies is considerably increased.

We have only to expose a photographic plate in an equatorially mounted telescope driven by clockwork at sidereal rate, then all stars will appear as circular discs, and any minor planet, which, of course, has its own proper motion, will be represented by a small trail, the length of this depending on the duration of the exposure and the amount of movement of the minor planet during that interval.

plate searched for are by no means easily seen. The plates, further, must always be carefully washed for some hours, in order to get rid of all trace of the hyposulphate of soda. It is an exceedingly easy matter to quickly dry photographic plates; but most methods, even that of the use of alcohol, are inclined to create disturbances in the film, such as unequal contraction, which render it unfit for accurate measurements afterwards.

Herr Witt therefore waited until the following day before the negative was examined. Not only did he find on it the record of the long-lost minor planet he was seeking after, but another one, Althaea (119), which had been previously discovered. With the help of a lens a further trail was noticed, but on account of its unusual length, which was an indication of a quick moving body, he thought at first it must be a comet. To verify this conclusion, the following evening he turned the 12-inch refractor towards the same region, and found in that position a stellar- not cometary-like body of magnitude 10 to 11. Without any further delay the dis-

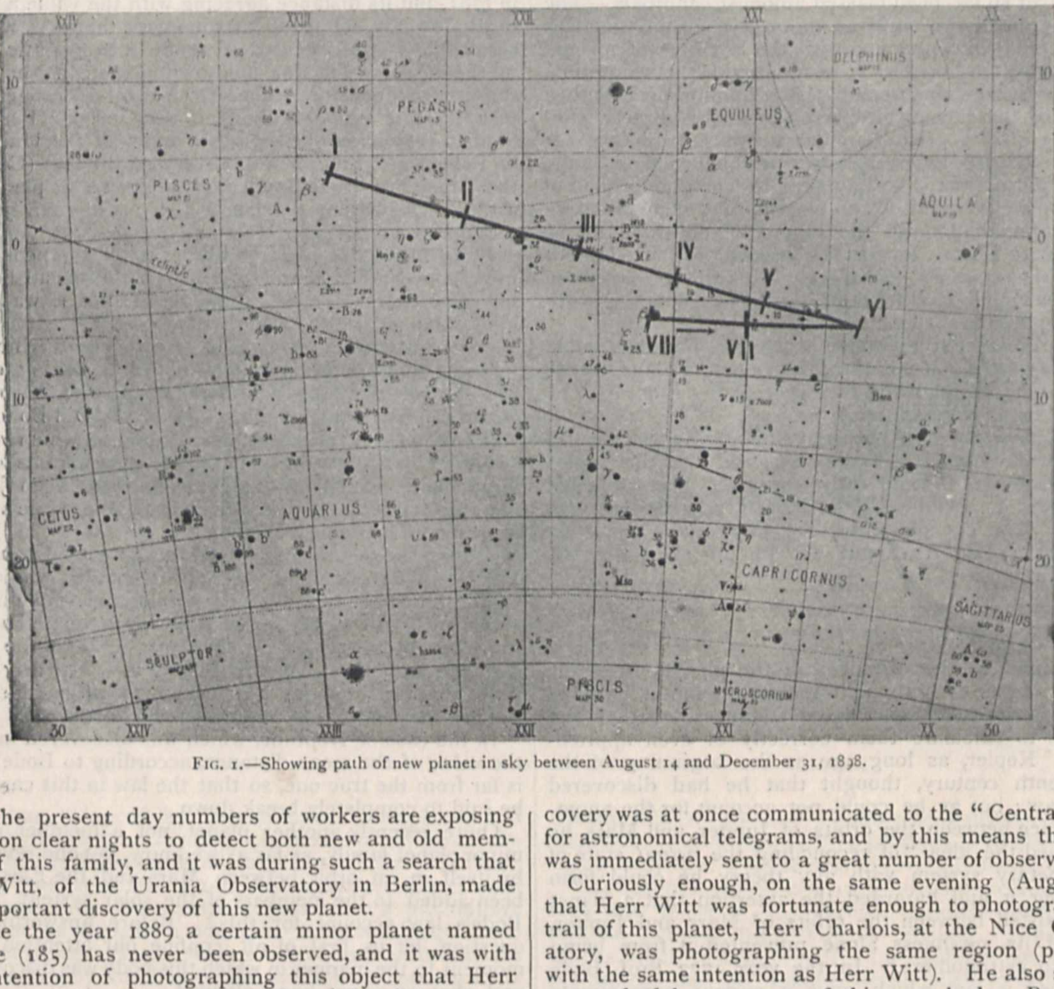

FIG. 1.—Showing path of new planet in sky between August 14 and December 31, 1898.

At the present day numbers of workers are exposing plates on clear nights to detect both new and old members of this family, and it was during such a search that Herr Witt, of the Urania Observatory in Berlin, made the important discovery of this new planet.

Since the year 1889 a certain minor planet named Eunike (185) has never been observed, and it was with the intention of photographing this object that Herr Witt turned his telescope, on the night of August 13, towards the region of β Aquarii, previous calculation having told him that the planet should be in or near that region. After a two hours' exposure the plate was developed and washed, and left to dry until the next day, when it was carefully examined. It may be asked, why the plate, after development, was not immediately examined? Any one who is familiar with such work will know that not only is the film very soft, and therefore easily liable to be damaged, but that the trails on the

covery was at once communicated to the "Centralstelle" for astronomical telegrams, and by this means the news was immediately sent to a great number of observatories.

Curiously enough, on the same evening (August 13) that Herr Witt was fortunate enough to photograph the trail of this planet, Herr Charlois, at the Nice Observatory, was photographing the same region (probably with the same intention as Herr Witt). He also secured a record of the presence of this new body. Prof. Perrottin, the director of the observatory, did not, however, make the discovery known until after Herr Witt's announcement; nevertheless, although the latter is entitled to declare himself the real discoverer, both names should be handed down to posterity, as is the case with the discovery of Neptune by Leverrier and Adams.

It was not long, however, before numerous accurate observations of this new body were made, and they extended over a period of days (seventeen in number) sufficient to allow that well-known indefatigable minor planet-orbit calculator, Herr H. Berberich, to compute its orbit. The accompanying chart (Fig. 1) shows the path of the planet in the sky from August 14 to December 31. The Roman figures in the chart from VIII to I correspond to the dates August 14, September 1, October 1, November 1, 15, December 1, 15, 31, of the present year.

Now comes the astonishing result of Herr Berberich's computation. The planet was not one of those small bodies which revolve round the sun between Mars and Jupiter, but was an entirely new body, its path lying for the main part within that of Mars.

Here are the elements of the planet's orbit as given by the calculations. It must be mentioned, however, that these elements cannot be considered as final, since more observations, extending over a much longer period, are required to ultimately establish the true elements. These elements, however, will not deviate very much from those given below.

Epoch 1898, *August* 31·5, *Berlin Mean Time.*

	°	′	″	
Mean anomaly	220	14	3·7	
Perihelion distance from ascending node ...	178	28	26·2	1898·0
Longitude of ascending node	303	48	53·0	1898·0
Inclination of orbit to that of the earth ...	11	6	57·1	1898·0
Eccentricity	13	13	3·8	

Mean daily movement, 2010″·131
Period of revolution round the sun, 645 days.

Taking the mean distance of the earth from the sun as unity, the new planet at perihelion approaches the sun to within 1·12 of these units, and when furthest away is distant 1·79 of these units. These values in the case of Mars are 1·38 and 1·67 respectively. We thus see that we can now no longer look upon Mars as our nearest neighbour (excepting, of course, our moon), for the mean distance of Mars from the sun amounts to 1·52, while that of the new planet is 1·46.

The accompanying diagram (Fig. 2) shows the relation of the new planet's orbit relative to that of Mars.

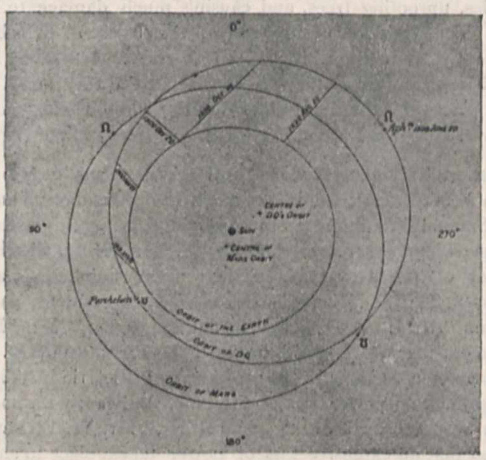

FIG. 2.—Comparison of orbits of Mars and the new planet D Q.

Assuming that Berberich's elements are correct, it is interesting to inquire into some of the relations which this orbit presents. Mr. Crommelin, to whom we are indebted for the above diagram, has considered such relations in his article in *The Observatory* (October, p. 372). A synodic period being two successive conjunctions with the sun as seen from the earth, this in the case of the new planet is 2·30692 years. We thus see that three synodic periods equal nearly seven years, so that after this period oppositions are repeated in nearly the same regions of the orbit. A closer approximation would be obtained if thirteen synodic periods, which extend over 29·99 years, were considered. As regards the time when the planet comes into opposition—a point of great importance, especially in the case of this planet—Mr. Crommelin tells us that, unfortunately, "an opposition under the most favourable circumstances took place in January 1894," and that we shall have to wait now until January 1924 until another equally favourable one occurs. In the years 1900 and 1917, only moderately favourable oppositions will occur, the planet in November of the former year then being of magnitude 8 or 9.

The close approach of this planet to the earth at times of favourable opposition will give us excellent opportunities of determining, more accurately than was possible before, the parallax of the sun—or, in other words, the distance of the sun from the earth.

The importance of a correct value of this quantity is very great, when it is considered that all measurements of distance in our solar system are based on it. Just as the foot is taken as a unit in measuring the side of a room, or a mile in measuring a strip of country, so astronomers adopt the mean distance of the earth from the sun as the unit in measuring the distance of Jupiter or Mars. A more accurate value of the standard of measurement for the solar system is, therefore, of the highest importance.

Since the new planet when nearest to and furthest from us will vary from the sixth to the twelfth magnitude, several useful photometric problems may be attacked. Thus, as Prof. Pickering suggests, the approximate diameter may be determined by comparing it with those of the brighter minor planets and satellites, on the assumption that the reflecting power is the same.

Again, the well-known law that light varies inversely as the square of the distance might be tested, as the planet's distance from the earth varies very considerably. At the same time, it could be determined whether there exists in the solar system any medium capable of absorbing light.

Let us now consider whether the law of Bode holds good for the presence of this new planet.

We give below a table showing a comparison between the true mean distances and those calculated by Bode's law.

Planet.	Distance.	Bode.	Diff.	Syn. period. Days.
Mercury ...	0·387 ...	0·4 ...	−0·013 ...	116
Venus ...	0·723 ...	0·7 ...	+0·023 ...	584
Earth ...	1·000 ...	1·0 ...	0·000 ...	—
Witt DQ ...	1·461 ...	? ...	— ...	644·7
Mars ...	1·523 ...	1·6 ...	−0·077 ...	780
Mean asteroid ...	2·650 ...	2·8 ...	−0·150 ...	Various
Jupiter ...	5·202 ...	5·2 ...	+0·002 ...	399
Saturn ...	9·539 ...	10·0 ...	−0·461 ...	378
Uranus ...	19·183 ...	19·6 ...	−0·417 ...	370
Neptune ...	30·054 ...	38·8 ...	−8·746 ! ...	367·5

In the above table the column headed "Bode" gives the distance according to the law of Bode, while the following column, that headed "Diff.," represents the difference between the true mean distance, as given in the second column, and that calculated after Bode's law.

A glance at this will show that the distance of the new planet does not fall into line at all, but, like Neptune, is an exception to the law.

Indeed, for the new planet, Bode's law does not even suggest a number, as there is no break between the distance accorded to our Earth and that of Mars. If we assume the law of Bode as mainly correct, then we must look upon the new planet as one of the minor planets gone somewhat astray.

There is, however, one outlet which believers in this law can take advantage of, namely, that perhaps the new body was originally part of the planet which, when broken up, gave rise to the group of minor planets. As opinion is still divided as to the true origin of asteroids, namely, whether they are the result of a large series of explosions of an original planet which revolved between Mars and Jupiter; whether they are the condensation of matter which originally was distributed in rings like Saturn, but which was disturbed by the action of Jupiter; or, lastly, whether they are the result of tidal action on the tenuous primitive masses, the presence of the new planet in this exceptional orbit might be accounted for on any of these hypotheses. Perhaps, for all we know, this planet may be one of several similar bodies which were so thrown off or perturbated from the original mass, that they were able to get into more favourable positions for being disturbed by the attraction of Mars when nearest them, and that their orbits were changed.

Mr. Rees, in a lecture before the New York Academy in 1897, suggested that "the very rapid augmentation in the number of minor planets indicates that there may be thousands or even millions in the zone: with more powerful telescopes and more sensitive plates we may hope to find many of these thousands. And perhaps the same agencies will discover asteroids between the orbits of all the planets." There is, however, no doubt that the orbits of some of the minor planets are not very dissimilar from those of Mars and Jupiter, and must be subjected at times to large disturbing forces by both these planets. That one, or even several, of these bodies may have been violently disturbed by Mars when in a very favourable position, and thus made to revolve in orbits more eccentric and inside that of Mars, does not seem at all improbable.

Jupiter also would be responsible for a great disturbing force, and it is as likely as not that beyond his orbit many of these small bodies pursue their paths; these, however, would probably be invisible to us on account of the greater distance. In fact, it seems more natural and in harmony with the solar system in general to consider this newly-discovered small planet as an unusually situated member of the minor planet group, than as a single condensed body which has from the beginning of its career been up till now an unseen major planet.

If future research on the movement of this new body should indicate the probability that we are dealing with a member of the minor planet group that has suffered considerable perturbations, then the law of Bode will, with the ususal exception (Neptune), still afford us the simple approximate means of quickly calculating the distances of the members of the solar system.

WILLIAM J. S. LOCKYER.

NOTES.

WE regret to see the announcement of the death of Mr. Latimer Clark, F.R.S., the well-known electrician, at the age of seventy-six.

PROF. JAMES A. CRAIG, of the University of Michigan, spent his summer vacation in London at work in the British Museum, on the astrological-astronomical tablets of the Kujundjik (Nineveh) collection known as the Illumination of Bêl. This is the most important series of unedited texts in the British Museum, and by far the most important in many respects to be found in any of the collections extant. Prof. Craig has worked upon it during the last three summer vacations, and has now completed all the texts of the series, which number about 130 tablets. His manuscript is already in the press with Die Hinrichssche Buchandlung, Leipzig, and will appear shortly in the "Assyriologische Bibliothek," in which the author has already published two volumes.

THE Paris correspondent of the *Chemist and Druggist* states that Dr. Calmette, Directeur of the Pasteur Institute at Lille, has endowed that body with a sum of 250,oco francs (10,cco*l.*), representing the profits realised by the distilleries at Seclin by one of his inventions.

Natural Science, the impending decease of which was announced in the October number, has received a new lease of life. An editor has been found willing to take upon himself the burden of responsibility, so the journal will appear as heretofore during 1899, and, it is hoped, for many years to come.

THE Committee on endowment of the Franklin Institute, Philadelphia, is making an appeal for subscriptions to the endowment fund. It is of the utmost importance for the future prosperity and progress of the Institute, that a substantial addition to its annual revenues be acquired, not only to provide income sufficient to carry on its present work, but also to enable it to extend this in other directions.

PROF. ISRAEL C. RUSSELL, of the department of geology of the University of Michigan, has recently conducted a geological survey for the United States Government over the northern portion of the Cascade Mountains. The greater part of the work was in Washington State, and extended from the Northern Pacific railroad to the Canadian boundary, crossing the mountains several times. Among the places of interest visited was Glacial Peak, the height of which was verified.

AT the close of the last, and the beginning of the present week, the weather over these islands was of a very unsettled character. On Saturday, October 29, a cyclonic disturbance appeared off the south of Ireland, and subsequently passed to the Shetlands, causing gales, especially over the western and northern parts of the country, and rough weather in the Channel and Bay of Biscay, with very heavy rainfall generally, amounting in forty-eight hours to 1·26 inches at Greenwich and 2·48 inches at Pembroke, while thunder and lightning were observed at several places. At Camberwell Green (south-east London) a terrific squall, resembling a small tornado in its character, occurred at about 9h. 30m. on Saturday evening, overturning vehicles, uprooting trees, and causing much damage to buildings. The violence of the storm, the track of which was apparently from about E.S.E. to W.N.W., fortunately lasted only a few minutes, and was confined to a very small area, other places in the immediate locality experiencing nothing beyond strong wind accompanied by very heavy rainfall.

THE ordinary general meeting of the members of the Institution of Mechanical Engineers was held on October 26 and 27, Mr. Samuel W. Johnson, the president, being in the chair. The president announced that Sir W. H. White, Chief Constructor of the Royal Navy, had been nominated as his successor, Mr. T. Hurry Riches as a vice-president, and Sir William Arrol, M.P., Sir Benjamin Baker, Mr. Henry Chapman, Mr. W. J. Pirrie, and Sir T. Richardson, M.P., as members of the Council. In a paper on "Electric installations for lighting and power on the Midland Railway, with notes on power absorbed by shafting and belting," Mr. W. E. Langdon showed that an extensive loss of power takes place in shafting and belting, but this may be reduced by driving each tool or machine direct from an electric motor. With large tools or machines absorbing over one horse-power, there seems to be no question of the advantage derived from driving them direct by electricity. Mr. W. M. Smith described some recent practical experience with express locomotive engines. The train resistance was found to be considerably increased by side winds. On one trip it was found that the side wind increased the mean train resistance by abcut 3·558 lbs. per ton of lcad. The dynamometer apparatus used in the experiments measured and recorded (1) the pull or push exerted by the engine on the train; (2) the distance run; (3) the speed; (4) the places of starts, stops, and stations; and (5) the time when starts and stops were made, and when stations were passed. The horse-power shown by the indicator diagrams differed from that recorded by the dynamometer, which was in a separate car. Usually, however, the ratio between the two horse-powers did not vary much. On an average the dynamometer horse-power was equal to approximately 64 per cent. of the indicated horse-power. Thus about 36 per cent. of the driving power was absorbed by the engine and tender.

MR. N. R. HARRINGTON and Dr. Reid Hunt have arrived in New York from the Nile valley, where they have been several months collecting *Polypterus* and other interesting and valuable cytological material. We learn from *Science* that the chief object of the expedition was to procure the life-history of *Polypterus* and its bearings upon the problem of the relation of the Crossopterygian fishes to the Amphibia. In the last few years the former theory that Amphibia sprang from Dipnoan fishes has gradually given way to the present view that *Dipnoi* are to be regarded as parallel to Amphibia from a common Crossopterygian origin. Several very successful expeditions have been sent out to procure material for the embryology of Dipnoans, notably that of Prof. Richard Semon from Jena, and that of Mr. Graham Kerr from the University of Cambridge. The former secured the complete life-history of *Ceratodus*, and the latter brought back the embryology and complete life-history of *Lepidosiren*, a South American form. But before the recent expedition nothing had been done upon the development of *Polypterus*, because of the exceptional difficulties which stood in the way of procuring material. Messrs. Harrington and Reid found that the fish did not occur in Lake Menzaleh during the low Nile period, but they came across several *Polypterus* near Ras-el-Ghelig. The best *Polypterus* fishing ground, not closed on account of the Sudan campaign, was at Mansourah, forty miles from the sea; and the party settled there for the summer.

THE attention of botanists has of late years been turned to the biology of ferns, but there still remain a great many facts to be explained, and questions to be solved. Dr. Aurelio de Gasparis, in a paper to be published in the *Atti* of the Naples Academy, has brought to light a large number of new facts relating to ferns. Some of these relate to certain forms of dissemination not previously observed, others to the trophilegic action of the fronds, in connection with which certain arrangements have been observed, destined to facilitate the passage of water to the roots. The author has also discovered two new cases of myrmecophily, as well as a number of cases of acarophily among ferns, many of them very evident and easy of observation.

AN interesting addition to the list of myrmecophilous plants furnished with so-called "extra-nuptial" nectaries is given by Prof. Federico Delpino in the *Rendiconto* of the Naples Academy, iv. 7. In the Botanical Gardens at Naples about seven or eight plants have recently been observed to possess these glands, which differ from the ordinary melliferous glands in not being associated with the floral organs and being provided for the purpose of attracting ants instead of for promoting fertilisation. The newly-observed cases occur in *Cardamine cheledonia*, L., *Lilium croceum*, L., *Dyckia regalis* and *D. remotiflora*, a species of *Aechmea*, *Iris foetidissima*, L., and *Vicia serratifolia*, Koch. The families of *Cruciferae* and *Bromeliaceae* are thus added to the fifty-eight families previously known to contain species furnished with the glands in question.

IN a paper, published in the *Sitzungsberichte* of the Berlin Academy of Sciences, Dr. F. Johow states his belief that the number of flowers pollinated by the agency of birds is much smaller than is often stated. Humming-birds, in particular, since they feed entirely on insects, and not on nectar, play but a small part in the carriage of pollen. He describes, however, an unquestionably ornithophilous flower in a Chilian Bromeliad, *Paya chilensis*. The "nectar" in this flower is exceedingly abundant, but is not attractive to insects, being very watery, and containing but little sugar. It is, however, eagerly drunk by humming-birds, but more especially by the "Chilian starling," *Curaeus aterrimuus*; and these birds get their heads plentifully besprinkled with the pollen, which they then carry to other flowers.

PROF. RAMSAY has an article on the kinetic theory of gases and some of its consequences in the November *Contemporary*. He explains Dr. Johnstone Stoney's application of the kinetic theory to the atmospheres of planets and satellites, and then considers the recent discoveries of gaseous constituents of our own atmosphere, with special reference to the new element "neon." The facts dealt with are summed up as follows: "We have seen, then, that the discovery by Lord Rayleigh of a discrepancy in the density of atmospheric nitrogen has resulted in the discovery of a new constituent of air, argon; its discovery has led to that of a constituent of the solar atmosphere, helium; speculations on the ultimate nature and motion of the particles of which it is believed that gases consist has provoked the consideration of the conditions necessary in order that planets and satellites may retain an atmosphere, and of the nature of that atmosphere; the necessary existence of an undiscovered element was foreseen, owing to the usual regularity in the distribution of the atomic weights of elements not being attained in the case of helium and argon; and the source of neon was therefore indicated. This source, atmospheric air, was investigated, and the missing element was discovered."

THE expressions for the work done in magnetising a body have been given by Mascart and Joubert and Prof. J. J. Thomson, by Prof. Ewing, and by Prof. Ascoli respectively in three different forms, all of which lead to the same results when applied to closed cycles, but differ in the values they give for the work done in an open transformation. An interesting examination of these formulæ is given by Signor Guido Grassi in the *Rendiconto* of the Naples Academy, vi. 7. The author finds that Ewing's formula $(1/4\pi)\int H dB$ represents the general expression of the total work of magnetisation; that $\int H dI$ represents the difference between the total work of magnetisation and the work which would have to be expended in order to create the magnetic field if the latter did not contain any bodies of magnetic permeability different to that of air; and that the expression $\int I dH$ does not represent the work of magnetisation except in the case of a closed cycle.

PROF. B. O. PEIRCE and Mr. R. W. Willson have for several years been engaged in an attempt to measure, by the aid of the "Wall method," the thermal conductivities of certain relatively poor conductors, and the variations of these conductivities with the temperature. The methods they have adopted, and the results of a number of observations, are now published in the *Proceedings* of the American Academy of Arts and Sciences (vol. xxxiv. No. 1, August 1898). In the present paper the results are given of determinations of conductivities of about twenty specimens of marble of different kinds, when the faces of slabs of the material are kept at temperatures of about 18° C., and 45° C., compared with the conductivity of a special brand of glass which appeared to be practically constant within the limits of the measurements. It appears that the conductivity of a specimen of marble at ordinary mean temperatures may depend, to the amount of several per cent., as

Messrs. Hershell and Lebour have shown, upon the amount of moisture which the specimen holds. An accuracy of only one per cent. is therefore claimed for the determinations. The absolute conductivities of the marbles, calculated on the assumption that the conductivity of the standard glass was 0·00277, are between 0·00501 and 0·00761. Special attention is drawn to two groups of fine-grained marbles, which have conductivities of about 0·0068 and 0·0076 respectively, at about 30° C.

THE principal facts referring to the origin of the metamorphosis of insects are summarised by Mr. J. W. Tutt in the volume of *Transactions* just issued by the South-Eastern Union of Scientific Societies (Taylor and Francis). Metamorphosis, he concludes, appears to be an adaptive habit which certain insects have adopted, in their struggle for existence against those enemies by which they are everywhere surrounded, and against those animals that compete against them for food. The habit of flying, by which they are able to escape from numberless enemies that have not this power, was probably one of the first factors in their development that led to their ultimate success. The additional ability to store up food in the early active (larval) stages of their existence so as to allow them to adopt a hiding habit and quiescent external form at the most critical period of life, must, however, have been the proximate cause of that success which has culminated in their being numerically the most successful types of terrestrial life in existence, the number of species being almost incredible.

WRITING with reference to the account of the resuscitation of a toad taken from a snake, which appeared in NATURE of August 11 (p. 344), a correspondent in the Purneah district, India, informs us that similar occurrences are common in parts of India. He remarks :—"Almost any snake can be made to disgorge what he has just eaten if worried a bit, and on numberless occasions I have seen this done with grass snakes, and seen a toad or frog, generally the latter, hop away rejoicing. . . . Snakes when angry or alarmed apparently have the power of throwing up their food, and only the other day I caught a 'dhamin,' a harmless but very savage snake—a small one, about 40 inches long—and put him in a box with a glass lid. The next morning I found two half-digested rats which the snake had thrown up. The same thing happened once with a black cobra, whose meal had also consisted of two rats with the addition of a sparrow."

A VOLUME of *Transactions and Proceedings* (vol. xxx., 1897) of the New Zealand Institute, edited and published under the authority of the Board of Governors of the Institute by Sir James Hector, K.C.M.G., F.R.S., has been received. Several of the papers in it have already been referred to ; and the limitations of available space prevent us from referring to more of the present volume than a presidential address by Mr. W. T. L. Travers on material and scientific progress in New Zealand during the Victorian Era. Sir James Hector's work in New Zealand justly entitles him to distinction among the explorers and discoverers who have advanced the knowledge of the physical characteristics of the globe during the past sixty years. He commenced his duties as geologist to the Provincial Government of Otago in 1861, and under his direction very valuable investigations were made. Mr. Travers points out, however, that geological work in the field practically ceased in 1893, since which date Sir James Hector has not been provided with the necessary staff for pursuing it. Why this is the case is not clear, but the interruption in the work of one of the most important scientific departments of the Colony is much to be regretted.

REFERRING to the biological interests of the islands of New Zealand, Mr. Travers remarks, in the address referred to, that though the reptilian life found is very limited in extent, it contains two forms of the most remarkable character—namely, the *Tuatara* lizard and a frog known as *Leiopelma hochstetteri*, found chiefly in the Coromandel district. The lizard is only now found in some of the outlying islands, where its continued existence is threatened by the introduction of the pig and the cat. The affinities and structure of this reptile have been the subject of many memoirs, both by New Zealand and foreign naturalists, who have shown that it is evidently connected with some of the most ancient fossil forms. The frog is remarkable chiefly as occurring in an oceanic island. It is satisfactory to know that the fauna and flora of New Zealand have been, and are, studied by many collectors and investigators, the results of whose work have been embodied either in separate volumes or manuals published by the Government under the editorship of Sir James Hector, or in the shape of memoirs in the *Transactions* of the New Zealand Institute, such as those in the volume lately issued.

THE age of Niagara Falls, as indicated by the erosion at the mouth of the gorge, was the subject of a paper by Prof. G. Frederick Wright, read at the recent Boston meeting of the American Association. The late Dr. James Hall early noted the significant fact that "the outlet of the chasm below Niagara Falls is scarcely wider than elsewhere along its course." This is important evidence of the late date of its origin, and it has been used in support of the short estimates which have been made concerning the length of time separating us from the Glacial period. A close examination made by Prof. Wright this summer greatly strengthens the force of the argument, since he found that the disintegrating forces tending to enlarge the outlet and give it a V-shape are more rapid than has been supposed. As the result of his investigations, he concludes that a conservative estimate of the rate of disintegration for the 70 feet of Niagara shales supporting the Niagara limestone would be one inch a year, with a probable rate of two inches a year. But at the lowest estimate no more than 12,000 years would be required for the enlargement of the upper part of the mouth of the gorge 1000 feet on each side, which is very largely in excess of the actual amount of enlargement. Some of the recent estimates, therefore, which would make the gorge from 30,000 to 40,000 years old, are regarded as extravagant. According to Prof. Wright, the age of the gorge cannot be much more than 10,000 years, and is probably considerably less.

DR. AD. STRUCK, of Salonica, contributes an interesting paper on the Macedonian Plain to the issue of *Die Natur* for October 9. Some details of the mean temperature and rainfall are given, and a short account of the chief products of the region.

THE *Bollettino* of the Italian Geographical Society for October contains a paper, by M. Baratta, on the geographical distribution of earthquakes in Umbria. All the authentic records in existence are summarised and discussed, and a map showing the chief regions of seismic disturbance is appended.

WE have received a copy of the double number of *Spelunca*, the organ of the French *Société de Spéléologie*, for the first half of the current year. This journal is now in the fourth year of its existence, and it continues to publish valuable papers on subjects connected with caves and other subterranean structures. The present number contains some notes of interest on the protection of sources of potable water, indicative of increased attention to this matter in France.

A PAPER, by Prof. Dr. J. Walther, on historical and geological aspects of the problem of the course of the Oxus, appears in *Petermann's Mittheilungen*. Dr. Walther shows that the Oxus has always flowed into the Sea of Aral, and that the belief that its waters reached the Caspian arose from ignorance of the existence of the Sea of Aral, and from the credit given to the fanciful reports of the English merchant Jenkinson, who travelled from Astrakhan to Bukhara in 1558.

A COPY of the general report of the work carried on by the Geological Survey of India for the period from January 1, 1897, to April 1, 1898, has been received. The headquarter notes, forming the first part, announce amongst other things the removal of the offices of the department to a new building which affords improved accommodation, but the Director pleads for transference of headquarters to a hill station. The second half of the report gives short accounts of nine separate surveying expeditions, including one on the north-west frontier by Mr. H. H. Hayden, who was permitted to accompany the Tirah Expeditionary Force.

THE September number of the *National Geographic Magazine* contains papers on the growth of the United States, by W. J. McGee; on the Bitter Root Forest Reserve, by Richard U. Goode; on Atlantic Estuarine tides, by M. S. W. Jefferson; and on the forest conditions of the State of Washington, by Henry Gannett. Mr. McGee's paper traces the growth of the States in area, population, wealth, railway-mileage, and carrying trade since 1790, and shows that the history of the growth of the United States is one of unequalled progress in all these elements, but, above all, in "development of a national character in which individual enterprise and capacity are the most conspicuous traits."

FOUR new parts of the second edition, revised, of "An Illustrated Manual of British Birds," by Mr. Howard Saunders, have been received from Messrs. Gurney and Jackson. Twelve parts of the work have now been published, and eight more have yet to appear to complete the work.

A RICHLY illustrated book for nature lovers is "An Elementary Botany" by Prof. George F. Atkinson, of Cornell University, announced for early publication by Messrs. Henry Holt and Co. Among the more than five hundred pictures are many full-page landscapes in half-tone.

MESSRS. ARCHIBALD CONSTABLE AND CO. will publish, early in November, "The Life of the late Sir Charles Tilston Bright, C.E., M.P.," wherein is included the story of the first Atlantic cable, the first telegraph to India and the Colonies, and the early land telegraphs of the United Kingdom. This work is written by Mr. E. B. Bright and Mr. Charles Bright, brother and son respectively of the subject of the memoir. The book, which contains many full-page and text illustrations, as well as photogravure plates, maps, charts, &c., will be published in two volumes.

UNDER the title of *Sell's Commercial Intelligence* a weekly newspaper has been started with the object of publishing authentic commercial intelligence, and developing British trade. The periodical will do a useful service to British industry if it will show our manufacturers how technical education and scientific research abroad have enabled other nations to beat us in the markets of the world. The following note on a decrease in the exports of chemicals is interesting in this connection:—"The American Consul at Liverpool points out that the exportation of chemicals from the Liverpool districts to the United States, has fallen from about nine million dollars in 1891 to a little under four million dollars in 1897, and at the present rate the exportations for 1898 will only amount to about a quarter of a million dollars. He comments on the application of electrolysis to chemical manufactures, and points out that where electricity can be produced by water-power, as at Niagara and many other places in the United States, the new process will have a better chance of success than in England." We are glad to see that a series of equivalents of British and metric measures is commenced in the new journal.

THE additions to the Zoological Society's Gardens during the past week include a Drill (*Cynocephalus leucophaeus*) from West Africa, presented by Mr. Alfred J. Dempster; two Wild Canaries (*Serinus canarius*) from the Canary Islands, presented by Mr. W. H. S. Quintin; two Tarantula Spiders (*Mygale*, sp. inc.) from the West Indies, presented by Mr. H. R. Taylor; a Common Hamster (*Cricetus frumentarius*), European; a Matamata Terrapin (*Chelys fimbriata*) from Brazil, deposited; a Blue Jay (*Cyanocitta cristata*) from North America, a Naked-throated Bell-bird (*Chasmorhynchus nudicollis*) from Brazil, a Common Boa (*Boa constrictor*) from South America, purchased; two Cockateels (*Calopsitta novae-hollandiae*), a Graceful Ground Dove (*Geopelia cuneata*), a Spotted Turtle Dove (*Turtur suratensis*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

NEW ALGOL VARIABLE.—A Kiel Circular (No. 14) tells us that Mr. Sawyer has discovered a new variable of the Algol type + 12° 3557. Its period is very short, amounting to 0·89 days; the change in magnitude during this interval being 7·0 to 7·5. A minimum occurred on October 3·54 last, Greenwich mean time.

COMET BROOKS.—Kiel Circulars Nos. 13 and 14 give the elements of this comet as computed by Ristenpart and Möller on the one hand, and Hussey on the other. Those of the latter were computed from observations made on October 21, 23 and 25, and are as follows:—

T = 1898 November 23·14 Greenwich M.T.

$$\left.\begin{aligned} \omega &= 123^\circ\ 22' \\ \Omega &= 96\ \ 10 \\ i &= 140\ \ 19 \end{aligned}\right\} 1898{\cdot}0$$

$$q = 0{\cdot}7564$$

The ephemeris which accompanies these elements is only computed up to November 8, so we give below the position of the comet on that day for Greenwich midnight.

R.A. = 17h. 44m. 52s. Dec. = + 12° 41′.

The comet is rapidly decreasing in declination, and will be found in the region south of λ and δ Herculis, moving in the direction but slightly to the west of α Ophiuchi.

The Circular further states that the orbit of this new comet is similar to that of Comet 1881 IV. This latter was discovered by Schaeberle, and was visible to the naked eye for more than two weeks in August, its tail being over 10° long on August 21. Telescopically it was visible for a period of fourteen weeks.

THE ORBIT OF CASTOR.—Prof. Doberck, of the Hong Kong Observatory, has recently been investigating the elements of the orbit of Castor, or α Geminorum, as the components seem to have been behaving rather differently from what computation has destined them. The orbit, which was calculated in 1877, seems to have been entirely upset by the fact that since 1887 the components have been steadily approaching each other. With the assistance of Mr. J. I. Plummer, Prof. Doberck has collected all available observations and compared them with computed elements (*Astr. Nachr.*, 2168). From this he has formed the normal places, which have led him to obtain the following elements referred to the year 1900:—

$$\Omega = 33^\circ\ 0' \qquad e = 0{\cdot}5909$$
$$\gamma = 69\ \ 34 \qquad P = 318{\cdot}23 \text{ years}$$
$$\lambda = 87\ \ 14 \qquad T = 1948{\cdot}86$$
$$a = 6''{\cdot}605$$

From these Prof. Doberck has calculated an ephemeris for the apparent places for the years 1900–1920, from which we make the following extract:—

t.	Pos. angles θ °	Dist. ζ ″	$\Delta\alpha$ s	$\Delta\delta$ ″
1900	225·65	5·644	−0·310	−4·04
1901	225·22	5·625	−0 312	−4·00
1902	224·78	5·603	−0·313	−3·95
1903	224·34	5·579	−0·314	−3·90
1904	223·89	5·554	−0·315	−3·85
1905	223·44	5·527	−0·315	−3·80

THE INTERNATIONAL CONFERENCE ON TERRESTRIAL MAGNETISM.

WE publish below the more essential parts of the Report of the Permanent International Committee on Terrestrial Magnetism. That report will, we believe, be submitted to the Committee of the International Meteorological (and Magnetic) Conference, to be held next summer in St. Petersburg, and may be referred by them to the full meeting of the Conference to be held in 1900 or 1901. The decisions arrived at will thus be fully considered on several occasions, and will probably command universal acceptance when they are finally approved.

It is unnecessary to discuss in detail the four points which were submitted to the Committee by the Paris Conference. Two of these refer to the form in which the observations made at observatories should be published. A third, based on a report by M. Mascart, is, no doubt, intended to crush the curious superstition, which still prevails, to the effect that the larger the magnet employed to measure the magnetic elements the more accurate will be the results attained.

The fourth point referred to the Committee was of more importance. The whole science of Terrestrial Magnetism is waiting for more accurate knowledge of the magnetic state of the earth in the tropics and the southern hemisphere. The Committee propose that temporary observatories shall be established at some dozen different places, most of which are easily accessible, and, if possible, maintained during a sun-spot cycle. This can only be done by international co-operation, and it is to be hoped that the scheme may be carried out before long; more especially as the report on which the resolution was founded was jointly prepared by General Rykatcheff and Prof. von Bezold, who hold high official scientific positions in Russia and Germany respectively.

The other papers read before the Conference were devoted to various subjects which fairly covered the whole range of the science.

Prof. Adams' account of his brother's calculations on the Gaussian constants, and Prof. Schuster's paper on a similar subject, led to the remark that the mathematics of the subject were at present far ahead of the accuracy of our knowledge of the facts to which they are to be applied.

The announcement made by Dr. Schott that a magnetic observatory was about to be established in Honolulu, the steps taken by the Prince of Monaco to found an observatory in the Azores, and the plucky start made by Dr. Beattie and Mr. Morrison in a magnetic survey of South Africa, were sufficient proof that efforts are being made to bring our experimental facts to the standard our mathematics have attained.

Local disturbances were dealt with in Sig. Palazzo's paper on the neighbourhood of Etna, and in Captain Creak's interesting statement as to the island of Funafuti. As our readers are aware, this is the coral island on which boring operations have been carried on for some time in order to test the rival theories of the origin of atolls. The magnet has to a certain extent anticipated the results to be obtained by the drill. Indubitable evidence has been found that the island is a centre of magnetic attraction, and the magnitude of the vertical disturbance indicates the presence of highly magnetic rock. It is, of course, possible that this may exist at a depth which no boring could reach; but the result is certainly of interest with reference to the problem which the boring is intended to solve.

Drs. van Rijckevorsel and Bemmelen announced that their elaborate survey of the Rigi had failed to establish any definite connection between the magnitude of the magnetic elements and height above the sea level. Earth currents were dealt with by Prof. Schuster and Dr. Lemström. Dr. Schmidt utilised the occasion to enforce the fact that isolated observations, made at irregular intervals, at ill-defined positions, are of little use in the determination of the secular change; while Dr. Eschenhagen pleaded for the co-operation of other observers in the simultaneous observation of the minute magnetic disturbances of which he is virtually the discoverer.

The Conference on the magnetic and electrolytic disturbances produced by electric railways was not well attended by electrical engineers, but the fact that Mr. Preece and Prof. Fleming were on the side of those who insist that these evils shall be dealt with while they are still in their infancy, gives hope that the bitter cry which is going up from directors of observatories, all the world over, will not be unheeded.

It only remains to add that the improvements in the organisation of the Permanent Magnetic Committee, which were advocated by the President in his opening address, were adopted by the Committee; and that the Magnetic Section of the International Meteorological Conference will probably in future be far more important than it has been in the past.

REPORT OF THE PERMANENT COMMITTEE ON TERRESTRIAL MAGNETISM AND ATMOSPHERIC ELECTRICITY TO THE INTERNATIONAL METEOROLOGICAL CONFERENCE.

Constitution of the Committee.

I. The Committee on Terrestrial Magnetism and Atmospheric Electricity appointed at Paris in September 1896, consisted of eight members. These gentlemen found that it was desirable to add to their number, by co-option, and the constitution of the Commitiee is now as follows:—

Appointed at Paris: Prof. Rücker (President), Prof. Eschenhagen, Prof. Liznar, M. Th. Moureaux, Sig. L. Palazzo, Dr. Paulsen, Dr. van Rijckevorsel, General Rykatcheff.

Co-opted: Dr. Bauer, Prof. W. von Bezold, Sig. Brito-Capello, Dr. Carlheim-Gyllenskjold, Prof. Mascart, Prof. T. Mendenhall, Prof. A. Schmidt, Dr. C. Schott, and Prof. A. Schuster.

The report then proceeds to give an account of the proceedings of the Conference at Bristol, which have been described in these columns.

II. Dr. C. H. Lees, of the Owens College, Manchester, and one of the Secretaries of the Section of Mathematics and Physics of the British Association, acted as Secretary of the International Conference and of the Permanent Committee.

Meetings of the Permanent Committee.

III. During the session of the British Association, the Committee also held meetings on September 7, 9, 12 and 13, at which the following resolutions were unanimously approved:—

(*a*) Matters referred to the Committee by the International Meteorological Conference.

Four questions were referred to the Committee.

The first of these was the following resolution of M. Dufour (Report of the Paris Conference, p. 30).

> "In calculating monthly means, all days are to be taken into consideration. It is left open to each Director to give, in addition, means calculated without taking disturbed days into account."

This was approved by the Committee with the substitution of the words "It is desirable" for the words "It is left open to each Director."

(1*a*) The Committee were also of opinion that the quiet days chosen by the Directors of the different observatories should be communicated to the President of the Permanent Magnetic Committee, and circulated by him, and also that it is desirable to inquire if it will be possible to select the same quiet days for the different observatories.

(2) The second resolution referred to the Committee was the following, proposed by Prof. von Bezold and M. Mascart (Report, p. 31).

> "It is desirable to publish the monthly means of the components X, Y, Z, and at least for the months of January and July, the differences dX, dY, dZ, of the hourly means from the preceding means."

In lieu of this the Committee adopted the following resolution:—

> "It is desirable to publish the monthly means of the Geographical Components of the Magnetic Force for each month, and also the differences between the hourly means for each month, and the monthly means for that month."

(3) The third resolution referred to the Committee was the following, proposed by General Rykatcheff (Report, p. 32).

> "It is desirable for the progress of Terrestrial Magnetism that temporary observatories should be installed in certain localities, especially in tropical countries."

On this subject a report had been prepared at the request of the President, by Prof. von Bezold and General Rykatcheff, of which a copy is appended.

After considering the report the Committee resolved:—

> "That it is desirable that temporary magnetic observatories should be established in places such as the following:—Taschkent, Peking, the Lick Observatory, Quito, Para, Colombo, Cape of Good Hope, St. Paul or N. Amsterdam, Honolulu, and Point Barrow or Sitka, or some other station in a high latitude in North America."

"That these observatories should, if possible, be provided with both absolute and variation instruments, of which the latter should be self-registering instruments, and should be established for at least seven, and if possible, for eleven or twelve years, *i.e.* for a complete sun-spot period."

The Committee were informed by Dr. C. Schott that it was the intention of the Coast and Geodetic Survey of the United States to establish a magnetic observatory at Honolulu.

In the course of the discussion on the above resolution, the Committee also resolved :—

(3*a*) "That it is desirable to point out that observatories at great distances from others should be provided with both absolute and self-registering variation instruments."

(4) The fourth matter referred to the Committee was the question as to the relative advantages of long and short magnets, raised by M. Mascart at the Paris Conference (Report, p. 39).

On this subject a report, of which a copy is appended, had been prepared, at the request of the President, by M. Mascart.

After considering this report, the Committee resolved :—

"Unless special reasons exist to the contrary it is desirable that the dimensions of the magnets should be as small as possible, provided that the accuracy of the results is adequately maintained."

(*b*) Resolutions passed by the Committee on matters arising during the International Conference.

(5) Prof. Eschenhagen made a statement to the Conference as to his recent investigations on minute disturbances made by very sensitive apparatus with a very open time scale.

In view of this statement, the Committee expressed their sense of the importance of the resolutions on this subject passed by the Paris Conference (Report, p. 35), and the hope that the principal observatories would carry out simultaneous observations of the character proposed.

M. Moureaux informed the Committee that preparations for such observations were already complete in the observatory at Parc St. Maur.

The Committee took note of the statement that Prof. Eschenhagen would be willing to give information as to the construction of the instruments used by him.

(6) The Committee also passed the following resolution :—

"The Committee is of opinion that the early establishment of a magnetic observatory at the Cape of Good Hope, provided with absolute and self-registering variation instruments, would be of the highest utility to the science of Terrestrial Magnetism, especially in view of the Antarctic expeditions which are about to leave Europe, and that the observatory should be established at such a distance from electric railways and tramways as to avoid all possibility of disturbance from them."

Directions were given that the proper steps should be taken to obtain the approval of the British Association for this resolution, with the request that, if approved, it should be forwarded to the Colonial Government.

(7) On the motion of Prof. Adolph Schmidt, the Committee resolved :—

"That it is desirable that magnetic observations taken in regions not included in a magnetic survey, should be repeated from time to time, care being taken to secure the identity of the point of observation."

(8) Prof. Eschenhagen was requested to draw up a detailed scheme for the exchange between the various observatories of the curves of the self-registering variation instruments taken during important magnetic storms, and to lay the scheme before the next meeting of the Conference.

(9) With reference to certain inquiries which Prof. Eschenhagen suggested should be addressed to the Directors of Magnetic Observatories, the Committee was of opinion that, although it would be outside the scope of their duties to make the inquiries, it was desirable that the information should be collected and published.

(10) After the discussion on the magnetic disturbances introduced by electric railways and tramways, the following resolution was adopted by the Committee :—

"The Committee are of opinion that any sensible magnetic disturbance produced in a magnetic observatory by electric railways or tramways, is seriously detrimental and may be fatal to the utility of the observatory. They consider that special precautions should be taken to prevent such disturbances, and append as an example the provisions for the protection of the Kew Observatory, inserted in a Bill passed by the British Parliament authorising the construction of an electric railway, the nearest point of which is to be at a distance of one kilometre from the observatory (Appendix II.)."

Future Organisation of the Committee.

(10) The Committee took into consideration their own future organisation, and passed the following resolutions :—

"It is desirable that terrestrial magnetism should continue to be within the scope of the International Meteorological Conference, provided that :—

(*a*) Invitations to attend that Conference are issued as widely as possible to Directors of Magnetic Observatories and to all students of Terrestrial Magnetism.

(*b*) That the Permanent Committee on Terrestrial Magnetism and Atmospheric Electricity, as established at the Paris Conference, be continued.

(*c*) That in future there shall be a magnetic section of the International Meteorological Conference, which shall elect, or otherwise share in the appointment of, a permanent Magnetic Committee.

(*d*) That the Magnetic Committee have power to summon an International Magnetic Conference at times other than those at which the whole of the International Meteorological (and Magnetic) Conference may meet."

The Committee also consider that the President of the Permanent Magnetic Committee should hold office between two successive meetings of the International Meteorological (and Magnetic) Conference.

(Signed) ARTHUR W. RÜCKER, *President.*

September 13, 1898.

APPENDIX II.

Clause for the protection of Kew Observatory.

(1) The whole circuit used for the carrying of the current to and from the carriages in use on the railway shall consist of conductors which are insulated along the whole of their length to the satisfaction in all respects of the Commissioners of Her Majesty's Works and Public Buildings (in this section called "the Commissioners"), and the said insulated conductors which convey the current to or from any of such carriages shall not at any place be separated from each other by a distance exceeding one hundredth part of the distance of either of the conductors at that place from Kew Observatory.

(2) If in the opinion of the Commissioners there are at any time reasonable grounds for assuming that by reason of the insulation or conductivity having ceased to be satisfactory a sensible magnetic field has been produced at the observatory, the Commissioners shall have the right of testing the insulation and conductivity upon giving notice to the Company, who shall afford all necessary facilities to the engineer or officer of the Commissioners or other person appointed by them for the purpose, and the Company shall forthwith take all such steps as shall in the opinion of the Commissioners be required for preventing the production of such field.

(3) The Company shall furnish to the Commissioners all necessary particulars of the method of insulation proposed to be adopted, and of the distances between the conductors which carry the current to and from the carriages.

APPLICATIONS OF ELECTRICITY.[1]

LIGHTNING.

THE first practical application of the science of electricity was for the protection of life and property. Franklin in 1752 showed how to secure ourselves and our buildings from the disastrous effects of a lightning stroke. Very little has been done since to improve upon his plan. A Lightning-Rod Conference, upon which I served, met in 1878, and its report, published in 1881, remains an admirable and useful standard of reference. The principle advocated by Franklin was prevention rather than protection. If a building or a ship be fitted and maintained with good continuous copper conductors, making a firm electrical contact with the earth or the sea, and

[1] Abridged from an inaugural address delivered at the Institution of Civil Engineers, on November 1, by the President, Mr. W. H. Preece, C.B., F.R.S.

be surmounted well up in the air with one or a cluster of fine points, all the conditions that determine a charge of atmospheric electricity and a flash of lightning are dissipated silently away and no terrible discharge is possible. A mischievous and baseless delusion is prevalent that protectors actually attract lightning and may be sources of danger. Every exposed building should be fitted, but a well-protected dwelling-house is the exception not the rule. Even when protectors are fixed apathy leads to their imperfect maintenance. Their failure to act is always traceable to the neglect of some simple rule. Carelessness is the direst disease we suffer from. Telegraph and telephone wires which spread all over our towns and country are very much exposed to the influence of atmospheric electrical effects. Every instrument is now protected. Every telegraph pole has a lightning conductor. Accidents are rare, and the system itself is a public safeguard. In some countries like California and South Africa thunder-storms are very frequent and very severe, but their effects have been tamed.

TELEGRAPHY.

In 1837 Cooke and Wheatstone showed how electricity could be practically used to facilitate intercommunication of ideas between town and town and between country and country. The first line was constructed in July of that year upon the incline connecting Camden Town and Euston Grove Station, the resident engineer being Sir Charles Fox, father of the senior Vice-President. Five copper wires were embedded in wood of a truncated pyramidal section and buried in the ground. The instrument used possessed five needles or indicators to form the alphabet. A portion of this original line was recently recovered *in situ*.

The pioneer line of 1837, 1½ miles long, has, during a period of sixty years, grown into a gigantic world-embracing system. The extent of the present system of British telegraphs is shown by the following table:—

	Miles of wire.
General Post Office and its Licensees ..	435,000
Railway companies	105,000
India and Colonies	387,966
Submarine cables	183,400
Total	1,111,366

The speed of signalling and the capacity of working have been increased sixfold, and wires can now be worked faster than messages can be handled by the clerical staff.

The form of submarine cable and the nature of the materials used in its construction have varied but very little since the first cable was laid in 1851. The recent invasion of our channels and seas by the *Limnoria terebrans*, a mischievous little crustacean which bores through the gutta-percha insulating covering, and exposes the copper conductor to the sea-water, leading to its certain destruction, has led to the use of a serving of brass tape as a defence. It has proved most effective.

No one has done more than Lord Kelvin to improve the working of submarine cables. His recording apparatus is almost universally employed on long cables. By the duplex method of transmission the capacity of cables has been practically doubled, and this has been still further improved by applying to cables the system of automatic working, which is such a distinguishing feature of our Post Office system. The number of electrical impulses which can be sent through any cable per minute is dependent upon its form, and is subject to simple and exact laws, but it varies with the quality and purity of the materials used. There is no difficulty in maintaining the purity of copper. Indeed, copper is frequently supplied purer than the standard of purity adopted in this country—known as Matthiessen's standard. The purity of gutta-percha is, however, questionable. The supply of this dielectric has dwindled; it has failed to meet the demand; its cultivation has been neglected. The result is a dearth of the commodity, a great increase in price, and its adulteration by spurious gums. India-rubber, its sole competitor for cables, is being absorbed for waterproof garments and pneumatic tyres, but for underground purposes paper is being used to an enormous extent. Paper has the merit, when kept dry, not only of being an admirable insulator, but of being very durable. There is paper in existence in our libraries over 1000 years old. The difficulty is to keep it dry. This is one of the problems the engineer delights to consider. He has been most successful in obtaining a solution. The lead-covered paper cables, which are being laid in the streets of all our great cities, are admirable. I am laying one of seventy-six wires for the Post Office telegraphs between London and Birmingham, and the Cable Companies are contemplating leading their long cables from Cornwall up to London, so as to be free from the weather troubles of this wet and stormy island.

It is impossible to forecast the future of telegraphy. New instruments and new processes are constantly being patented, but few of them secure adoption, for they rarely meet a pressing need or improve our existing practice. The writing telegraph originating with our late member of Council, E. A. Cowper, which reproduced actual handwriting, much improved by Elisha Gray, and called the "Telautograph," is steadily working its way into practical form, and electrical type-writing machines of simple and economical form are gradually replacing the A B C visual indicator. The introduction of the telephone is revolutionising the mode of transacting business. There seems to be a distinct want of some instrument to record the fleeting words and figures of bargains and orders transmitted by telephone. Hence a supplement to that marvellous machine is needed. The telautograph and electrical type-writer will fill this want. Visions of dispensing with wires altogether have been fostered by the popularity of Marconi's "wireless telegraphy"; but wireless telegraphy is as old as telegraphy itself, and a practical system of my own is now in actual use by the Post Office and the War Department.

TELEPHONY.

I was sent, in 1877, together with Sir Henry Fischer, to investigate the telegraph system of the American continent, and especially to inquire into the accuracy of the incredible report that a young Scotchman named Bell had succeeded in transmitting the human voice along wires to great distances by electricity. I returned from the States with the first pair of practical instruments that reached this country. They differed but little from the instrument that is used to-day to receive the sounds. The receiver, the part of the telephone that converts the energy of electric currents into sounds that reproduce speech, sprang nearly perfect in all its beauty and startling effect, from the hands of Graham Bell. But the transmitting portion, that part which transforms the energy of the human voice into electric currents, has constantly been improved since Edison and Hughes showed us how to use the varying resistance of carbon in a loose condition, subject to change of pressure and of motion under the influence of sonorous vibrations. The third portion, the circuit, is that to the improvement of which I have devoted my special attention. Speech is now practically possible between any two post-offices in the United Kingdom. We can also speak between many important towns in England and in France. It is theoretically possible to talk with every capital in Europe, and we are now considering the submersion of special telephone cables to Belgium, Holland, and Germany.

RAILWAYS.

The employment of electricity in the working of railways has not only been highly beneficent in the security of human life, but it has vastly increased the capacity of a road to carry trains. The underground traffic of the metropolis is conducted with marvellous regularity and security, though the trains are burrowing about in darkness and following each other with such short intervals of time, that the limit of the line for the number of trains has been reached. Electric traction is going to extend this limit by increasing the acceleration at starting and improving the speed of running. It will also reduce the cost of working per train-mile, so that the advent of electricity as a moving agency is certain to prove highly economical. What it will do as a remover of bad smells and foul air and for personal comfort cannot be estimated. Time alone will enable us to assess the intrinsic value of public satisfaction acquired by the change.

DOMESTIC APPLIANCES.

The introduction of electricity into our houses has added materially to the comfort and luxury of home. If we were living in the days of ancient Greece, the presiding domestic deity would have been *Electra*. The old bellhanger has been rung out by the new goddess. Electra has entered our hall-door, and attracts the attention of our domestics, not by a gamut of ill-toned and irregularly-excited bells, but by neat indicators and one uniform sound. The timid visitor fears no more that he has expressed rage or impatience by his inexperience of the mechanical pull required at the front door. The domestic telephone is coming in as an adjunct to the bell. Its use saves two journeys. The bell attracts attention, the telephone transmits the order. Hot water is obtained in half the time and with half the labour. Fire and burglar alarms are fixed to our doors and windows; clocks are propelled, regulated and controlled. Even lifts are hoisted for the infirm and aged. Ventilation, and in warmer countries coolness, are assisted by fans. Heating appliances are becoming very general where powerful currents are available. Radiators assist the coal fire by maintaining the temperature of a room uniform throughout its length and breadth. Ovens are heated, water is boiled, flat-irons become and are maintained at a useful temperature, breakfast dishes and tea-cakes are kept hot, even curling-tongs have imparted to them the requisite temperature to perform their peculiar function.

ELECTRIC LIGHT.

But it is in supplying us with light without defiling the air we breathe in our dwellings with noxious vapour, that electricity has proved to be a true benefactor to the human race. The Legislature has facilitated the acquisition by municipalities of those local industries that affect the welfare of the whole community, such as road-making, sewerage, the supply of water, tramways, and, above all, electric light.

It is on board ship that electric light has been pre-eminently successful, and where it filled such a crying want that its introduction met with no check. It was almost immediately and universally adopted. Search lights, prompted by the great development of the torpedo, were introduced into our Navy as early as 1875 by Mr. Henry Wilde. The first ship to be fitted with internal electric lighting was the *Inflexible* in 1882. In 1884 the Admiralty ordered it to be applied to all H.M. warships. The first application of electrical power was in the case of H.M.S. *Barfleur*, where motors were used for working guns and for the supply of ammunition. It has subsequently been partially extended to the working of gun-turrets, ventilating fans, capstans, and boat-hoisting gear; but hydraulics, the child of our venerable Past-President, Lord Armstrong, is the form still more generally preferred and used for power in our Navy, though other nations make a much more extended use of electricity. The technical reports received by the United States Navy Department indicate that the electrical appliances on their warships worked very successfully during the recent war.

LIGHTHOUSES.

The introduction of electricity into our lighthouses has not been such an unqualified success as into our ships. No new electric light has been installed on the coast of Great Britain since St. Catherine's (Isle of Wight) was fitted up in 1888. Other electric lamps are to be found at the South Foreland, at the Lizard, and at Soutar Point, only four lighthouses in all upon our coasts.

This is due chiefly to the great prime cost of its installation and to the annual expense of its maintenance. But the sailor himself is not enamoured of it. It does not assist him in judging distances. It is too brilliant in clear weather, while in bad weather it penetrates a fog no further than an ordinary oil lamp. Moreover, great modern improvements have rapidly followed each other in other apparatus, lenses and lamps. A third order light of to-day can be made superior to a first order light of ten years ago. Oils have improved and gas has been introduced. Lord Kelvin proposed that lighthouses should signal their individuality to passing ships by flashing their number in the Morse alphabet. But the Morse alphabet, in 1875, was as unknown as Egyptian hieroglyphics to our nautical authorities. The same end was obtained with less mental exertion by occulting and group-flashing systems.

A new and very promising plan has recently been introduced in France, called the "Feux-éclairs" or "lightning flash" system. It has been installed in many places, but especially at the two Capes dominating the Bay of Biscay. Nothing more brilliant or more effective is to be seen anywhere than the lights that rapidly sweep across the horizon, like well-directed flashes of summer lightning, with a motion that conveys the idea of a wave of some illuminated spirit-arm warning the navigator away from the rocky dangers of Ushant.

Our Trinity House has not yet introduced this plan. Any change of our well-considered and deeply-important coast-lightning system is not to be hastily effected. We are very proud of our well-guarded shores. Every headland and landfall, every isolated rock, all dangerous shoals and banks and narrow channels in lines of trade are so illuminated that navigation by night is as safe and easy as by day. Lighthouses and lightships stud our channels. Most of them are placed in direct communication with our Post Office telegraph system, so that the speediest help can be secured in moments of difficulty and danger.

We, however, want improvement in fogs and storms. Here electricity steps in. I wrote, in 1893, of wireless telegraphy:—"These waves are transmitted by the ether; they are independent of day or night, of fog or snow or rain, and, therefore, if by any means a lighthouse can flash its indicating signals by electro-magnetic disturbances through space, ships could find out their position in spite of darkness and of weather. Fog would lose one of its terrors, and electricity become a great life-saving agency." We are nearing that goal.

TRACTION.

Electrically worked railways originated in Europe. The first experimental line was constructed by Dr. Werner Siemens in Berlin in 1879. When I visited America in 1884 there was only one experimental line at work in Cleveland, Ohio. Now there are more miles of line so worked in Cleveland alone than in the whole of the United Kingdom. The reason for this is not difficult to comprehend. The climatic influences of the States, the habits of the people, the cost of horseflesh, the necessity for more rapid transit, soon proved the vast superiority of electric over every other form of traction. Horses and cables will soon disappear. The successful progress in the States and on the Continent has proved contagious, and everywhere our great cities are rising to the occasion. The relative merits of overhead and underground conductors, and the use of storage batteries, are practically the only important engineering questions under discussion. The underground conduit system has been materially helped by the practical object-lesson to be seen in New York, where the tramways are being very successfully worked on this plan. The trolley system is much more economical. Its erection does not interfere with the traffic of the streets. The principal objection to it is its anti-aesthetic appearance, but it is wonderful how ideas of utility and the influence of custom make us submit to disfigurement. What is more inartistic than a lamp-post, or more hideous than the barn-like appearance of many a railway terminus?

The corrosion of water- and gas-pipes, the disturbances of telegraphs and magnetic observations, are serious questions arising from the introduction of powerful currents into the earth, but fortunately the remedies are simple, easily attainable, and very effective.

I have alluded to the proposed working of our underground railways. The success of the Mersey Dock line, and of the South London and Waterloo lines, have placed the question beyond controversy. The problem to be solved is how is the conversion from steam to electricity to be effected without interfering in any way with the existing traffic or with the existing permanent way? This is not to be solved on paper. It must be determined by actual trial, and this is about to be done on the short line connecting Earl's Court and High Street, Kensington. Electric traction as an economical measure in all cases of dense traffic is so certain that every great railway company must consider, sooner or later, the working of their surburban traffic by electricity. This experiment on the Metropolitan Underground Railways, therefore, should interest them all. It is a question deeply affecting the interests and comfort of the public and the condition of the congested traffic of our streets.

The storage battery fulfils a very important function in the economical working of an electric railway. It equalises the pressure on the circuits. It meets the fluctuations of the load. It takes in current when the load is light; it lets out current when the load is heavy. It thus secures the continuous working of the engines at their full constant and most economical conditions, and it enables the engines to be shut down altogether when the load is very light, as it is at night, in the early morning, and on Sundays.

In Buffalo the battery is charged by energy from Niagara, twenty-one miles away, and the local engines are shut down for twelve hours every day, and for ten hours on Sunday.

ELECTRO-CHEMISTRY.

The transference of electricity through liquids is accompanied by the disintegration of the molecules of the liquids into their constituent elements. The act of conduction is of the nature of work done. Energy is expended upon the electrolyte to break it up, and the quantity thus chemically decomposed is an exact measure of the work done. Every electrolyte requires a certain voltage to overcome the affinity between its atoms, and then the mass decomposed per minute or per hour depends solely upon the current passing. The process is a cheap one and has become general. Three electrical HP. continuously applied deposit 10 lbs. of pure copper every hour from copper sulphates at the cost of one penny. All the copper used for telegraphy is thus obtained. Zinc in a very pure form is extracted electrolytically from chloride of zinc, produced from zinc blende, in large quantities. Caustic soda and chlorine are produced by similar means from common salt. The electroplating of gold, silver and nickel is a lucrative and extensive business, especially in Birmingham and Sheffield. Gold and silver are refined by this electrolysis in Russia, and nickel in the United States. Sea-water is decomposed in this way for disinfecting purposes by the Hermite process.

The passage of electricity through certain gases is accompanied by their dissociation and by the generation of intense heat. Hence the arc furnace. Aluminium is thus obtained from cryolite and bauxite at Foyers by utilising the energy of the Falls. Phosphorus is also separated from apatite, and other mineral phosphates. Calcium carbide, obtained in the same way, is becoming an important industry.

It is remarkable that our coalfields have not been utilised in this direction. Electrical energy can be generated on a coal-field, where coal of good calorific value is raised at a cost of 3*s.* per ton, cheaper than by a waterfall, even at Niagara.

Electro-metallurgy is now a very large business, but it is destined to increase still more, for the generation of electrical energy is becoming better understood and more cheaply effected.

THE TRANSMISSION OF POWER.

The energy wasted in waterfalls is enough to maintain in operation the industries of the whole world. Great cities as a rule are not located near great falls; nor has a beneficent Providence provided great cities with waterfalls as, according to the American humourist, He has with broad rivers. There is but one Niagara, and we are seeing how industries are rather going to the falls than the energy of the falls is being transmitted to the industrial centres. The arbitrament of money is limiting the distance to which energy can be profitably transmitted. The Cataracts of the Nile can be utilised in irrigating the waste lands of the upper regions of the river, but their energy cannot compete, at Alexandria, with that of coal transported in mass from England.

At Tivoli, fifteen miles across the Campagna, the energy of the falls are economically utilised to light Rome and to drive the tramways of that city. The electric railways at Portrush and Bessbrook, in Ireland, are worked by water-power, and Worcester, Keswick and Lynton use it in this country, but on a very small scale. It is not used more, for the simple reason that there are no more falls to use. Water-power is used very extensively in Switzerland, because it is so abundant there, and in our Colonies, especially in South Africa; but it is in the United States, especially in Utah and California, where the greatest works have been installed especially for the transmission of energy to mines.

In mines electricity is invaluable. It is used for moving trams and for working hoists. It lights up and ventilates the galleries, and by pumping keeps them free of water. It operates the drills, picks, stamps, crushers, compressors, and all kinds of machinery. The modern type of induction motor, having neither brushes nor sliding contacts, is free from sparks and safe from dust. Electrical energy is clean, safe, convenient, cheap, and it produces neither refuse nor side products. It is transmitted to considerable distances. In mountainous countries the economical distance is limited by the voltage which insulation can resist; 40,000 volts are being practically used between Provo Canyon and Mercur, in Utah, in transmitting 2000 horse-power thirty-two miles.

CONCLUSION.

I have touched lightly—I fear too lightly—upon some of the applications of electricity. I have confined myself, in a very general sense, to those with which I have been personally associated. I have shown how electricity began its beneficent career by protecting our lives and property from the disastrous effects of nature's dread artillery, how it facilitates intercommunication between mind and mind by economising time and annihilating space. It

> "Speeds the soft intercourse from soul to soul,
> And wafts a sigh from Indus to the Pole."

By its metallic nerves it brings into one fold not only the scattered families of one nation, but all countries and all languages, to the manifest promotion of peace and general good will. Not only does it show us how to utilise the waste energies of nature, but it enables us to direct them to the place where they are most wanted and to use them with the greatest economy. It opens to our view nature's secret storehouses, presenting us with new elements, new facts and new treasures. It economises labour and purifies material. It lightens our darkness in more senses than one, and by enabling us to see the unseen, it tends to aid the gentle healing art and to alleviate both suffering and pain. It aids us in the pursuit of truth, and it has exploded the doctrine that the pursuit of truth means the destruction of faith.

RECENT CORAL BORING OPERATIONS AT FUNAFUTI.

THE subjoined extract from the *Sydney Daily Telegraph* of September 9, containing particulars as to the coral-boring operations at Funafuti, has been sent to us by a correspondent:—

News has just been received *via* New Zealand, through the U.S.S. Co.'s steamer *Poherua*, which coaled H.M.S. *Porpoise* at Funafuti, as to the progress of the two bores, one on land, and the other in the lagoon of that coral atoll. With regard to the lagoon bore, operations were commenced on August 15, Commander Sturdee having succeeded in mooring the war-ship so taut that it was possible to work the boring pipes without risk of their bending or breaking from the bows of the war-ship. Mr. G. H. Halligan, who is in immediate charge of the boring plant, reports that for the first twenty-four hours of boring a depth of 109 feet was attained, the total depth of the bore being 212 feet below the water level of the lagoon, the depth of water to the bottom of the lagoon being 103 feet. The *Poherua* left at the end of the first day's boring. As regards the nature of the material bored, Mr. Halligan states that the first 80 feet below the bottom of the lagoon were formed of sand, composed of joints of Halimeda (a seaweed which secretes a jointed stem of lime) and of fragments of shells. The remaining 29 feet were in similar material, but containing small fragments of coral getting larger at the deeper levels.

This is a record rate of boring, and considering the difficulty of holding the war-ship at her moorings absolutely steady, in spite of wind and tide, is a wonderful performance. The whole undertaking may be looked upon as a success from a scientific standpoint, even if no greater depth than 109 feet be ultimately reached. As, however, there was still nearly a week available for further boring, it is hoped that before the war-ship has to leave Funafuti, the bore may have been considerably deepened. This is probably the first bore that has ever been made in the bottom of the lagoon of a coral atoll.

The deepening of the old bore, discontinued last year at a depth of 698 feet, on the main island of Funafuti, has been proceeding slowly but steadily. The party were landed there by the London Missionary Society's steamer *John Williams*, on June 20 last. As was anticipated, little difficulty was experienced in re-driving the lining pipes into the old bore, and washing out the sand and rubble which had choked the bore-hole. Pipes were laid from the site of the old bore to some small water-holes from which a supply of fresh water was obtained for the boiler. By July 25, the re-lining and cleaning of the old bore having been successfully accomplished, boring was resumed, and up to the time when the steamer *Poherua* left, a depth of 840 feet had been reached. The bore last year terminated in soft dolomite limestone at 698 feet, but it has now been ascertained that below this is a hard rock, so hard that the portion of the bore-hole which penetrates it no longer needs to be lined with iron pipes, a condition which must facilitate the work of boring.

Mr. A. E. Finckh reports that this hard rock is largely composed of corals and shells. This depth of 840 feet is exactly the crucial depth which it was hoped the bore might reach, and if possible exceed, as at a corresponding depth on the ocean face of the reef there is a strongly marked shelf, as shown by the soundings by Captain A. Mostyn Field, of H.M.S. *Penguin*, and it is considered that this shelf, at the 140 fathoms level, marks the downward limit of the coral formation.

Exceptionally dry weather has been experienced, which has somewhat delayed the boring, on account of the temporary failure of the water-hole from which the water supplies were being drawn. Foreman Symons, however, who is in charge of the drill, had, by extending the line of suction pipes, been able to tap a second water-hole, from which water was being pumped to the boiler. Mr. Finckh's experiments on the rate of growth of the various reef-forming animals and plants were progressing satisfactorily. It was hoped that the bore would, in about eight weeks' time, reach the total depth of 1200 feet, which is the maximum depth contemplated. Further information may be expected shortly upon the return from Funafuti of H.M.S. *Porpoise*, which will convey all the core hitherto obtained from Funafuti, and tranship it to Sydney; and until the core has been subjected to thorough microscopic and chemical examination it would, of course, be premature to attempt to forecast the exact trend of the evidence. The results so far obtained are very satisfactory.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. Langley, F.R.S., has been elected a member of the Council of the Senate in the place of Principal Glazebrook, now of Liverpool University College.

Lord Wolsingham, the High Steward, has generously offered a second (bronze) medal for specially meritorious essays in biology which do not succeed in winning the Wolsingham gold medal.

At the matriculation on October 21 last, 897 students joined the University. These included 19 "advanced students" admitted to post-graduate research or other advanced work. The total entry for the year 1898 is thus brought up to 944, which is the highest since 1890.

An animated discussion on the proposed Sedgwick Memorial Museum took place in the Arts School on October 22. Two plans, a larger and a smaller, were before the Senate. The geological staff strongly pressed that the larger should be adopted, though it appeared that it would cost some 44,000*l.* Of this the Memorial Fund would contribute 27,000*l.*

Mr. R. S. Morrell, who was placed in the first class in both parts of the Natural Sciences Tripos in 1888-90, and Mr. J. S. Gardiner, who was similarly placed in 1893-95, have been elected to Fellowships at Gonville and Caius College.

ON Wednesday, October 26, Sir William Harcourt opened the new central block of Aberystwith University College, erected at a cost of about 20,000*l.*, towards which sum he, when Chancellor of the Exchequer, gave a grant of 10,000*l.* Speaking subsequently at a luncheon, Sir William Harcourt referred to the unsatisfactory state of secondary or intermediate education in England, and said that what was required was a system of intermediate education similar to that which has been established in Wales, to connect the elementary schools with the universities.

SPEAKING at University College, Liverpool, on Friday last, Sir J. Gorst, Vice-President of the Committee of Council on Education, said that at the present time there was a strong desire on the part of all interested in education that a great step forward should be made in commercial and technical instruction. The necessity arose from industrial competition in foreign countries. Undoubtedly our higher and elementary education for industrial purposes was vastly inferior to that of many of our rivals, and no time was to be lost in setting to work to effect an improvement. To this forward step there were two essential conditions. In the first place, elementary education must be improved, for it was no use to attempt to organise a system of higher schools without having a sound elementary basis upon which to build. Moreover, it was essential that higher education should be perfectly organised, and that in each educational area there should be one clear and definite plan of education suitable to the particular conditions of the place.

THE report on the work of the Examinations Department of the City and Guilds of London Institute for the session 1897-98 has been published. From it we learn that the number of technical classes throughout the country registered by the Institute shows a marked increase, and the instruction is in closer touch with industrial requirements. The recognition by the Post Office of the Institute's certificate in telegraphy as qualifying the holder of it for increased remuneration has had the effect of nearly doubling the number of candidates for examination in that subject, and shows the influence, which employers generally might exercise, in encouraging attendance at technical classes, by giving some kind of reward to such of their employés as succeed in passing the Institute's examinations. County Councils have during the past year further availed themselves of the services of the Institute in connection with the technical classes under their control. Several important additions and alterations have been made in the programme of Technological Examinations.

THE Calendar of the University College of North Wales (which is a constituent College of the University of Wales) for the year 1898-99, has been published. The syllabus of classes shows that students are educated as well as instructed at the College, and the questions set in the science subjects in which candidates for entrance scholarships have been examined, give evidences that no credit is gained by perfunctory work or for information derived entirely from books. The College offers a course of training to those who intend to become teachers in secondary or intermediate schools, and in this, as in other subjects, the course involves practical as well as theoretical work. Among the subjects to be dealt with in the lectures are the psychology of the growing mind, and physiology and hygiene in their relation to school life. The agricultural department, and the College Farm, have recently been referred to (p. 611). After following a course of study at the College extending over three years, students may take the degree of Bachelor of Science of the University of Wales in the group "Agriculture and Rural Economy."

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 24.—M. Wolf in the chair.—On double integrals of the second species in the theory of algebraic surfaces, by M. Émile Picard.—Properties of calcium, by M. Moissan. The pure crystallised calcium whose properties are given in this paper, was prepared by the method already described in NATURE. The melting point, determined by a thermo-couple, was found to be 760° C. The metal can be cut, but it is much less malleable than sodium or potassium, as it can be broken, and shows a crystalline fracture. When totally free from nitride, its colour is brilliantly white, recalling that of silver. The density was found to be about 1·85; and it is hard enough to scratch lead, but not calcium carbonate. Neither chlorine, bromine, nor iodine attacks calcium in the cold, although the corresponding haloid salts are formed at higher temperatures. Calcium burns brilliantly in oxygen, the temperature resulting from the combustion being so high that a part of the quicklime produced is melted and volatilised. When burnt in air, the calcium combines with both constituents together, nitride and oxide being simultaneously formed. At a dull red heat the metal also combines with carbon with great energy, forming CaC_2. At high temperatures the reducing power of calcium is remarkable, oxygen being readily removed from sulphur dioxide, phosphoric anhydride, boron trioxide, silica, and the oxides of carbon.—On the decomposition by aluminium chloride, of a straight-chain saturated hydrocarbon, by MM. C. Friedel and A. Gorgeu. The reactions have been studied arising between aluminium chloride and the normal paraffins from methane to hexane. The latter, when heated to its boiling point with dry $AlCl_3$ gave rise to pentane and butane, the pentane predominating.—On a peculiar mode of formation of the pollen in *Magnolia*, by M. L. Guignard. As regards the mode of formation of the partitions in the pollen mother-cell, the *Magnolia* present a condition quite unknown in other plants. They are intermediate between Monocotyledons and Dicotyledons, resembling rather the former than the latter.—Extension of No. 162 of the "Disquisitiones Arithmeticae" of Gauss, by M. de Jonquières.—Remarks by M. Hatt on the new portion of the hydrographic map of the coasts of Corsica.—Observations of the new Brooks' comet (October 20, 1898), made at the Observatory of Paris, by M. G. Bigourdan.—On the intermediate integrals of equations of the second order, by

M. E. Goursat.—On singular points situated on the circle of convergence, and on the summation of divergent series, by M. Leau.—Measurement of the velocity of sound, by M. Frot. The experiments were made near Bourges, at a temperature near 0° C., the time being measured automatically by electric chronographs. Two sets of experiments gave for the velocity in air at 0° mean results of 330·6 and 330·9 metres per second.—On the tones of vibrating strings, by M. A. Guillemin. By suitably fixing any portion of a vibrating string any desired overtone can be produced; but this does not in any way prove that this note really existed as a partial tone in the original note given by the string. — On the atomic weight of tellurium, in relation to the multiple proportions of the atomic weights of other simple bodies, by M. H. Wilde.—On the positions of tellurium and iodine in periodic systems of the elements, by M. H. Wilde. Remarks on the recent determination by Metzner of the atomic weight of tellurium (128) as invalidating the periodic arrangements of Mendélejeff, Crookes and others.—On calcium amalgam, by M. J. Ferée.—Action of metallic sulphates on potassium paratungstate, by M. L. A. Hallopeau.—On the amines and amido-derivatives of the aldehydes, by M. Marcel Delépine. A thermochemical paper.—On the changes in composition which take place in fatty seeds in the course of germination, by M. L. Maquenne. The oily materials in the seeds of the earth-nut and castor-oil plant undergo a rapid diminution during germination, the latter being especially marked in this respect, the change being accompanied by an increase in carbohydrates.—Contribution to the biology of wine yeasts, by M. J. A. Cordier. The appearance of *Saccharomyces* upon fruit, especially the grape, at the period of ripening, has hitherto been described as due to the action of insects, but it would appear from the experiments quoted that the air is really the principal factor in the transport of these yeasts.—The specific characters of *Endomyces albicans*, by M. Paul Viullemin.—On the place of the Phoronidiae in the classification of animals, and on their relations with the vertebrates, by M. Louis Roule.—On the respiratory apparatus of the larvae of entomophagous Hymenoptera, by M. L. G. Seurat. It is shown that the respiratory apparatus of the different larvae of entomophagous Hymenoptera, although all built on the same fundamental plan, present differences in the number and arrangement of some of their parts, sufficient to establish distinctive characters of the several families. There is not yet sufficient knowledge, however, to draw any general conclusions.—On an organ, not previously described, which closes the poison reservoir in ants, and on the method of stinging in the same, by M. Charles Janet.—New observations on the cave and subterranean river of Han-sur-Lesse (Belgium), by M. Martet. The paper is accompanied by a plan and section of the cave and stream. The unknown part of its course is now only two kilometres.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 3.

CHEMICAL SOCIETY, at 8.—A Determination of the Equivalent of Cyanogen: George Dean.—Note on the Action of Light on Platinum, Gold, and Silver Chlorides: E. Sonstadt.—Methanetrisulphonic Acid; E. H. Bagnall.—A Composite Sodium Chlorate Crystal in which the Twin Law is not followed: W. J. Pope.—On the Composition of American Petroleum: Dr. Sydney Young, F.R.S.—(1) On the Separation of Normal and Iso-heptane from American Petroleum; (2) On the Action of Fuming Nitric Acid on the Paraffins and other Hydrocarbons: Dr. F. E. Francis and Dr. Sydney Young, F.R.S.—On the Boiling Points and Specific Gravities of Mixtures of Benzene and Normal Hexane: D. H. Jackson and Dr. Sydney Young, F.R.S.

LINNEAN SOCIETY, at 8.30.—On *Craterostigma pumilum*, Hochst.: Prof. H. Marshall Ward, F.R.S., and Miss Dale.—Amphipoda from the Copenhagen Museum and other Sources, Part II.: Rev. T. R. Stebbing, F.R.S.—Exhibitions: Embryos of *Hatteria*: Prof. Howes, F.R.S.—Photographs of Chicken with Foster-Parent a Common Buzzard: Alan F. Crossman.—*Nitella hyalina*, Ag., a New British Plant: H. and J. Groves.

FRIDAY, NOVEMBER 4.

GEOLOGISTS' ASSOCIATION, at 8.—Conversazione and Exhibition of Specimens.

QUEKETT MICROSCOPICAL CLUB, at 8.

TUESDAY, NOVEMBER 8.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Extraction of Nickel from its Ores by the Mond Process: Prof. W. C. Roberts-Austen, C.B., F.R.S.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—The Tribes inhabiting the Mouth of the Wanigela River, New Guinea: R. E. Guise.

WEDNESDAY, NOVEMBER 9.

GEOLOGICAL SOCIETY, at 8.—On the Palæozoic Radiolarian Rocks of New South Wales: Prof. T. W. Edgeworth David and E. F. Pittman.—On the Radiolaria in the Devonian Rocks of New South Wales: Dr. G. J. Hinde, F.R.S.

THURSDAY, NOVEMBER 10.

MATHEMATICAL SOCIETY, at 8.—Some Secondary Needs and Opportunities of English Mathematicians: Presidential Address.—The Structure of certain Linear Groups with Quadratic Invariants: Dr. L. E. Dickson.—Multiform Solutions of certain Differential Equations of Physical Mathematics and their Applications: H. S. Carslaro.—A Discovery in the Theory of Compound Partitions: Major Macmahon, R.A., F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Rotatory Converters Prof. Silvanus P. Thompson, F.R.S.

FRIDAY, NOVEMBER 11.

ROYAL ASTRONOMICAL SOCIETY, at 8.

PHYSICAL SOCIETY, at 5.—Discussion on Mr. A. Campbell's Paper on the Magnetic Fluxes in Meters and other Electrical Instruments, to be opened by Prof. W. E. Ayrton, F.R.S.—On the Propagation of Damped Electrical Oscillations along Parallel Wires: Prof. W. B. Morton.—On the Properties of Liquid Mixtures: R. A. Lehfeldt.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Domestic Hygiene: Dr. A. W. Williams (Bell).—A Manual of the Grasses of New South Wales: J. H. Maiden (Sydney, Gullick).—Manual of Bacteriological Technique and Special Bacteriology: T. Bowhill (Edinburgh, Oliver).—The Teacher's Manual of Object Lessons in Domestic Economy: V. T. Murché, Vol. 2 (Macmillan).—Electricity made Easy: Drs. Houston and Kennelly (Sonnenschein).—Algebra made Easy: Drs. Houston and Kennelly (Sonnenschein).—The Interpretation of Mathematical Formulae: Drs. Houston and Kennelly (Sonnenschein).—A Pocket Dictionary of Electrical Words, Terms, and Phrases: Dr. E. J. Houston (Sonnenschein).—Organic Evolution Cross-Examined: Duke of Argyll (Murray).—The Groundwork of Science: Dr. St. Geo. Mivart (Murray).—The Natural History of Digestion: Dr. A. L. Gillespie (W. Scott).—Graham-Otto's Ausführliches Lehrbuch der Chemie, Erster Band, Dritte Abthg. (Braunschweig, Vieweg).—University College, Nottingham, Calendar 1898-99 (Nottingham, Sands).—An Introduction to Practical Physics: D. Rintoul (Macmillan).—The Egyptian Soudan: its Loss and Recovery: Lieuts. Alford and Sword (Macmillan).—L'Art de Découvrir les Sources et de les Capter (Paris, Baillière).—Marvels of Ant Life: W. F. Kirby (Partridge).

PAMPHLETS.—Lessons in Domestic Science: E. R. Lush, Part 2 (Macmillan).—Ein Ausflug auf den Aetna: A. Belar (Laibach, Kleinmayr).

SERIALS.—Longman's Magazine, November (Longmans).—Good Words, November (Isbister).—Sunday Magazine, November (Isbister).—Journal of the Royal Statistical Society, September (Stanford).—Transactions of the Institution of Engineers and Shipbuilders in Scotland, October (Glasgow).—Record of Technical and Secondary Education, October (Macmillan).—Chambers's Journal, November (Chambers).—Century Magazine, November (Macmillan).—Humanitarian, November (Duckworth).—National Geographic Magazine, October (Washington).—Physical Review, August (Macmillan).—Contemporary Review, November (Isbister).—Journal of the Royal Microscopical Society, October (20 Hanover Square).

CONTENTS. PAGE