THURSDAY, APRIL 28, 1892.

THEORETICAL CHEMISTRY.

Outlines of Theoretical Chemistry. By Lothar Meyer, Professor of Chemistry in the University of Tübingen. Translated by P. Phillips Bedson, D.Sc., and W. Carleton Williams, B.Sc. Pp. 220. (London: Longmans, Green, and Co., 1892.)

"GOOD wine needs no bush," but a well-known bush makes one look for good wine. The translation of Prof. Lothar Meyer's "Die Modernen Theorien der Chemie," made by Messrs. Bedson and Williams, is so well known and so appreciated by all English-speaking chemists, that everyone welcomes a new book by the author of "Modern Theories," and expects the book to be a good one. The "Outlines of Theoretical Chemistry" is a translation, by the translators of the "Modern Theories," of a book published in German in the course of last year. The translation is exceedingly well done; the English runs smoothly and lucidly; the book reads as if it were composed in English, rather than as a translation from another tongue.

The subject-matter of this book is very similar to that of "Modern Theories"; details are avoided wherever the author thought this could be done with advantage, and the treatment is made as general as possible. In his preface to the English translation the author says:—

"The general—I may say the philosophical—review of the subject has been my chief aim, to which the details should be subordinated."

The book is not divided into chapters, but runs on from paragraph to paragraph. Beginning with a statement of the province of chemistry, the author passes in review the stoïchiometric laws, sketches the atomic hypothesis, considers the various aspects of chemical equivalents, states and applies the law of Avogadro, refers to Prout's notions about the relations between the values of atomic weights, and states and briefly illustrates the periodic law; he then considers in several paragraphs the constitution of compounds in the light of the molecular and atomic theory, and, through a short discussion of physical isomerism, he passes to the consideration of such physical properties of bodies as melting and boiling point, capillarity, solubility, evaporation, &c., and the connexions between these and the molecular weights and constitutions of bodies. Finally the author devotes some fifty or sixty paragraphs to the treatment of the thermal and electrical aspects of chemical changes, and the subject of chemical affinity.

At the outset the essential character of chemical phenomena is emphasized:—

"Chemistry deals with the changes which affect the material nature of the substance. Chemistry, then, is the scien e which treats of matter and its changes" (p. 2).

It is to be wished that all writers of books, whether elementary or advanced books, on chemistry, and all who endeavour to help others to learn this science, would keep steadily before them the characteristic feature of all chemical events, viz. that they are those which occur when changes of composition accompany changes of properties in definite kinds of matter. If this were done we should not be deluged with those catalogues of the properties of innumerable disconnected substances which are frequently sold under the misleading name of text-books of chemistry.

The paragraphs on the determination of atomic weights from stoïchiometric values (pp. 11–13) seem to me extremely lucid and apposite, provided the reader will give his close attention to them. I do not think the subject of chemical equivalents is treated sufficiently fully to make it clear (pp. 13–16). Paragraph 13 does not make perfectly intelligible the process whereby atomic weights are determined from the crystallographic relations of compounds. I am much taken by the order in which the author arranges his treatment of combining weights, equivalents, thermic equivalents, crystallographic equivalents, &c., culminating in Avogadro's law. The determination of atomic weights by the application of the law of Avogadro is made very clear in a couple of paragraphs (pp. 39–42); and the author is especially to be congratulated, in my opinion, on paragraph 26, wherein he most skilfully and gracefully avoids the popular error of making a stumbling-block of so-called "abnormal vapour-densities."

Paragraph 28, which deals in about thirty lines with "nascent state," would much better have been omitted; the treatment is neither interesting nor accurate. It seems to me that paragraphs 34–40, which are supposed to give a clear general conception of the periodic law, quite fail to enable the student to grasp this all-important generalization. I think that much too little space is given to the periodic law, which comprises in itself all other schemes of chemical classification; and that too much space is devoted to valency, which, at the best, is a conception that is of very limited application. Anyone who turns from the study of Mendeleeff's great work on "The Principles of Chemistry" to the paragraph on p. 76 will be greatly astonished; the paragraph reads thus:—

"Formerly it was more or less explicitly assumed that a chemical compound was held together by the total attractive force of the affinities of all the atoms contained in it; but, as our knowledge increased, it was gradually recognized that the connexion is between atom and atom, and that the atoms are attached to each other like the links in a chain, the continuity ceasing if even a single link of the chain is removed."

This sentence seems to imply that no one now looks on a molecule as held together by the interactions between all the atoms; but if one says this view is held by none, one must make a few exceptions, such as Mendeleeff and the chemists of his school. The treatment of atomic linkage on pp. 80–83 seems to me to be very one-sided and unsatisfactory. We are told (p. 81) that such a formula as $H_2O \cdot SO_3$ is inadmissible because it represents the compound as made up of atomic groups which are already saturated, and "therefore have no free affinities for mutual combination"; but on p. 107 we are informed that, in substances which crystallize with water, "every molecule is united with a definite number of molecules of water." But how can water molecules unite with, say, dehydrated alum, if the group H_2O is saturated and "has

therefore no free affinities"? This example shows that the paragraph quoted above from p. 76 is much too dogmatic.

I do most strongly object to such a statement as that on p. 69, where, speaking of carbon monoxide, it is said:—

"The molecule of this compound is represented by the formula

$$\overset{*}{\overset{*}{=}}C\,||\,O.$$

Here the asterisks are intended to show that two affinities are unsaturated; this is proved by the fact that the compound unites with two atoms of chlorine, forming phosgene gas,

$$\begin{matrix} Cl \\ Cl \end{matrix}\!\!>\!C{=}O."$$

What is proved by the fact of combination with chlorine? No one can attach any clear meaning to the statement "two affinities are unsaturated." The only practical meaning these words have is, "The molecule CO can unite with two other atoms of certain kinds"; that is to say, the sentence quoted, when put into the speech of the plain man, asserts that the fact that CO does unite with 2Cl proves that CO can unite with 2Cl.

The later paragraphs, treating of the physical properties of bodies and the connexions between these and the constitutions of the same bodies, seem to me to be both very well done and very disappointing. They are well done because an earnest attempt is made to put the matter clearly, but they are disappointing because it is quite impossible to grapple with these very difficult matters in the space which is given to them in this book. I do not think that anyone will succeed in getting a grasp of Raoult's law from the pages which are grouped around paragraph 133. The application of Raoult's law to determine molecular weights, given on p. 137, is based on the constant '62°, which has been shown by van 't Hoff and others to be erroneous.

But it is much easier to find fault than to compose such a book as this. A careful perusal of the work leaves the impression on my mind that, as a synopsis and suggestive remembrancer to the student who knows general chemistry well, this book will prove useful, but that it is too condensed and too slight to be of much service to him who is beginning the study of general chemistry. Most of the subjects dealt with cannot be made clear except by going into details, and illustrating them with considerable profusion. When one attempts to deal with these matters in a broad and general way, and at the same time to devote only a few pages to each section, one is almost obliged either to make statements so generalized that they are of very little use to the earnest student, or only to touch the fringe of each part of the subject. Chemistry is an abstract science to a much less degree than physics; hence such short statements as those which sum up and include in themselves whole provinces of physical knowledge cannot yet be made in chemistry. Where the "Outlines of Theoretical Chemistry" fails for the most part it fails because no book could succeed; it fails because it attempts to do that which cannot, at present, be done.

M. M. PATTISON MUIR.

THE TRAVELS OF A PAINTER OF FLOWERS.

Recollections of a Happy Life, being the Autobiography of Marianne North. Edited by her sister, Mrs. John Addington Symonds. In Two Volumes. (London: Macmillan and Co., 1892.)

MOST of the readers of NATURE will know without telling that Marianne North was a world-wide traveller, that she travelled in pursuit of nature, that she was an accomplished and faithful painter of plant and animal life, and that the results of a life's labour were presented by her to the nation, and now cover the walls of a building in Kew Gardens, erected at her expense Most persons, too, who knew her personally—and her acquaintances and friends are as numerous as her travels were wide—will be glad to know something more of her history, and especially something more of her travels, of her impressions of peoples, of places, and, above all, her impressions of the plant and animal life of the many countries she visited and to which she gave her life. All who had the pleasure of knowing her personally will remember her stately presence, her kind face, her charming manner, and her entertaining conversational powers—now relating the difficulties and delights of her experiences in foreign lands, now her appreciation of home comforts and genial society. She wrote as she talked, and she was a fertile letter-writer; and she has written her book in the same style.

In early life Miss North made various journeys in Europe, and also went up the Nile and visited Syria, and painted many flowers; but with the exception of the Sicilian *Papyrus*, and perhaps two or three other little pieces, none of this early work is in the gallery at Kew. Only 38 pages of her book are devoted to her early life, and it practically begins with her more distant travels; the first long trip being to Canada and the United States, and extended to Jamaica, whence she returned to England. Two months later she started for Brazil, where she made a long stay, and then returned direct to England. The next journey included Teneriffe, California, Japan, Singapore, Borneo, and Java, and then home again. Her paintings attracted attention, and she complied with a request to exhibit some 500 of them at Kensington. This matter being arranged, she proceeded to India, landing on the way at Lisbon, Gibraltar, Malta, and Galle; and India was traversed almost from east to west and north to south.

The narrative of this journey is perhaps the most interesting part of the whole work. On her return home there was an exhibition of the accumulated paintings in Conduit Street; and a visit to Mr. Darwin, which ended in a determination to go to Australia and paint the flowers of the fifth quarter of the globe. It should be mentioned that in the meantime Miss North had adopted a suggestion of the *Pall Mall Gazette* that her paintings should find their home at Kew, and her generous offer was accepted. So it was, that when Darwin told her that her collection of paintings would be an imperfect representation of the vegetation of the world without the Australian element, she took it as a "royal command," and prepared to go forthwith. This journey some of the old scenes were revisited, brief halts being made at Galle and Singapore, a longer stay with the Rajah and Rani

Brooke in Borneo, and thence to Queensland. New South Wales, Victoria, West Australia, Tasmania, and New Zealand were successively visited; but incessant travelling, climatal changes, and continuous work had begun to tell on the constitution of this brave woman, who suffered much in the colder regions. Now, the great object was to make the collection of paintings as complete as possible, and she spared neither her pocket nor her person in trying to carry it out. Her book is so essentially the history of her gallery at Kew that one cannot dissociate them. The Australian journey was fruitful beyond all others, and the Australasian section of the gallery is perhaps the most attractive of all, being a marvellously complete representation of the varied and curious flora of that region. The homeward route was across the Pacific, calling at Honolulu, landing at San Francisco, and off at once to the redwood and mammoth-tree forests for more painting. Then across America by the southern route, and back to old haunts in the North-Eastern States, and home again to open the gallery, which had been built during this journey. Hanging the pictures was a most laborious task, from which Miss North took no rest. At this time the writer first made her acquaintance, and was engaged by her to botanize the paintings and compile a popular instructive catalogue. This occupied two or three months; and most interesting work it was, usually brightened by her presence.

No sooner was the opening of the gallery accomplished, than the terribly jaded donor of this munificent gift to the public began to think of visiting new regions to further enrich it. But I must be brief, for even to catalogue these journeys occupies much space. South Africa was next visited, and several months' uninterrupted work, much of it done under trying conditions of failing health, yielded so bountifully that it was determined to build a wing to the gallery, for the existing walls were already completely covered.

Miss North intended going from South Africa to Madagascar, but the means of communication were irregular and uncertain, and her health so bad that she returned home; but having to some extent recovered, she went the following year (1883) to the Seychelles, to paint the beautiful palms and screw pines of those islands. Even this did not satisfy her, and she started on her last journey in November 1884. Chili was her goal, and the principal object of this long journey was to paint the *Araucaria imbricata* in its home, as she had already painted the Brazilian and Australian species. She also succeeded in painting a considerable number of the characteristic types of the vegetation of that country. But this voyage, by way of the Straits of Magellan, tried her waning strength very much, and a less energetic person would have collapsed entirely. In the last chapter of her "Recollections" we read that all was enjoyment until they reached Bordeaux. "Then my nerves gave way again (if they were nerves), and the torture has continued more or less ever since." Beautiful Rio was touched on the outward voyage, and on the homeward route, by Panama, old friends were looked up in Jamaica. England was reached in the spring, and it cost another year to rearrange the gallery; the introduction of the South African, Seychelles, and Chilian paintings entailing renumbering throughout, in order to preserve the geographical order.

The foregoing is an outline of her journeyings, but the book should be got for the details, which are almost always interesting, often clever and quaint. Here and there one meets with uncompromising criticisms and descriptions of persons that might have been expunged with advantage. The descriptions of the vegetation of various regions, with particulars of the principal elements, are pleasant and instructive, often containing much original information; and will be greatly appreciated by those who frequent the gallery at Kew, of which the book, as already stated, contains the history.

After completing her work at Kew, Miss North took an old-fashioned house at Alderley, in Gloucestershire, where she formed a charming garden; but her constitution was broken, her sufferings increased, and she died in August 1890. W. B. H.

AMERICAN TOWN TREES.

Our Trees. By John Robinson. (Salem: Horton and Son, 1891.)

THIS short account of the trees of an American town and its neighbourhood consists of reprints of newspaper articles written in 1890–91 for the benefit of local readers: they have been re-compiled into book form at the request of the directors of the Essex Institute, and date from the Peabody Academy of Science, Salem.

Several points strike a careful reader of the book. The writer draws special attention to the fact that the articles, or chapters, are not intended as botanical essays; and the reader will probably decide that the remark was unnecessary, for a more unscientific work dealing with a scientific subject would be difficult to find; but there is a peculiar charm in a certain style of talks about natural objects—for instance, in some of the more chatty paragraphs of White's "Selborne," or Walton's "Angler," and even Evelyn's "Flora"—which attracts the most devoted student to refreshing looks around his subject-matter from every-day points of view, and this little work possesses that charm. Few facts of scientific importance are met with in such writings, and still fewer of the generalizations which make science what it is: the specialist may even deride the writing as "talkee-talkee"—gossip, if you will; and even the broadest thinker may be inclined to wonder why such articles are written; all this, and more, may be true, and yet—there is the charm, nevertheless, and it is very apt to seem appropriate where trees and flowers are concerned. Whether it is advisable that such writings should increase is a matter likely to settle itself, simply and certainly, because very few can produce them. A scientific work, then, this is decidedly not. It is a series of homely chats about trees, by one who knows and loves them. The latter fact leads to another—namely, that such a writer cannot help telling you something worth learning even though it be by the way, and merely incidental.

In the first place we gather some ideas as to what trees are common in the streets and gardens of a Massachusetts town, and the evidently thriving condition of magnolias, sumachs, maples, witchhazels, mulberries, hickories, gingkos, catalpas, sassafras, and many other beautiful trees, makes envious one who knows what difficulties are

met with in this country in attempts to rear even presentable "specimens" of such favourites in our smoke-beladen and crowded cities and suburbs.

Then, again, the English reader gathers some information as to the Western popular names of trees, well known to him by very different ones; how many English people know what are the "cucumber-tree," the "yulan," the "buckeye," the "butter-nut," and the "button wood"?

Bits of history also occur, and incidental notes on the rates of growth of various trees, their ages, &c. So that, after all, there are some dry facts in this singularly quaint and simply written talk about trees. We must not claim much for the work in this respect, however; and perhaps the chief reason we like the writing is because of its contrast to the empty and inflated style of too many of our native newspaper articles on similar subjects.

OUR BOOK SHELF.

Synopsis of Non-Metallic Chemistry. By William Briggs, B.A., F.C.S. Pp. 90. (London: W. B. Clive and Co.)

THIS book is intended for students preparing for the Matriculation Examination of London University. After the contents of an ordinary text-book have been studied, the reader is here supposed to find the more important points which have to be remembered, and which serve to recall the less important. Interleaved note-paper is provided, whereon facts readily forgotten may be recorded.

As is usually the case with such cram-books, little can be said in favour of the quality of the information supplied.

Formulæ are stated to be "arrangements of letters representing *a molecule* of a compound," and this definition is illustrated by regarding Fe_3O_4 as denoting a molecule. The vapour-density of hydrofluoric acid is given as 10, and the solubility of hydrogen in water as "practically the same at all temperatures from 1° to 20°": neither statement is up to date. Such antiquated terms as *basylous* and *chlorous*, which are freely employed, might well be replaced; and to speak of *distilling* potassium perchlorate with strong sulphuric acid is inaccurate. The account given of fractional distillation is worthy of reproduction. The mixture of liquids is heated "up to the lowest of the boiling-points of the liquids present. *The whole* of that liquid (?) will be converted into vapour, and can be condensed in the usual way. On heating the remaining liquid up to the next boiling-point, we can separate *another* of the constituents, and so on until they are all separated out. The different liquids thus obtained must be redistilled to get them quite free from the others, small quantities of which *may* have been distilled over in the first process."

This last extract is typical of the bulk of the knowledge contained in the book, which, to say the least, savours more of the class-room than the laboratory.

A table of contents, a glossary, and three appendixes are provided. The last are concerned with the preparation and purification of substances and with the simpler chemical calculations. A list, with answers, of numerical examples set at the matriculation examinations is included.

Chemical Calculations. By R. Lloyd Whiteley, F.I.C. With a Preface by Prof. F. Clowes, D.Sc., F.I.C. (London: Longmans, Green, and Co., 1892.)

THIS is still another addition to the numerous manuals on chemical arithmetic, and the points wherein it differs from its predecessors are somewhat difficult to discover. Once more we have specific gravity observations in which corrections for temperature and air displacement are ignored; and although the author attempts to set right the prevalent misconception as to the meaning of density and specific gravity, it is questionable if he succeeds. According to him, specific gravity is always relative; it is the same magnitude as relative density. The use of absolute specific gravity—or, shortly, specific gravity with no temperatures of comparison attached—as denoting the weight of unit volume, is here overlooked. From a physical point of view, the definition of the absolute density of a gas as the mass of 11·16 litres is a needless complication. In ascertaining the percentage composition of a compound it is insisted that, first of all, the *molecular* weight must be calculated. The examples given to illustrate the rule include apatite, apophyllite, basic lead chromate, &c. The student is thus led to infer, here as elsewhere in the book, that the molecular weights of such bodies can be fixed.

The freezing-point and boiling-point methods of obtaining molecular weights are disposed of in two pages. No hint is given that the solutions must be dilute and non-electrolytic, if consistent results are to be obtained; or that, in general, the interpretation of the results of these methods is still subject to difference of opinion.

It is erroneous to state that "the *alteration* in the volume of a gas is proportional to the so-called absolute temperature," or to speak of "Dalton and Henry's law." Henry's law is distinct from Dalton's, and is the older by two years.

We have dwelt on some of the points which seem to call for criticism. On the other hand, the book has its good features. The problems are numerous, carefully selected, and well arranged. Contents, answers, and index are supplied. It seems to us, however, that, instead of being as good as several of its kind already in existence, it, as a new book, should have been better.

The Year-book of Science. Edited for 1891 by Prof. T. G. Bonney, D.Sc., LL.D., F.R.S. (London: Cassell and Co., 1892.)

ALL who have any sympathy with scientific pursuits will heartily welcome the appearance of this epitome of the more important results of the investigations which were published during the past year. Scientific inquiry now covers so much ground that all men of science must be more or less specialists, and it is difficult for them to keep in touch with the developments in other branches through the usual channels, although it frequently happens that an advance in one subject may throw light upon and induce investigations in another. There are also many engaged in practical pursuits who require a convenient means of determining how far contemporary researches may be technically applied.

With a well selected staff of contributors, the editor has attempted to meet the wants of all by the present volume, which is divested as far as possible of technicalities. The scope of the work is sufficiently defined by the following paragraph from the editorial:—

"It is almost needless to remark that this volume is not intended to be a record or catalogue of papers. The endeavour of its projectors and compilers has been to select those memoirs, in each several department, which appeared to be of somewhat exceptional interest, either by throwing light on special difficulties or by being suggestive of further advances."

In a work of this kind strict impartiality is essential, and we see no reason to suppose that the various contributors have abused the power vested in them. On the whole, the production is very satisfactory, and the improvements which the editor contemplates for the next volume will make it more so. One can only wonder that science has had to wait so long for a year-book of its own.

Handy Atlas of Modern Geography. (London: Edward Stanford, 1892.)

IT would be difficult to obtain a small atlas more complete than this. Every place of any importance appears to be represented on one or more of the thirty coloured maps. The degrees of latitude and longitude are subdivided into parts of five minutes each, so that the positions of places, the names of which are not engraved, can be easily and accurately located by reference to the alphabetical list at the end. This list is a comprehensive one. It gives the latitude and longitude of the principal mountains, rivers, capes, bays, islands, towns, and villages, and forms an excellent supplement to a very good atlas.

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.*]

Aurora.

A VERY brilliant display of aurora was seen here last night, the 25th inst. At about 9.25 p.m. a number of red streamers proceeded from a length of some 110° in azimuth along the northern horizon, and extended upwards for (on an average) 30°. The length of the streamers varied quickly, sometimes shooting upwards for 70° from the horizon. In the course of five minutes the red streamers gave way to white or yellowish white ones, narrower and more sharply defined than the red ones. At 9.40 p.m. there was a decrease in the brilliancy of the phenomenon, but at 9.45 p.m. long red streamers again appeared for a few minutes, which again shortly gave way to a brightness of the horizon only. Close to the horizon the colour was white, or nearly so, the whole time. The apparent point of convergence of the streamers was far south of the zenith, say 30°.

GEO. M. SEABROKE.

Temple Observatory, Rugby, April 26.

PROBABLY many of your readers witnessed the brilliant display of the northern lights between nine and twelve o'clock last night, the 25th, but it may be as well to call attention to it, as being the finest display seen here for many years. Appearing soon after nine o'clock, the luminous arc and the radiating beams, sometimes rose and orange coloured, presented a varied and beautiful spectacle until close upon midnight, when they faded away.

The most noteworthy features of this display were the vividness and height of the arc, which reached an angle of about 13° above the horizon, whilst the beams were visible up to 51°. The whole expanse of the arc from east to west was about 93°, and the duration of the phenomenon a little under three hours.

ARTHUR MARSHALL.

Cauldon Place, Long Row, Nottingham.

A FAIRLY distinct aurora was visible here on the northern horizon last night. I first observed it at 9.15, when the streamers appeared somewhat less bright than the Milky Way. Ten minutes later one streamer, about 15° west of north, brightened considerably, and appeared of a pale reddish-yellow tint. It fluctuated in intensity, and soon became less bright. The streamers, which inclined slightly to the west of the vertical, extended to about 30° to 40° above the horizon.

I watched them till 9.50, when they seemed fading in intensity, and when I looked again at 10.30 they had disappeared entirely.

ARTHUR E. BROWN.

Thought Cot, Brentwood, April 26.

Pigments of Lepidoptera.

THE appearance of Mr. F. Gowland Hopkins's letter on this subject in the last issue of NATURE (p. 581) demands a brief explanation from me—although it is not easy to reply satisfactorily within narrow limits—and the more so since Mr. Hopkins appears to have somewhat misunderstood my standpoint.

Let me first acknowledge the courteous tone of Mr. Hopkins's letter, and express my sense of the value to myself of criticism from his pen, and the more so since I have been labouring under the disadvantage of being practically entirely uncriticized so far—a disadvantage that I have not failed to appreciate.

Now, Mr. Hopkins remarks: "Mr. Coste's experiments are very useful as forming a method of classifying these pigments; but . . . they are of far too empirical a nature for any considerations as to the constitution of the bodies to be based upon them."

Here it is that Mr. Hopkins appears to have missed the point of my work. If he will do me the favour to refer to the detailed account of my experiments in the *Entomologist*, *passim*, I think that he will find it tolerably clearly emphasized that my interest in this work, so far, has been almost entirely *biological*. I stated expressly in my opening article that my object had been to discover, if possible, the genealogies of the colours, and to obtain evidence (so far as coloric characters could afford it) of the phylogenetic relations of allied species: and I may perhaps add that the results obtained have enabled me to predict several varieties of whose occurrence in the natural state I have since been informed. So that Mr. Hopkins is mildly reproaching me because my work does not tend in a direction at which it was not originally aimed, while he is at the same time good enough to admit that it is of some use for the end at which it was aimed.

However, it was only to be anticipated that one could not go very far without becoming involved in the further question as to the constitution of the pigments; but here I was met by three considerations. In the first place, I was anxious to obtain first of all as much as possible of what Mr. Hopkins designates "empirical" evidence as to the reactions and classification of the pigments before making any researches at all into their constitution; secondly, the amount of material at my command was far too scanty for any even approximate analysis; and in the third place, shortly after my experiments had been commenced, my attention was drawn to an abstract of a paper by Mr. Hopkins on the constitution of the yellow pigments. Finding that he was already in possession of the field here, I felt almost bound to leave this part of the subject alone, at least for the present; and I think that I may say that I have on the whole taken exaggerated care not to extend my experiments into that quarter where Mr. Hopkins was engaged, or to avail myself of the discoveries that he had already made, in order to trespass on his investigations. Putting aside my provisional suggestions as to the nature of the "reversion effect," it has only been at a comparatively recent stage of my work, and in consequence of experiments that have not yet been published, that I have at all turned my attention to the constitution of the pigments; these results being such as would have compelled me to consider the question even had I heard nothing of Mr. Hopkins's work. I hope that this explanation will put me right in Mr. Hopkins's eyes, and will satisfy him that he has considerably misunderstood the spirit of "some remarks [perhaps clumsily expressed by me] made at the close of the last article"; and that it will also satisfy him as to the question of priority. I had no thought of questioning Mr. Hopkins's priority in his own work, and the less so since I have throughout been under the impression that we were working mainly on different—though sometimes adjacent—lines.

I must not so far trespass upon your space as to criticize Mr. Hopkins's criticisms upon the "reversion effect"; but I will ask him kindly to examine the detailed accounts of the "reversion" experiments which I gave in the *Entomologist*, since his remarks appear to me somewhat to ignore the evidence there brought forward: and at the same time I may remark that his statements as to the constitution of the *yellow* pigments appear to me hardly to invalidate, but rather indirectly to confirm, the suggestions made by me as to the reversion reaction with *red* pigments. The new information that Mr. Hopkins promises in his closing paragraph I shall look forward to with great interest.

April 22. F. H. PERRY COSTE.

I WAS about to pen some remarks on Mr. Perry Coste's recent articles on this subject, when a letter from Mr. Gowland Hopkins in the last number of NATURE (p. 581) expressed substantially the same views as those which I had arrived at. I write now rather to support Mr. Hopkins in his strictures than to offer any fresh criticisms of my own. The articles on "Insect Colours" published in these columns are, as the author

states, to be regarded in the light of an abstract of a series of more extended papers published in the *Entomologist*. The papers in the latter publication from their title led us to suppose that Mr. Coste had made some contribution to our knowledge of the chemistry of insect pigments. I read them from month to month in the hope of getting new light on this subject, which is of such general interest to both chemists and biologists: I regret to say that I have been grievously disappointed. The experiments thus far described amount simply to the fact — not altogether astonishing — that strong chemical reagents modify the colours of Lepidopterous pigments or in some cases dissolve them out of the wings. The bearing of these observations on the chemistry of the pigments is so remote as to be practically useless until we know something of the chemical nature of these pigments. The methods adopted by Mr. Coste are not likely to advance our knowledge in this direction very much, and it is certainly remarkable that in treating of yellows he makes no reference [1] to the only real contribution to the chemistry of Lepidopterous pigments, viz. the experiments made by Mr. Hopkins, and published in the Proceedings of the Chemical Society in 1889. Mr. Coste is no doubt acquainted with those South American *Papilios* with a large red spot on the hind wing, which spot loses its red colour and becomes of a brilliant metallic bluish green when the wing is tilted so that the incident and reflected rays form a very wide angle. The colour is in this case doubtless a mixed result, partly due to pigment and partly to interference. Now, anyone who has observed this and other similar colour phenomena in insects might describe his observations as contributions to the physics of insect colours. If he thought proper to adopt this course, he would be misleading physicists. The observation of the bare facts is as much a contribution to the physics of insect colours as the statement that a rainbow can be seen in the sky is a contribution to the physics of illuminated water-drops. It seems to me that Mr. Coste's experiments bear the same relationship to the chemistry of insect colours that the mere observation of interference colours in insects bears to the physics of insect colours.

Quite independent of the facts recorded by Mr. Coste is the interpretation which he puts upon them. Here I must decidedly express dissent. It cannot be admitted, because by the action of certain reagents green is changed into yellow or red into yellow, that this indicates the evolution of green or red from yellow. There is no evidence that this result is a reversion effect at all. The analogy between the action of strong acids in modifying the colour of an animal pigment and the effect of true reversion is forced, and has no parallel in natural processes. Hot water is a chemical reagent; by its action on the brown pigment of the lobster the latter becomes red. If from this observation I drew the inference that the ancestral lobster was red, and that the hot water produced a reversion effect, I do not think that Mr. Coste would agree with me.

R. MELDOLA.

Oxford, April 24.

Eozoon.

MR. GREGORY has, I fear, slightly mistaken the meaning of my remarks, which were intended rather to excuse than to blame him. The specimen of Eozoon collected by the late Mr. Vennor at Tudor was figured in connection with my paper of 1867 as a type specimen, in so far as macroscopical characters are concerned; but it does not follow that slices from specimens less perfect in that respect, and now in my collection, may not be more instructive as showing minute structures. I may refer in this connection to the three specimens from Tudor and Madoc (Madoc being in the same formation with Tudor) figured by Dr. Carpenter in our original paper in the Journal of the Geological Society, vol. xxiii., pl. xii., Fig. 1. If anyone will take the trouble to compare these with the figures in Mr. Gregory's paper in the same Journal, vol. xvii., he will have a singular and impressive illustration of the different ways in which things supposed to be the same may appear to observers of different types.

Mr. Gregory is in error in supposing that he could see in the cases of the Peter Redpath Museum my specimens from Tudor and Madoc. I have not yet been able to place there any portion of my microscopic cabinet of Eozoon; but only a few hand specimens sufficient to show students the ordinary types of the fossil.

As to the Laurentian age attributed to the Tudor beds, I have already explained that this I subsequently regarded as an error, and so stated not long after the date of the paper of 1867. I now regard them as less ancient, though of pre-Cambrian age.

I shall be happy to show to anyone my little collection from Tudor and Madoc, including specimens in which Carpenter detected the canal system; but of these particular specimens I have unfortunately no duplicates for distribution, and would prefer to exhibit the slices in the modes I have found best suited for the development of the structures; as otherwise there might be some doubt whether the resulting impressions would more resemble Mr. Gregory's figures or Dr. Carpenter's.

Montreal, April 6. J. WILLIAM DAWSON.

[1] At least in NATURE: I have not the *Entomologist* at hand where I am writing.

The Theory of Solutions.

I AM glad to see that as to the main point, the character of the "gaseous laws" of solutions, there seem to exist no more differences between Mr. Rodger and me. For Mr. Rodger, in his letter on p. 487 of NATURE, limits his remarks to some dialectical expressions, to cover an honourable retreat. I wish not to follow him on this way, because it is an endless one.

As to the application of van der Waals's formula on solutions, Mr. Rodger is now forced to confess that this application is not so "meaningless" as he has formerly written; but he asserts that, shortly spoken, the form of application given in my book is so. To say the truth, if I have to choose, as in this case, between the agreement of a formula with Mr. Rodger's opinion, and the agreement of this same formula with experiment, I prefer the latter.

W. OSTWALD.

Leipzig, April 12.

Physiological Action of Diminished Atmospheric Pressure.

WITH reference to the effect of diminished atmospheric pressure on the vital powers, alluded to in Prof. Bonney's review of Mr. Whymper's "Travels among the Great Andes of the Equator" (NATURE, April 14, p. 561), I do not know whether it is worth while recalling the well-known fact that numerous passes in the Himalayas, ranging from 17,000 to 19,000 feet, are habitually traversed by the hillmen, in the summer, with their flocks of sheep and goats carrying borax, &c. The highest pass is said to exceed 20,400 feet. In the same mountains Messrs. Schlagintweit reached an altitude of about 22,200 feet (Proc. As. Soc. Bengal, January 1866), while Mr. W. W. Graham ascended to 23,500 feet in 1883 (NATURE, September 11, 1884). I have myself, on several occasions, been to elevations of 17,000 to 19,000 feet, and beyond shortness of breath when climbing, never experienced any ill effects except once, when I, the four plainsmen with me, and three out of a considerable number of hillmen, felt severe headache during the evening after crossing a high pass. My companion on one trip, however, almost invariably suffered very severely from mountain sickness under similar circumstances.

F. R. MALLET.

18, The Common, Ealing.

Sensitive Water Jets.

A FORM of this effect lately presented itself, which seemed in some ways new. A thin jet, 5 feet high and arched so as to be 3 feet at the base, was falling in a feathery spray. At 13 feet distance a small Wimshurst machine was set going: not instantly, but after two minutes, the spray gathered itself up almost into one clear line: although the jet was turned up and down and the machine was discharged the falling water would not resolve itself again into spray for fifteen or twenty minutes. It is difficult to imagine the medium for this action: it is too indefinite, perhaps, to suppose that an indicator is found for the trembling of a disturbed ether while it is dying down.

The well-known experiment is not known enough, for it is not often described in books. Take a glass rod, electrified ever so little, to a certain point; at once the jet collects itself; a slight move away brings back the old disorder, while an inch nearer makes things much worse. It is a striking illustration to help one to imagine what the electrical forces of the air may do We can perhaps understand those thick thundery rain-drops, that almost allow us to pass between them while they are giving friendly warning of what will come.

W. B. CROFT.

Winchester College, April 14.

Double Orange.

THE abnormality in a Maltese orange described in NATURE of April 7 (p. 534) would appear of common occurrence in the Queensland or South Australian fruit. A friend assures me that in a case recently received from Australia, 80 per cent. of the contents showed small oranges, more or less perfect, either embedded in the pulp or in the rind. The quality of the fruit I observed was in no way affected. It would, however, be interesting to obtain further testimony. Although the small oranges may not affect the commercial value of the fruit, their presence must be undesirable in the groves where perfection is sought.

GERALD B. FRANCIS.

Katrine, Surbiton.

ON THE LINE SPECTRA OF THE ELEMENTS.

THE distribution of the lines in the spectra of the elements is by no means so irregular as it might seem at first sight. Since Lecoq de Boisbaudran, in 1869, discovered the general plan in the spectra of the alkali metals, a number of interesting facts have been brought to light, which will probably one of these days find their mechanical explanation, and will then greatly advance our knowledge of the molecules.

Mechanical explanations of some of the facts have been attempted already. Lecoq de Boisbaudran explains the fact that the rays of the alkali metals are, on the whole, less refrangible the greater the atomic weight, by observing that the oscillations of a body suspended in a given elastic medium will become less frequent when the mass of the body is increased. This explanation, however, seems to me to remain rather vague and unsatisfactory as long as it does not lead to any numerical results that agree with the observations. Taken literally, it makes the oscillation-frequency inversely proportional to the square root of the atomic weight, which is far from being the case.

A second well-established fact has received different explanations by Julius[1] and by Johnstone Stoney.[2] It has long been observed by Hartley that in the spectrum of several elements a number of doublets or triplets of lines appear, the oscillation-frequencies in each doublet or triplet differing by the same amount. Recent measurements by Prof. Kayser and myself have confirmed this observation. Julius believes that this phenomenon is due to a cause analogous to the combination tones in the theory of sound.

If two rays, with oscillation-frequencies α, β, combine with other rays, p, q, r, s, to oscillation-frequencies

$$\begin{array}{cccc} p+\alpha & q+\alpha & r+\alpha & +\alpha \\ p+\beta & q+\beta & r+\beta & s+\beta, \end{array}$$

the same difference $\alpha - \beta$ will occur several times. That the doublets under consideration are in many cases remarkably strong is accounted for by the fact that the intensity of the combination tone is proportional to the product of the intensities of the primary tones, so that it must become very strong when the amplitude of the primary tones is sufficiently increased.

Johnstone Stoney gives a different explanation of the doublets. He supposes that the path of the molecule from which light emanates is an ellipse, which by disturbing forces is gradually changed, and he shows that on this supposition, instead of one ray, two rays or more would originate, and the oscillation-frequencies of these rays would differ by an amount depending on the rate of change of the ellipse. If now, instead of the ellipse, the path of the molecule is any other curve, it can be considered as consisting of a number of superposed ellipses, all of which change in the same way on account of the disturbing forces. To each of the ellipses a doublet of lines corresponds, and the oscillation-frequencies of each doublet differ by the same amount. In this explanation I do not understand the decomposition of the arbitrary curve in a series of superposed ellipses. For the movement is supposed not to be periodical, and Fourier's theorem then would not apply, at least the periods of the superposed ellipses would not be definite, as long as there are no data except the arbitrary curve itself.

Besides, both Johnstone Stoney and Julius only try to explain one of a number of regularities that have been observed in the spectra of the elements. A plausible suggestion about the movement of the molecules ought to explain more than one of the observed phenomena. I think it may be useful to point out the other regularities that have been observed in the distribution of lines, and for which as yet no mechanical explanation has been attempted.

(1) The doublets and triplets existing in the spectrum of an element can be arranged in series which show an appearance of great regularity. These series seem to be analogous to the over-tones of a vibrating body. But they possess a remarkable peculiarity, which, as far as I know, is without analogy in the theory of sound. The difference of two consecutive oscillation-frequencies decreases as these increase, and there seems to exist a finite limit to the oscillation-frequencies of a series. If n represents integer numbers, the oscillation-frequencies of a series may with great accuracy be represented by the formula—

$$A - Bn^{-2} - Cn^{-4},$$

where A, B, C are positive constants. B has nearly the same value for all the series of the different spectra. A is the limit towards which the oscillation-frequency tends, when n increases.

(2) For elements that are chemically related, the series are distinctly homologous, both in appearance of the lines and in the values of A, B, C, and with increasing atomic weight shift towards the less refrangible end of the spectrum. Homologous series have been observed in the following groups of elements :—

Lithium, sodium, potassium, rubidium, cæsium ;
Copper, silver ;
Magnesium, calcium, strontium ;
Zinc, cadmium, mercury ;
Aluminium, indium, thallium.

In the first two and in the last group the series consist of doublets,[1] while in the remaining two groups they consist of triplets. Thus we may say that the spectrum shows a relationship between the elements similar to that between their chemical properties. It is interesting to note that magnesium forms a group with calcium and strontium, and appears more nearly related to them than to zinc, cadmium, and mercury.

(3) The doublets and triplets in each group broaden as the atomic weight increases. In the first group the difference of oscillation-frequencies is nearly proportional to the square of the atomic weight. The constant difference of the oscillation-frequencies in the doublets and triplets may also be noted in the values of A, B, C. For a series of doublets or triplets we have two or three different values of A, but only one value of B and one value of C.

(4) In each of the spectra of sodium, potassium, rubidium, and cæsium, a series of doublets has been observed, in which the oscillation-frequencies do not differ by a constant amount, the difference diminishing inversely proportional to n^4. For these series A and B have only one value each. The least refrangible doublet of the series has the same difference of oscillation-frequencies as the doublets in the other series of the same element. In the spectrum of lithium there is a homologous series of single lines. All the lines of these series have the same

[1] Julius, *Annales de l'École Polytechnique de Delft*, tome v. (1889).
[2] Stoney, Trans. of the Roy. Dublin Soc., vol. iv. (1891).

[1] Lithium has here to be excepted, whose lines are all single.

character; they are strong and easily reversed, and in all of them the first doublet is situated on the less refrangible side of the spectrum, and all the others in the violet and ultra-violet. The series shift towards the less refrangible side with increasing atomic weight.

For further details the reader is referred to the following memoirs:—Kayser and Runge, "Ueber die Spectren der Elemente," *Abhandl. der Berl. Akademie*, 1890-92; Rydberg, "Recherches sur la constitution des spectres d'émission des élements chimiques," *Kongl. Svenska Vetenskaps-Akademiens Handlingar*, Bandet 23, No. 11, 1890.

C. RUNGE.

ABERRANT FOSSIL UNGULATES OF SOUTH AMERICA.

TILL within the last few years palæontologists and zoologists were being continually startled by the discovery of strange forms of extinct Ungulates which rewarded the researches conducted in the Tertiary rocks of the United States. The animals thus brought to the notice of the scientific world have, to a very large extent, modified our conceptions of the relationships of the various groups of hoofed or Ungulate Mammals to one another; and have led to the very general adoption of the view of the ordinal unity of all these multifarious types. Several of them, indeed, so far as we may judge from their mere skeletons, indicate signs of a transition between the Perissodactyle and Proboscidean modifications of Ungulate structure; but none of them tend in the least degree to break down the hard and fast line of demarcation between the Perissodactyle (odd-toed) and Artiodactyle (even-toed) modifications, which is maintained throughout all the known Tertiary deposits of the Old World. Moreover, after a little "shaking down," the whole of these North American Ungulates, with the exception of the curious Rodent-like *Tillotherium*, fall fairly well into their places in the Ungulate order; although some of the earlier and smaller types present indications of close affinity with the common stock from which we may presume both Ungulates and Carnivores to have taken origin.

At the present time the wave of discovery of new forms appears to be passing from the northern to the southern half of the New World; so that while the palæontologists of the United States are to a great extent engaged in the important task of revising and completing the preliminary work of the last twenty years, their *confrères* in Argentina are almost flooding scientific literature with descriptions—sometimes, it is to be feared, rather crude and hasty ones—of a number of new or hitherto imperfectly known forms of extinct mammals. This descriptive work has been mainly undertaken by Messrs. Ameghino, Burmeister, and Moreno. Unfortunately, however, the greater part of it is still in the form of preliminary notices, unaccompanied by illustrations; while on several points the three describers above mentioned are by no means in accord, and it is quite clear that unnecessary names have frequently been published. There is, indeed, one large illustrated work published by Dr. Ameghino; but since, so far as we are aware, there is only a single copy (in the Natural History Museum) in England, palæontologists have not the opportunity of paying it that attention in private study which its importance demands.

In spite, however, of these drawbacks, the information at present before us—imperfect though it be—introduces us to several groups of extinct Ungulates totally unlike any found in all the rest of the world put together, and which are of especial interest as tending to a certain extent to break down the distinction between Perissodactyles and Artiodactyles. It should be observed, before proceeding further, that the explorations conducted in Patagonia and various parts of Argentina have shown that the deposits containing mammalian remains, instead of being exclusively of Pleistocene age, comprise a large portion of the Tertiary period, probably extending down at least as far as the Oligocene; although the exact correlation of the different beds with European deposits is probably premature.

With these preliminary observations, and asking our readers at the same time to bear in mind that a considerable part of our knowledge is still in a very imperfect and crude condition, we propose to glance at some of the peculiarities presented by the more remarkable forms of Ungulates described from the deposits in question.

Since the date of the publication of the results of Darwin's voyage in the *Beagle*, we have been gradually acquiring a knowledge of the structure of that remarkable South American Ungulate known as *Macrauchenia*, of which the complete osteology has been described by Burmeister. This animal, which had the general proportions and size of a horse, conforms in several respects—more especially in having three-toed feet, in which the middle (third) digit is symmetrical in itself—so markedly with the Perissodactyles, that by common consent it has been generally regarded as an extremely aberrant member of that group. The molar teeth are, indeed, more like those of the Rhinoceros and Palæotherium than of any other Old World Ungulates, while the infolding of the enamel of the crowns of the incisors is a character known elsewhere only in the horses. The absence of any gap in the dental series, and the nearly even height of the teeth, are characters in which *Macrauchenia* agrees with the Old World *Anoplotherium*. Perissodactyle affinities are indicated by the presence of a third trochanter on the femur; but in certain peculiarities in the ankle-joint this animal differs from all typical Perissodactyles, and agrees with the Artiodactyles. Moreover, a certain peculiarity of structure in the vertebræ of the neck is repeated elsewhere only in the camels and llamas, which form an isolated group of Artiodactyles. In the complete closure of the orbit by bone, *Macrauchenia* resembles the horses and many Artiodactyles; but in the narial aperture being situated on the top of the skull between the orbits (whence the nostrils were probably produced in the form of a proboscis), it is absolutely peculiar.

There are thus many indications that, while *Macrauchenia* is a specialized form that can in no sense be regarded as the ancestral type from which Perissodactyles and Artiodactyles have originated, it retains certain generalized features which were probably directly derived from such ancestral stock.

Among the Ungulates discovered in Patagonia is one named *Proterotherium*, which was at one time referred to the Artiodactyles, but subsequently placed among the Perissodactyles. In the skull, so far as can be gathered from Ameghino's description, the orbit is closed, as in *Macrauchenia*, but the narial aperture appears to have had the normal position. The molar teeth are so like those of true Perissodactyles that they were originally described under the name of *Anchitherium*; but the rest of the dentition is very peculiar. Thus, in the upper jaw there appears to have been only a single pair of incisors in the premaxillæ, these being pyramidal and obliquely truncated like the canines of the pigs; and as there were no canines, it may be inferred that there was a long toothless interval in the jaw. In the lower jaw there were two pairs of incisors, and no canines. The lower molar teeth were inserted by four distinct roots—a feature unknown in any existing Perissodactyle, although occurring in the pig. In the limbs, both the front and hind feet were furnished with three complete toes, much resembling those of *Hipparion*; the ankle-joint is, however, said to resemble that of the Artiodactyles. We have no information as to the third trochanter of the femur. On the whole, this genus appears to indicate a

Perissodactyle-like Ungulate, somewhat more specialized as regards its dentition than *Macrauchenia*, but exhibiting strongly-marked Artiodactyle affinities in the ankle-joint.

Still more remarkable are the generalized affinities displayed by the group known as the Toxodonts, of which the first representative was also discovered during Darwin's memorable voyage. These Ungulates cannot be included in either the Perissodactyla or Artiodactyla, and, therefore, come nearer the original generalized Ungulate stock than the animals already noticed. *Toxodon*, from the Pleistocene of Argentina, was of the approximate size of a Hippopotamus, and its osteology is tolerably well known. It takes its name from the curvature of the molar teeth, which approximate in structure to those of the Rhinoceros, and, like the incisors, have ever-growing roots. The front teeth are separated from the cheek-teeth by a considerable interval; the upper dental series being reduced in number by the loss of the outermost incisors and the canines, and the lower by the disappearance of the first premolars; the lower canine is, moreover, rudimentary. The feet conform to the Perissodactyle type in having three toes, of nearly equal size, and also in the interlocking of the bones of the upper and lower rows of the wrist- and ankle-joints. In the absence of a third trochanter to the femur, and also in the articulation of the fibula with the calcaneal bone of the ankle, as well as in the structure of the palatal and tympanic regions of the skull, *Toxodon* is, however, constructed on a decided Artiodactyle type; so that its characters are to a great extent intermediate between the existing members of the two groups.

Going back to the earlier Tertiaries of Argentina and Patagonia, a number of Ungulates allied to *Toxodon*, but with much more generalized characters, have been brought to light. The skulls from Patagonia brought back by Darwin, and named *Nesodon*, also belong to this same generalized group. In *Nesodon* there is the full complement of 44 teeth; and the same formula also obtains in the recently described *Protoxodon*, in which the feet are known to have been tridactylous in both limbs, although retaining rudiments of the metacarpals of the first and second digits, and being of a longer and more slender type than in *Toxodon*. The allied animals described as *Acrotherium*, some of which were about the size of a pig, present a peculiarity totally unknown among other Ungulates; and, indeed, in any Eutherian Mammals except some individuals of the small African long-eared fox (*Otocyon*). This peculiarity consists in the presence of eight cheek-teeth on either side of each jaw; the constancy of this character being proved by its occurrence in a considerable number of specimens. Whereas, however, in *Otocyon* the eight cheek-teeth are reckoned as four premolars and four true molars, in *Acrotherium* there are said to be five premolars and three true molars. If this interpretation be correct, it is difficult to point out a probable derivation for this most remarkable type of dentition, since no other heterodont mammals are definitely known to have more than four premolars.

If, however, the cheek-teeth really prove to be four premolars and four true molars, there might be a possibility of direct inheritance of the fourth molar of the Marsupials, although even then there is the difficulty that none of the Lower Eocene Ungulates of the United States are known to have possessed more than three of these teeth. And the probability accordingly suggests itself that the additional tooth may be an acquired redundancy. There are a number of other more or less closely allied types which have received distinct generic names, such as *Colpodon* and *Adinotherium*, but it is at present somewhat difficult to realize all their distinctive features and peculiarities. One genus, however, if the specimen on which it was established is normal, is so remarkable as to call for special notice; and taken together with *Acrotherium* seems to show that these South American Ungulates ran riot in the disregard of all rules as to the number and arrangement of their teeth. The genus in question is *Trigodon*, founded upon the lower jaw of an animal about the size of a pig, but evidently related in the structure of its cheek-teeth to *Toxodon*. In this mandible the middle of the extremity of the long and narrow symphysis is occupied by a single cylindrical incisor tooth, flanked by a pair of larger incisors, and these, again, by the still larger triangular canines. If normal (and from Dr. Moreno's description and figure it would seem to be so) this single median incisor is totally unique in the whole mammalian class.

A still more remarkable and puzzling group is typically represented by the long-known *Typotherium* from some of the Tertiaries of Argentina, which, while presenting many dental characters connecting it with the Toxodonts, has upper incisors resembling those of the Rodents; with most of which it also agrees in the presence of clavicles, which are invariably absent in all true Ungulates. The number of the teeth is similar to that obtaining in many Rodents, with the exception that there are two pairs of lower incisors. An allied type has, however, three pairs of these teeth, thus departing further from the Rodent type; and the skull of both genera is constructed on the Ungulate plan. All the teeth are rootless. From other beds in Argentina we have the genus described as *Hegetotherium*, which, while having rootless teeth, differs from *Typotherium* in possessing the whole typical series of 44, without any marked interval between them. Here, then, we have almost entirely lost the Rodent features which are so marked in *Typotherium*, and thus revert nearer to a normal Ungulate type; it is unknown whether clavicles were present. Still more generalized is an allied group typified by *Interatherium*, in which the dentition is always complete, the anterior premolars have distinct roots, and the incisors conical roots. This genus and the allied *Protypotherium* thus appear to be connected both with *Typotherium* and the Toxodonts; the specific name *rodens* applied to one of the species of *Protypotherium* apparently indicating the existence of Rodent-like upper incisors.

The existence of these intermediate forms renders it exceedingly difficult to come to any satisfactory conclusion as to whether *Typotherium* really has any genetic affinity with the Rodents (among which it was placed by the late Mr. Alston); for if there be such relationship it would seem to imply the descent of all Rodents from a form more or less closely allied to *Interatherium*—a view which can scarcely be maintained.

That these Typotheroids were, however, in some manner connected with the Toxodonts is tolerably clear; and there are nearly equally clear indications of a more or less distant connection between the Toxodonts and the Macrauchenias. The most probable explanation of the latter relationship is that both groups took origin from generalized Ungulates allied to those found in the Eocene of the United States, and known as the Condylarthra, which appear to have been the common ancestral stock of both the Artiodactyle and Perissodactyle modifications of the order. On this view the retention of characters common to both the groups last-mentioned by the Toxodonts and Macrauchenias is readily accounted for; the Macrauchenias having acquired sufficiently well-marked Perissodactyle characters to admit of their inclusion in that group, while the Toxodonts cannot be placed in either of the two existing divisions of typical Ungulates. Having thus diverged at an early epoch (perhaps in the neighbourhood of Central America) from the original generalized Ungulate stock, the ancestral Toxodonts and Macrauchenias become the dominant forms in South America, where they appear to have developed into such numerous and unexpected modifications of struc-

ture, as to render the task of deciphering their mutual relationships and determining their exact systematic positions an exceedingly difficult, if not an impossible one. At the same time, however, it does not appear to us that the existence of these puzzling and aberrant types need interfere in the least degree with the commonly-accepted classification of the Ungulates, although there may be legitimate doubt as to the propriety of including the Macrauchenias among the Perissodactyles, instead of retaining them with the Toxodonts as a special group, exhibiting on the one hand many generalized features, coupled with extreme specialization in other respects.

R. L.

THE CHANGEFULNESS OF TEMPERATURE AS AN ELEMENT OF CLIMATE.

ONE of the features in which the climates of great continents most contrast with those of oceanic islands, and those of higher latitudes with the climates of the tropics, is the greater range through which the temperature varies between night and day, and between winter and summer. Another, perhaps not less important, is the greater changefulness of the temperature from day to day. Both of these are comprised under the general expression *variability of temperature*,[1] and they are similar in their effects on living organisms, but they depend on very different causes, and in their local association are often manifested in very different degrees; places with a great annual and diurnal range of temperature, displaying great constancy of climate at any given season of the year, while others, at which the former variations are moderate in amount, are, nevertheless, subject to irregular vicissitudes of considerable magnitnde. The Punjab and Sind may be cited as examples of the former class, Western and Central Europe of the latter.

Now, although from a sanitary point of view these two kinds of variation are of equal importance, the degrees in which they have respectively engaged the attention of climatologists and others are strikingly different. While the daily and annual range of temperature of all the more important and many minor places that have furnished meteorological registers are now well known, or are easily ascertainable from published records, the first systematic inquiry into the changefulness of temperature as an element of climate was that made by Prof. Hann in a memoir published in the *Sitzungsberichte* of the Vienna Academy of Sciences in 1875. In this paper, Dr. Hann tabulated the results of ninety stations, seven of which are situated in the southern hemisphere, and the remainder chiefly in Europe, Siberia, Canada, and the United States. The extraction of the data was not a little laborious, since it consisted in taking out from the daily registers, of generally from five to ten years, the differences of the mean temperatures of every pair of successive days throughout the whole period; then classifying them according to algebraic sign, as rises or falls of temperature, and also, in certain cases, according to their incremental values. The means of these different categories were then taken month by month, and the results are given in numerous tables in the memoir. The changefulness of temperature at any given place is the general mean of all changes during the period considered, irrespective of their being rise or fall. As instances of these, I take the following three stations, representing respectively the climates of Siberia, England, and Canada. They show the average change of any two consecutive days on the Fahrenheit scale.

	Barnaul.	Oxford.	Toronto.
January	8·8	3·4	6·8
February	8·5	3·1	6·8
March	7·2	2·9	4·9
April	4·7	2·9	4·0
May	5·6	3·1	3·8
June	4·3	2·7	3·8
July	3·4	2·3	3·6
August	3·2	2·5	3·2
September... ...	4·5	2·5	4·5
October	5·6	3·4	4·1
November	9·0	3·6	4·5
December	10·1	3·8	6·7
Year ...	6·3	3·1	4·7

These three stations serve to illustrate the fact, amply confirmed by the general tables, that temperature is subject to greater and more rapid changes in the winter than in the summer; either December or January being, as a rule, the month of greatest variability.

Since the publication of this memoir, the inquiry thus started by Dr. Hann has been followed up by several writers with especial reference to particular countries. Prof. O. Döring, for instance, has thus discussed the statistics of the Argentine Republic; Herr E. Wahlén, those of 18 stations in Russia; Dr. V. Kremer, those of 57 stations in Northern Germany; and Mr. Robert Scott, those of 7 observatories in the British Isles, at which the temperature has been recorded by thermographs since 1869. These are Valentia, Armagh, Glasgow, Aberdeen, Falmouth, Stonyhurst, and Kew. At all these stations the variation was found to be less than at Oxford; but this may be partly due to the longer period (15 years) over which the records extend, and partly also to the fact that the daily means compared are those of the twenty-four hourly measurements of the thermograph curve, whereas the Oxford register was for 10 years only, and the observations less numerous. On the general average of the year, it was greatest at Kew (2°·7), and least at Falmouth and Valencia (1°·9).

Finally, Dr. Hann has resumed the subject in a memoir published in the Transactions of the Vienna Academy,[1] in which he discusses the temperature records of 66 stations in the Austrian Empire and the adjacent territories, of which one-half extend over from 10 to 20 years, and the majority of the remainder over at least five years; all, however, are corrected to the period 1871–80. In the case of Vienna, not less than 91 years have been included in the reckoning, and this register affords the means of comparing the results of any decade with those of a long period.

The first point that stands out in the results of this discussion is that even a period of ten years is insufficient to give more than an approximate value. The general mean change at Vienna, between any two consecutive days, is 3°·4 F., but in the decade 1861–70 it was only 3°·26, whereas in the decades 1801–10 and 1871–80 it averaged 3°·53. The means of the individual months show much greater variation; that of December especially, ranging between 3°·2 and 4°·3 in different decennia, or through 30 per cent. of the general mean for the month. It is evident that when computed from shorter periods than ten years the discrepancies will

1 The term "variability" of temperature, adopted by Mr. Scott for the element now in question, has been already used in so many different senses, that in this paper I have adopted in preference the term "changefulness," which is not open to the same objection.

1 "Die Veränderlichkeit der Temperatur in Oesterreich," von J. Hann, W.M.K. Akad., aus dem lviii. Bande der *Mat. Naturwiss. Classe der k. Akad. d. Wissenschaften.*

be still greater. In order, therefore, to obtain comparable values, even for neighbouring stations, it is essential that the data compared should be those of the same interval.

Both as regards season and amount, the changefulness of temperature depends very greatly on local geographical circumstances, so that neighbouring places very often differ greatly from each other. In Europe it increases from west to east and from south to north, in both cases towards the interior of the continent. It increases also on the whole with altitude, but very irregularly, being great on exposed plateaux, and comparatively small on mountain peaks. Places situated in valleys show very great differences, according to their exposure. Among the Austrian stations, those on the southern slopes of the Alps have the greatest vicissitudes, owing to the warmth they acquire in sunny weather and the consequent greater fall of temperature when a change of weather sets in. In general the changes of temperature at high elevations are greater than at low altitudes in summer, but less in the winter season. In the high mountain valleys in spring the changes are much smaller than on the neighbouring plains.

In the British Isles, Mr. Scott found that the number of rises exceeding 5° between any two consecutive days was greater than the number of falls of the same amount, and also that the mean value of the rises exceeds that of the falls. In Austria, also, except in the Southern Tyrol and on the coasts of the Adriatic, rapid rises are greater than rapid falls in the winter, and less in the summer; but on the whole the former preponderate. In the south, however, rapid falls are greater than rapid rises at all times of year, and therefore also on the mean of the year. This peculiarity is a still more marked characteristic of lower latitudes, since in Northern India it was found that rapid falls are about three times as numerous as rapid rises, and on the whole greater in amount.

The duration of rises of temperature is somewhat greater than that of falls, and both are rather greater at mountain stations than at low levels. Thus the passage of a wave of temperature, on the mean of the two stations Klagenfurt and Salzburg, occupies, on an average, 4·56 days, on the Sonnblick 4·93 days; or, in other words, 6½ waves pass within the month at the higher and 7 at the lower stations. The longest period of continuous cooling that occurred at any station was ten days at the mountain observatory of Hoch Obir, and the longest continuous rise of temperature ten days at Klagenfurt. There is a marked annual periodicity in the length of the temperature waves, with two epochs of maximum, viz. in March and September, and two of minimum, in July and December. From the data afforded by certain stations in Austria and Saxony, Dr. Hann computes the following formula for their annual variation in Central Europe—

$$4{\cdot}813 + 0{\cdot}138 \sin(26^\circ\,45' + x) + 0{\cdot}164 \sin(318^\circ\,27' + 2x).$$

The last subject investigated in Dr. Hann's memoir is the question whether the inter-diurnal changefulness of temperature shows any periodical variation during the sun-spot period; for which purpose he takes the 90 years' registers of Vienna, Wilna, and Warsaw. He finds that on the mean of these stations a certain minute variation is indeed apparent, but it is one of two maxima and two minima, and the whole range is so small that it is doubtful whether it is other than fortuitous.

In the foregoing paragraphs only a few of the more important results of Prof. Hann's investigation have been noticed. His memoir contains many others of interest, well worthy of study, and forming important contributions to general climatology; and like the original memoir, published seventeen years ago, it will doubtless stimulate others to prosecute the subject. It is especially important from a medical point of view that the statistics of all health resorts should be analyzed in the manner of which Prof. Hann has here given so admirable an example.

H. F. B.

FORESTRY IN AMERICA.[1]

IT cannot be said that, as far as the issue of reports and pamphlets on forestry is concerned the Agricultural Department at Washington has been idle; if only this activity would resolve itself into the establishment of a State Forest Service, and the formation of State forests out of the wreck of the former forest wealth of North America!

An important series of papers on forest matters has come to hand, and though they date as far back as 1889, they are probably new to many of the readers of NATURE.

The first paper is by Dr. James, Professor of Public Finance and Administration in the University of Pennsylvania, and is entitled "The Government in its Relation to Forests." The Professor has evidently studied his subject thoroughly, and the remedy he proposes is the exact counterpart of that which has been so successfully applied to the forests of India. He commences by stating that the forests of any large country not only constitute a large portion of its wealth, but form the indispensable basis of a flourishing manufacturing and commercial industry. They are also one of the most important elements in determining the climatic conditions of a region, and, through these, the distribution of the population, of industrial pursuits, and of disease and health. He states that the value of the forest crop in the United States in 1880, the census year, was 700,000,000 dollars (= £140,000,000), and that if the value of the total annual output of the mines, quarries, and petroleum wells were added to the estimated value of all steamboats and other craft on American waters, it would still be less than the value of the forest crop, by a sum sufficient to purchase all the canals, telegraph companies, and construct and equip all the telephone lines in the States.

He then shows how Government has fostered agriculture by offering land on easy terms, by establishing model farms and agricultural schools, by improving the breed of stock, by free distribution of seed, and in many other ways; it has also assisted manufactures by the protective tariff, bounties, and exhibitions, &c.; and that vast sums have been spent by the State on improving rivers and harbours, and on the general means of communication—railroads and roads. Game and fish are also protected by the State, but although from their forests the Americans have been drawing more natural wealth than from all other sources together, yet practically nothing has been done to preserve them from the devastations of selfish people. Besides the great demands on the forests for timber, three-fifths of the people in the States use wood for ordinary domestic fuel, and the value of the wood fuel annually consumed is placed at 325,000,000 dollars.

Prof. James then treats at length of the vast indirect value of forests in maintaining a steady supply of water in rivers, and preventing floods. He shows that the maintenance of a system of factories and mills dependent on a watercourse becomes impossible when the stream is converted into a mountain torrent for one quarter of the year and is all but dry during another quarter; and instances the River Schuylkill, from which Philadelphia draws its water-supply, where the current has become too shallow and sluggish to carry off the ever-increasing

1 "Department of Agriculture, Forestry Division. Bulletin No. 2.—Report on the Forest Condition of the Rocky Mountains, and other Papers." With a Map showing location of Forest Areas. Second Edition. (Washington: Government Press, 1889.)

quantity of impurities which pour into it, and consequently the quality of its water is steadily deteriorating.

The Professor considers it proved by European experience that a certain percentage of forest land is indispensable for any civilized country, and that when the forest area sinks below that percentage, through carelessness, or a selfish desire to get all the advantages from the resources of a country for the present generation, regardless of the interests of posterity, the result can only be an impaired industry and declining prosperity. He asserts that in the United States nothing is being done to cultivate forests, whilst vast areas, besides those which fall under the axe, are being wasted by fires and by unregulated grazing; so that, to put it mildly, the Americans are using up their forests at a much greater rate than they are replacing them, and are changing the character of their streams, soil, and local climate. Emphasis is laid on the fact that *tree-planting* is not *forest-culture*, and based on the experience taken from European countries, Mr. James insists that only the State can insure the preservation of the forests of America, and that private enterprise is powerless to prevent their eventual destruction.

His proposals to remedy matters are therefore that the Federal and State Governments should remove timber lands from the list of lands for sale, and after a thorough examination as to what forests are of climatic and industrial importance, should retain them under the control of Government. He also advocates the establishment of a School of Forestry, where men could be trained to manage the extensive tracts of forest lands in the ownership either of private individuals or of the State; and calls for further legislation, and active enforcement of existing laws to protect forests from fires and browsing animals. Here we have in a nutshell a proper forest policy sketched out for the United States; and it remains to be seen whether there is sufficient patriotism in the leading men to carry it out, or whether the great power of the timber trade, which has always insisted on non-interference with their business on the part of the State, will still obstruct the road to progress.

There is not space for much more than mere reference to the other papers contained in the Bulletin, the first being a most comprehensive report, by Colonel E. T. Ensign, on the forest conditions of the Rocky Mountains, showing the estimated area of forest still existing in each county of the States of Idaho, Montana, Wyoming, Colorado, and New Mexico, in 1887. A coloured map of the area shows the position and extent of the forest tracts. This report concludes with a most useful tabular statement, giving the area of forest in each county and for each State, as well as the character of the forest growth, the uses made of the timber, the principal causes of destruction of the forests, chiefly fires. Measures are suggested for the adequate protection of the forest growth, and any noticeable changes in the flow and volume of water in streams are noted. Under this head, we find that the streams have diminished in volume and their flow has become more intermittent in one-quarter of the ninety-one counties referred to, which altogether comprise an area of 555,081 square miles, still containing 83,460 square miles of forests in 1887.

The other papers are: "The Forest Flora of the Rocky Mountain Region," by G. B. Sudworth, and "On the Climate of Colorado and its Effects on Trees," by G. B. Parsons. The latter ascribes the barrenness of the eastern slopes of the Rocky Mountains to the extremes of temperature, and to the desiccating power of the north and north-west winds, which are frequently powerful enough to bark young trees by pelting them with gravel.

The Bulletin closes with a valuable paper on "Snow Slides and Avalanches," by B. E. Fernow, the present Chief of the Forestry Division of the Washington Agricultural Department.

W. R. FISHER.

NOTES.

THE following are the members of the Royal Commission appointed to investigate the question of a Teaching University for London:—Lord Cowper (Chairman), Lord Reay, Bishop Barry, Sir Lyon Playfair, Sir William Scovell Savory, Sir George Murray Humphry, Mr. George G. Ramsay, Rev. Canon Browne, Mr. Henry Sidgwick, Mr. John Scott Burdon Sanderson, Mr. James Anstie, Mr. Ralph Charlton Palmer, and Mr. Gerald Henry Rendall. No one who has devoted serious attention to the subject is likely to be of opinion that the choice of Commissioners is satisfactory. It shows that the Government has not grasped the problem.

THE International Congress of Chemical Nomenclature at Geneva has been attended by many representatives from various European countries. The representatives from England are Prof. H. E. Armstrong, F.R.S., Dr. J. H. Gladstone, F.R.S., and Prof. W. Ramsay, F.R.S.

PROF. A. CHAUVEAU has been elected to the presidency of the Société de Biologie, in place of Prof. Brown-Séquard, whose term has expired. The Société de Biologie was founded by Claude Bernard and a group of friends. Claude Bernard and Paul Bert were Presidents before M. Brown-Séquard.

A COMMITTEE has been formed to make preparations for the erection of a monument to Prof. de Quatrefages in his native village, Vallerangue (Gard).

WE regret to have to announce the death of Prof. Annibale de Gasparis, Director of the Observatory at Naples, which took place on the 21st of this month. Born in Bugnara, in the province of Aquila, on November 9, 1819, he passed the first few years of his youth in Tocco Casuria, where he studied classics. Going thence to Naples in 1838 he began the study of mathematics under Prof. Tucci, dealing specially with the problems relating to bridges and rivers. Afterwards he devoted himself to astronomy, in which he soon gained great celebrity. In 1840 he was appointed assistant at the Capodimonte Observatory, where he became a diligent observer and an industrious calculator. His discovery of the three minor planets—Hygieia, Parthenope, and Egeria—created a great stir in the scientific world, and secured for him the Royal Astronomical Society's medal. Nominated as Director of the Observatory in 1864, owing to the death of Capocci, he worked incessantly for the advancement of practical astronomy, and followed up his observations for the capture of small planets. Eunomia, Psyche, Massilia, Themis, Ausonia, and Beatrix were all discovered owing to his ever careful scrutiny. His theoretical labours included many on pure mathematics, while those on astronomy related principally to the best methods of determining the orbits of comets. The investigations he carried on from time to time were numerous, and the results appeared in many periodicals, of which we may mention the *Atti della R. Accademia delle Scienze Fisiche e Mathematiche de Napoli* and the *Astronomische Nachrichten*. De Gasparis was naturally robust, and enjoyed good health until he was attacked by the maladies which killed him. His powers of work were tremendous; he was always making either some calculation or observation. Being taken ill rather suddenly, he went away to recruit, but he became worse and worse, until at last he could not move. The sad days of the last year of his life he spent in reading the classics which he loved best, until his sight failed him.

MR. JOHN HARTNUP, the Astronomer to the Mersey Docks and Harbour Board, met with a fatal accident on the 21st while performing one of his Observatory duties. It seems that he was accustomed to examine occasionally the anemometers

situated on the flat roof of the building, the roof being skirted by a low wall about 20 inches in height. Being near the wall, and looking up at the anemometers, he was seized with a fit of giddiness, such as he had lately been accustomed to, and fell to the ground, breaking his neck. His sister-in-law, who saw the sad accident, had previously been cautioned by him not to go too near the wall when on the roof, for he considered it a dangerously low one. Mr. Hartnup was a member of the Royal Astronomical and Liverpool Astronomical Societies, and a Fellow of the Meteorological Society. He had succeeded his father in 1885, so that he was thoroughly familiar with the Observatory in which he had to work.

MISS AMELIA B. EDWARDS, whose death we have already recorded, has in her will endowed a Chair of Egyptology. Her library, which is very valuable, she has bequeathed to Somerville Hall, Oxford.

WE regret to hear that the venerable Prof. Svén Lovén has been compelled, as a result of the influenza, to retire from his position as Senior Keeper in the State Museum of Natural History, at Stockholm, where he has been active for fifty-one years. Prof. Lovén is now seeing through the press two important works on Echinoderm morphology, one dealing with the young stages of Echinoidea, the other with the Cystidea. We trust he may long be spared to enrich the world with these and other fruits of his wide knowledge and deep thought.

THE twelfth annual exhibition of natural history objects of the South London Natural History Society will be held on May 5 and 6 at the Bridge House Hotel, London Bridge, the whole of which building has been secured for the occasion. These exhibitions are growing in popularity, and several thousand visitors have each year taken lively interest in the exhibits. This year they will be exceptionally varied and novel. Lectures will be delivered by Mr. F. Enock on "The Life-history of the British Trapdoor Spider," by Mr. Step on "Edible and Poisonous Fungi," and by Mr. George Day on "Various Natural History Subjects."

AN Exhibition which will be interesting from a scientific as well as from a popular point of view will be held this year in the open ground near the Earl's Court railway station. It will illustrate the development of horticulture, and as Mr. H. E. Milner, F.L.S., is the chairman of the executive committee, we may expect that the scheme will be admirably carried out. There are to be examples of the gardens of all ages, including restorations of the ancient gardens of Egypt, Greece, and Rome; copies of those in China and Japan, and types of the Baronial, Italian, Tudor, Jacobean, Georgian, and Victorian eras. A large sub-tropical garden will be laid out, and there will be representations of the tea gardens of India and Ceylon. Various foreign countries—especially Belgium, Holland, France, Italy, and Germany—will co-operate to show the progress they have made in horticulture.

IN September a splendid Exhibition of fruit will be held in a temporary building, which is to be erected on a site on the Thames Embankment, near Blackfriars, lent for the purpose by the City Corporation. The Exhibition will be held under the auspices of the Fruiterers' and Gardeners' Companies, the Royal Horticultural Society, the British Fruit Growers' Association, and other kindred societies, and will last at least a week. In connection with the Exhibition lectures and object-lessons will be given on subjects relating to fruit culture and the planting of fruit trees.

THE Technical Instruction Committee of the Essex County Council appointed last year an organizing joint committee, consisting of six members of their own body, and six members of the Essex Field Club. By means of the funds voted to this joint committee, peripatetic courses of lectures on various scientific and technical subjects have been carried on in different rural centres with considerable success during the past year. The principle on which the joint committee has carried on this work has been to employ only thoroughly qualified lecturers, and to insist upon the instruction being made as practical as possible. In some cases the lectures have been followed by practical work, in which the students have been taught how to use the microscope, and to dissect plants, as a means of acquiring a good working knowledge of vegetable physiology. This practical work has been so much appreciated in the rural centres that there has been an actual competition to gain admission to the class, the number of students being necessarily limited by the supply of apparatus and material. One of the most popular courses given under the auspices of the joint committee has been that on general science, a kind of elementary introductory course showing the advantage of acquiring scientific knowledge in its applications to daily life. There has been such a demand for this subject that four lecturers have been engaged to meet the wants of different parts of the county. Special courses on marketable fish and oyster culture will shortly be commenced for the benefit of the maritime centres. The organizing joint committee has, we are informed, not been reappointed by the new County Council, but that its labours have been appreciated is shown by the fact that the Council has decided to merge the joint committee in the main Technical Instruction Committee. The latter will thus secure directly the co-operation of the six representatives of the Essex Field Club, among whom are Sir Henry Roscoe, Prof. Meldola, and Mr. G. J. Symons. Essex is to be congratulated upon the wisdom which its Councillors have displayed in securing the services of such well-known scientific advisers.

A VERY beautiful aurora was visible from Westgate-on-Sea on Monday evening last. When it was first observed, about 9.30 p.m., the sky was brilliantly illuminated to a height of about 30° above the horizon, extending laterally quite 50°. It seemed to be decidedly of a pinkish colour, but to all appearance this tint gradually disappeared. About ten minutes later, two fine streamers were thrown out, their approximate positions on the celestial sphere corresponding to the lines joining the stars π^2 Cygni, ϵ Draconis, and α Lacertæ, π Cephei. Their light was considerably more intense than the aurora itself, the beams reminding one rather of those produced by a strong search light. East and west of these, two more beautiful bright streaks were shot out, extending to a height not quite so great as the former two. The west one became especially fine, its light exceeding that of any of the others. Their positions, as near as could be gathered, lay between the stars ρ Cygni and o Draconis for the west one, and for the east one o Andromedæ and τ Cassiopeiæ. Five minutes later these vanished, and the two central ones merged into one and also disappeared. At 12.30, only one streamer was visible, while its light and that of the aurora itself was of a very feeble nature.

THE weather during the past week has become on the whole much more seasonable all over the country. Westerly winds have prevailed during the greater part of the period, and the air has been mild and genial; but the temperature, although high for the season, was lower than at the commencement of the month. Rain has fallen very generally within the last few days in all parts of the kingdom, and thunder, lightning, and hail have occurred in many places. A brilliant aurora, to which reference is made in the preceding note and in several letters, was observed in Scotland and in several parts of England during Monday night. The weather report of the Meteorological Office for the week ending April 23, showed that bright

sunshine, although less than in preceding weeks, still exceeded the mean value in nearly all districts.

LAST week California was visited by the most severe earthquake which has been known in that region since 1868. On April 19 shocks were felt over a distance of 200 miles, the intensity varying at different points. In San Francisco a number of large buildings trembled perceptibly, but only one was damaged—an old church building until lately occupied by the Academy of Science. The front wall gave way, tearing away the balconies. The centre of the disturbance was Vacaville, where a number of brick buildings both in the town and in the vicinity were destroyed or damaged. Many walls also fell into the streets. At Winters and Dixon serious damage was done to buildings. On April 21 further shocks occurred at San Francisco, and were felt in the surrounding districts. A number of buildings were demolished at Winters, and several persons received injuries. Eight distinct vibrations were felt. At Biggs clocks stopped, and plaster fell from the ceilings of the houses. At Woodville several brick buildings were damaged, while at Vacaville some walls which had been cracked by the previous shocks were demolished, and the ceilings in most of the houses were cracked. At Sacramento also some damage was caused, but the place which seems to have suffered most severely was Dixon, where extensive damage had already been caused by the shocks of April 19.

DR. A. C. OUDEMANS, Director of the Zoological Gardens at the Hague, has for some years made the sea-serpent a subject of special study, and now he is about to issue a book in which he will present his conclusions. He states in a prospectus that he was attracted to the question by "an account of the appearance of a sea-serpent published in NATURE of November 8, 1880." As NATURE was not published on November 8, 1880, a good many people may be tempted to think that this reference (due, of course, to a slip of the pen or to a misprint) is very suitable to the nature of the animal to which it relates. Dr. Oudemans has placed side by side "all the accounts, tales, and reports of this great unknown animal," and has convinced himself that "through all the reports there runs only *one* red thread, that there must be *one* single animal species which has given rise to *all* the reports." The author has chosen to write in English, because it is a language "known to all navigators, as well as to all zoologists, and other men of education." The full title of the work will be "The Great Sea-Serpent. An Historical and Critical Treatise. With the Reports of 166 Appearances, the Suppositions and Suggestions of Scientific and non-Scientific Persons, and the Author's Conclusions." There will be 82 illustrations.

WE are glad to hear that Mr. J. J. Wild, Ph.D., who accompanied the *Challenger* as secretary to the Director (Sir Wyville Thomson) and artist to the Expedition, is settled in Melbourne, Victoria, where he is engaged in producing plates illustrative of the zoology and palæontology of the colony, under the direction of Sir Frederick MacCoy, F.R.S. He is at present figuring the fossil remains of Acanthodian fishes discovered in the Old Red Sandstone of Mansfield, Victoria.

THE programme of the first series of summer excursions of the Manchester Field Naturalists' Society has just been issued. Mr. Leo Grindon, the founder of the Society thirty-two years since, has been compelled, by advancing years and impaired health, to resign the presidential chair, which Mr. Chas. Bailey has undertaken to occupy. Mr. Grindon retains the office of botanical referee, with the assistance of Mr. W. Gee, who is engaged in teaching natural history subjects under the Science and Art Department. A special study, appropriate to the season and locality, is appointed for each meeting; and a field card, directing observation in each of the seven sections of the Society, is in preparation. A course of lessons, treating in detail of the leading natural families of the Manchester Flora, is being given in the city.

AT the meeting of the Royal Statistical Society on Tuesday, Mr. R. Henry Rew read a valuable paper on the statistics of the production and consumption of milk and milk products in Great Britain. The subject, as he pointed out, is one of extreme complexity. The effective production of milk by a single cow ranges from *nil* (in the case of a cow which only rears her calf) to 1200 gallons or more. The number of cows and heifers returned in 1890, the year taken as a basis for calculation, was 3,956,220, of which it is reckoned that 3,544,575 are productive. Returns now collected from a large number of districts, together with other data, justified an estimate of 400 gallons per cow, making the total quantity of milk available for consumption in various forms in the United Kingdom 1417 million gallons. The number of cows has decreased in proportion to population. In Great Britain there were in the period 1866–70 82·1 cows per 1000 of population, while in 1886–90 there were only 77·9. The absolute number of cows had increased, but not sufficiently to keep pace with the growth of population. The latest return (for 1891) is more encouraging, showing as it does the largest number of cows on record. In Ireland the period 1886–90 showed a higher proportion (290·8) of cows to population than in any of the four preceding quinquennial periods, but this was due not to an increase in the number of cattle, but to the decrease of population. The 1417 million gallons of milk produced in the United Kingdom is thus accounted for:—Consumed as milk 570 million gallons; butter, 617 million gallons (representing 105,000 tons of butter); cheese, 224 million gallons (representing 100,000 tons of cheese); miscellaneous (condensed milk, &c.), 6 million gallons. Mr. Rew admitted that the results arrived at were only tentative. He expressed a hope that before long some official help might be given in the solution of a problem which was of the deepest interest to statisticians, agriculturists, and social economists.

THE Bath and West of England Society decided some time ago to appoint a research chemist to make investigations upon the making of cheddar cheese. Mr. Fred. Jas. Lloyd was chosen to fill this post, and he has recently presented his report of the work done in August, September, and October of last year. The results obtained, though by no means complete, are both valuable and interesting, and it is to be hoped that the Society will continue and extend the work. The experiments were made at the Society's Dairy School, near Frome, and it was found possible to make a cheese in such a way as to be guided in judging the condition of the curd by determinations of acidity alone. The product was a decided success in every respect. The average acidity of the mixed milk before adding rennet was ·24 per cent., but on setting the whey only showed ·16 per cent. of lactic acid. It was proved, by continued experiment, that when the whey showed a percentage of acidity slightly greater than that in the milk before renneting the process was sufficiently advanced to draw off the whey and pile the curd. Determinations of acidity in the later stages of manufacture have yielded similar results, and it appears to be certain that the careful development of definite amounts of lactic acid at definite steps in the process is essential to success. The bacteriological observations show that, although very many organisms are liable to get into the milk, the majority of them are not able to exist in an acid material, consequently by insuring a proper development of acidity in the curd we destroy their activity, which would otherwise spoil the cheese. Not only does the *Bacillus acidi lactici* play the most important part in the making of the cheese, but it is also the chief agent in the ripening process.

IT is well known that serious loss is caused in the various Australian colonies by the ravages of the rust fungus in wheat. An Intercolonial Conference met to consider the subject in 1890, and this body has since held two other meetings, the third having taken place at Melbourne last month. Many experiments have been made, and it has been clearly shown that there are several varieties of wheat which, except under very unusual circumstances, are never seriously attacked by rust. It has also been shown that in many districts early sown wheats of a rust-liable kind generally escape damage by rust, when the same wheats sown late suffer seriously. In view of these facts the Conference has directed attention mainly to encouraging the growth of varieties less liable to be attacked by rust, and also to early sowing. At the March meeting it was recommended that a practical system for the production and distribution of rust-resisting wheats suitable to different districts should be immediately established, and that this system should, subject to modifications needed by each colony, be conducted on the following lines:—A central station for each colony for the preliminary testing of new wheats introduced into the colony; for the production of new varieties by cross-fertilization and by selection; and for the distribution of suitable wheats thus obtained to representative districts of the colony, to be there subjected to a sufficient test, and, if necessary, fixed in their characters by farmers and others competent for the work; and that such wheats as pass satisfactorily this test should then be distributed to the farmers around in such a manner and by such agency as would be most suitable to the conditions of each colony. A committee was appointed to take steps for the proper naming of the different varieties of wheat.

THE U.S. Department of Agriculture has received information to the effect that *Vedalia cardinalis* has been successfully colonized at the Cape of Good Hope. Last autumn Mr. Thomas A. J. Louw, a special commissioner from the Legislative Assembly of the Cape, went to Washington charged with the task of collecting and taking back from America a supply of the useful little lady-bird mentioned. He was furnished with letters to the California agents of the Department, and took away from that State two parcels of *Vedalia*, one lot being shipped on ice and the other kept open and fed *en route*. Both were alive when he arrived at the Cape, and he writes that the experiment has been so successful that various parts of the colony have been supplied with the insect, which, no doubt, will be as useful in clearing off the Cottony Cushion Scale there as it has been in California and the Hawaiian Islands. Mr. Louw's letter, dated Malmesbury, Cape of Good Hope, March 5, 1892, to the Hon. Edwin Willits, Assistant Secretary of Agriculture, says: "While thanking you again for the kindness displayed towards me, may I request you also to convey to Prof. C. V. Riley my extreme obligations for the service rendered by him to me, and which I assure him will ever be appreciated by me."

DR. HYADES, as we noted last week, was impressed, while in Tierra del Fuego, with the resemblance between the Yahgan and the Botocudos of Brazil. Of the latter people an interesting account appeared lately in the Washington *Evening Star*, and is reproduced in the April number of *Goldthwaite's Geographical Magazine*. The colour of the Botocudos is described as of a light yellowish-brown. When brought into contact with Europeans they manifest not the slightest embarrassment on account of their lack of clothing. From certain seeds and fruits they obtain brilliant dyes, with which they adorn their bodies; and a common custom is to paint the face above the mouth a bright red, the upper half of the body being stained black, and a red stripe encircling the waist. A warrior thus decorated, with lip and ear ornaments, is said to present "a most demoniacal expression." The colours employed are mixed in the upper shell of a turtle, and carried in joints of the bamboo. The arms of the Botocudos consist of the bow and arrow. For calling one another in the forest they have speaking trumpets made of the skin of the tail of the great armadillo. While travelling through the woods, they build for themselves temporary shelters of palm-leaves, sticking the stems into the ground in a half-circle, so that the tips of the fronds arch together and form a sort of roof. When encamping for a considerable time in one place, they construct houses often big enough to hold several families. The fire is placed in the middle of the dwelling, and the beds are made of bark fibre. Gourds are used for drinking purposes and in the preparation of food. The Botocudos have been harshly dealt with by the Portuguese, and are rapidly dying out.

CAPTAIN BOWER, of the Indian Staff Corps, has arrived at Simla from China, after a very remarkable journey across the Tibet tableland. He had with him Dr. Thorold, a sub-surveyor, one Pathan orderly, a Hindustani cook, six caravan drivers, and forty-seven ponies and mules. The Calcutta correspondent of the *Times*, who gives an account of the journey, says that Captain Bower, leaving Leh on June 14, crossed the Lanakma Pass on July 3, avoiding the Tibetan outpost placed further south. Journeying due east, he passed a chain of salt lakes, one of which, called Hor-Ba-Too, is probably the highest lake in the world, being 17,930 feet above the sea. Gradually working to the south-east, the explorer saw to the north a magnificent snowy range, with a lofty peak in longitude 83° and latitude 35°. After many weeks' travel over uplands exceeding 15,000 feet in height, where water was scarce and no inhabitants were to be seen, the party on September 3 reached Gya-Kin-Linchin, on the northern shore of Tengri Nor Lake, in longitude 91° and latitude 31°. This is within a few marches of Lhassa, and two officials from the Devi Jong, or temporal governor of Lhassa, met him here and peremptorily ordered him to go back. But he refused to return, and a compromise was effected, guides and ponies being provided on his agreeing to make a detour to the north in order to reach the frontier of Western China. He reached Chiamdo on December 31, only just succeeding in getting off the tableland before winter set in. He struck Bonvalot's route for a few miles when marching to Chiamdo. The country about this town is very fertile and well wooded. Three thousand of the monks of Chiamdo, who lived in fine monasteries, threatened to attack the party, but were deterred on learning that they carried breechloaders. Captain Bower arrived at Tarchindo, an outpost on the Chinese frontier, on February 10. The distance covered from Lanakma to Tarchindo was over 2000 miles, all of which, save a few miles, has now been explored for the first time. The route for thirteen consecutive days lay over a tableland 17,000 feet high. Captain Bower is engaged in writing a report and completing his maps.

SPLENDID specimens of mica are to be sent to the Chicago Exhibition from Idaho, where the supply is said to be practically inexhaustible. Mica is to be used in the Idaho building as a substitute for glass in the windows. The *Photographic News* suggests that, if the reports as to the quality of the material prove to be accurate, it may become a rival to glass in photographic plate-making.

AT the meeting of the Paris Geographical Society on April 1, Lieutenant Vedel read an interesting paper on the Polynesians, whom he has had constant opportunities of studying during the last seven years. Referring to the Maoris, he said it was impossible not to be struck with the extraordinary resemblance which exists between their myths and those of the ancient Greeks.

THE Southport Society of Natural Science has issued its first report, from which we learn that the Society, although still very young, is doing good work as a local centre of scientific inquiry. The report includes a presidential address by Dr. H. H. Vernon, on the material and educational utility of natural science.

MR. EDWARD STANFORD has issued "The Hand-book of Jamaica for 1892." This is the twelfth year of publication. The work has been compiled from official and other trustworthy sources by S. P. Musson and T. Laurence Roxburgh. It comprises all necessary historical, statistical, and general information relating to the island.

THE latest instalment of the Transactions of the Royal Society of Victoria (vol. ii. part 2) opens with a paper on the occurrence of the genus Belonostomus in the rolling downs formation (Cretaceous) of Central Queensland, by R. Etheridge, Jun., and A. S. Woodward. There are also papers on the structure of *Ceratella fusca* (Gray), by Prof. W. Baldwin Spencer; additional observations on the Victorian land planarians, by Dr. A. Dendy; and land planarians from Lord Howe Island, by Prof. W. Balwin Spencer. Each of the papers is illustrated.

PROF. S. H. GAGE, of the Cornell University, has reprinted an interesting paper contributed by him to the *American Naturalist* on the life-history of the vermilion-spotted newt (*Diemyctylus viridescens*, Raf.). He has added to it a valuable annotated bibliography.

A REPORT on the geology and mineral resources of the central mineral region of Texas, by T. B. Comstock, was included in the second Annual Report of the Geological Survey of that State, and has now been issued separately. It ought to be of good service to practical men as well as to students of science. The author has a valuable note in which he shows how the prospector, the capitalist, or the property-holder may most advantageously use the report.

AN excellent essay on aboriginal skin-dressing, by Otis T. Mason, has been reprinted from the Report of the U.S. National Museum for 1888–89. It is based on material collected in the Museum, and includes an account of skin-dressing among the Eskimo and the Indians. There are many illustrations.

THE following science lectures will be given at the Royal Victoria Hall during May:—May 3, "Flying Bullets," by C. Vernon Boys; May 10, "Travels in Java and Sumatra," by Wm. Hancock; May 17, "The Wonders of the Rocky Mountains," by Wm. Carruthers; May 24, "Mines and Mining," by Bennett H. Brough; May 31, "The Alps in Winter," by C. T. Dent.

THE results of an investigation, concerning the conditions of silent combination of the hydrogen and oxygen contained in the detonating mixture of these gases obtained by the electrolysis of water, are communicated to the current number of *Liebig's Annalen* by Prof. Victor Meyer and Herr Askenasy. The object of the experiments was to ascertain whether any regular connection existed between the duration of time, during which such a mixture of the two gases is maintained at a temperature at which silent combination slowly proceeds, and the amount of water produced. The main result of the experiments has been to afford a direct negative to this question, the amount of combination under precisely the same conditions of temperature, pressure, and time varying most irregularly. Although this is the case, however, some interesting phenomena have been observed during the course of the experiments. It was found that, when a quantity of the pure dry mixture of two volumes of hydrogen and one volume of oxygen was sealed up in a glass bulb and heated in a bath of the vapour of phosphorus pentasulphide, the temperature of which (518°) is such that the bulb becomes faintly luminous, no explosion occurred, but a small proportion of the gases silently combined, with production of water. Upon immersing the bulb, however, in a bath of boiling stannous chloride (606°), explosive combination instantly occurred. It was surmised, therefore, that the temperature at which explosion occurs lies somewhere between 518° and 606°. But upon modifying the experiment in such a manner that the bulb was open, a slow stream of the gaseous mixture being allowed to pass continuously through, it was found that no explosion ensued under these conditions at the temperature of boiling stannous chloride, although at this temperature the bulb glows with a cherry red heat, and the glass is quite soft. It appears likely, therefore, that the extra pressure of the gases in the closed vessel determines the explosion at a lower temperature. The irregularity in the rate of silent combination would appear to be due to the different condition of the inner surfaces of the vessels containing the gaseous mixture; probably largely owing to the different amount of etching action by the water vapour at these high temperatures. In order to eliminate this disturbing element, the experiments have been repeated with bulbs whose inner surfaces have been equally etched beforehand and with bulbs whose interior walls have been silvered, the results, however, showing in both cases the same irregularity. In connection, however, with the experiments with silvered bulbs, another striking fact has been brought to light. It was found that in these bulbs the silent formation of water occurs at temperatures several hundred degrees lower than in unsilvered glass bulbs. Complete combination had occurred in two hours' time at the temperatures of boiling phosphorus pentasulphide (518°), sulphur (448°), diphenylamine (310°), and naphthalene (218°); 70 per cent. of the mixed gases had combined at the temperature of boiling aniline (183°), and a small amount of combination had occurred even at 155°. Finally, it was found that bright July sunshine is incapable of inducing the combination of hydrogen and oxygen, even when it is concentrated upon a bulb traversed by the gaseous mixture and heated to 606° in a bath of boiling stannous chloride.

THE additions to the Zoological Society's Gardens during the past week include a Patas Monkey (*Cercopithecus patas*) from West Africa, presented by Mr. W. S. Hewby; two Orinoco Geese (*Chenalopex jubata*) from South America, presented by Mr. Everard F. im Thurn, C.M.Z.S.; two Mute Swans (*Cygnus olor*), European, presented by Mrs. Melville; a Herring Gull (*Larus argentatus*), British, presented by Miss Lota Bower; two Chinese White-eyes (*Zosterops simplex*) from China; an Egyptian Goose (*Chenalopex ægyptiaca*) from Africa, deposited; a Cheer Pheasant (*Phasianus wallichii* ♂) from Northern India, a Swinhoe's Pheasant (*Euplocamus swinhoii* ♀) from Formosa, a Common Pheasant (*Phasianus colchicus* ♀), British, six Wigeon (*Mareca penelope*, females), twelve Common Teal (*Querquedula crecca* 6 ♂ 6 ♀), European, purchased; a Crested Porcupine (*Hystrix cristata*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

SPECTRUM OF NOVA AURIGÆ.—On February 22, Mr. E. W. Maunder obtained a photograph of the spectrum of Nova Aurigæ with an exposure of seventy minutes. The photographic magnitude of the star was then 4·78, and its visual magnitude was about 5·7. Bright lines were observed upon the plate at the following wave-lengths:—4919, 4860 (F), 4629, 4580, 4547, 4510, 4472, 4340 (G), 4229, 4174, 4101 (*h*), 3968 (H), 3933 (K), 3887·5 (α), 3834 (β). And dark lines had their positions located as follows:—4316 (G), 4212, 4155, 4085 (*h*), 3953 (H), 3913 (K). Measures of the displacement

of the dark lines relatively to the corresponding bright ones gave a mean of 18·3 tenth-metres. According to this, the relative motion of the two bodies engaged was about 820 miles a second. Mr. Maunder also observed the visual spectrum of the Nova. Three bright lines were seen, and estimated to be in the positions of C, D, and F of the solar spectrum. A line was detected "not far from E," another "near *b*, but further towards the blue," and another "very near the chief nebular line." The line measured on the photograph as at λ 4919 was also made out.

PHOTOGRAPHS OF THE REGION OF NOVA CYGNI.—At the March meeting of the Royal Astronomical Society, Mr. Roberts stated the results of a comparison of Drs. Copeland and Lohse's catalogue and chart of the region of Nova Cygni with two photographs of the same part of the heavens taken in September 1891. It appears that the brightness of some of the stars has undergone changes since 1878, when the chart was made. Changes of this character may, of course, be due to the well-known difference between visual and photographic magnitudes; but there are other differences, which are not so easily explained. Several stars, single on the chart, are seen to be double on the photographs, and some changes in relative position seem to have occurred. Although the Nova is not given on the chart, it appears on the photographs as a star of about magnitude 13. It will be interesting to compare Mr. Roberts's pictures with others taken under similar conditions at some future date, in order to determine definitely whether the changes are real, or due to errors in observation or cataloguing.

WINNECKE'S COMET.—Dr. G. F. Haerdtl gives the following ephemeris in *Astronomische Nachrichten*, No. 3083:—

1892.	R.A.	Decl.	Brightness.
	h. m. s.	° ′ ″	
April 29 ...	11 36 4·49 ...	+43 55 41·3	
,, 30 ...	34 22·64 ...	44 2 13·6	
May 1 ...	32 42·41 ...	8 8·3 ...	2·38
,, 2 ...	31 3·89 ...	13 25·6	
,, 3 ...	29 27·21 ...	18 6·3	
,, 4 ...	27 52·46 ...	22 11·9	
,, 5 ...	26 19·62 ...	25 43·4 ...	2·71
,, 6 ...	24 48·66 ...	28 42·1	
,, 7 ...	23 10·55 ...	31 8·6	
,, 8 ...	21 52·27 ...	33 3·6	
,, 9 ...	20 26·81 ...	34 28·1 ...	3·10
,, 10 ...	19 3·16 ...	35 23·3	
,, 11 ...	17 41·31 ...	35 50·0	
,, 12 ...	16 21·18 ...	35 49·6	
,, 13 ...	15 2·62 ...	35 22·5 ...	3·58
,, 14 ...	13 45·59 ...	34 29·4	
,, 15 ...	12 29·98 ...	33 11·2	
,, 16 ...	11 15·72 ...	31 28·7	
,, 17 ...	10 2·63 ...	29 22·9 ...	4·17
,, 18 ...	8 50·51 ...	26 55·0	
,, 19 ...	7 39·29 ...	24 5·2	
,, 20 ...	6 28·92 ...	20 53·7	
,, 21 ...	5 10·08 ...	17 21·4 ...	4·91
,, 22 ...	4 9·48 ...	13 29·0	
,, 23 ...	2 59·99 ...	9 17·4	
,, 24 ...	1 50·50 ...	4 47·8	
,, 25 ...	11 0 40·59 ...	44 0 0·3 ...	5·84
,, 26 ...	10 59 29·91 ...	43 54 55·3	
,, 27 ...	58 18·15 ...	49 33·4	
,, 28 ...	57 5·05 ...	43 55·1	
,, 29 ...	55 50·13 ...	38 0·7 ...	7·04
,, 30 ...	54 33·03 ...	31 50·9	
,, 31 ...	53 13·21 ...	25 25·2	

PERSONAL EQUATIONS IN TRANSIT OBSERVATIONS.—An accurate determination of an observer's personal equation is to-day of as much importance as an observation itself, when such small quantities, as we now deal with, have to be measured. The variation in the latitude, of which we have heard so much of late, amounts to a quantity only a few times larger than that of a moderate personal equation, showing that no small regard must be paid to its estimation. In observing an N.P.D., the star has to be bisected by the horizontal wire, while the nadir point has also to be observed: in both these cases an error can arise from personality, for the best observers cannot make a really true bisection. In the taking of transits another personality exists, but this is rather of a different kind, for, using the eye and ear method, the clock beats have to be taken into account simultaneously with the relative positions of the star and certain wires. In the April number of the *Bulletin Astronomique*, an account is given of some experimental researches on such transit determinations in which both methods, the eye and ear and the chronograph, were used. The observations were made with an apparatus similar to that designed by Wolf, who, to obtain artificial transits, employed a small truck to carry the plates, on which punctures of different sizes were made. From 115 observations made with both methods, it was found that equally accurate results were obtained, the eye and ear method, if any, proving a little inferior, while the degree of lighting of the field made no appreciable variation on the personal equation. For planets the electrical method showed that personality varied considerably, according to whether the preceding or following side was observed: the resulting personal equation for the centre of a planet turned out to be −0·046s., while that for a star under the same conditions was +0·023s. It would be interesting to find out whether this occurs when the eye and ear method is employed. The tendency of an observer, adopting the eye and ear method, to choose certain tenths of a second in preference to others, seems to have its analogy in the chronograph method, in the linear measurement from the second impressions. A comparison given here shows that the most favourable tenth is the *zero*, while the *nine* is very considerably left out in the cold. Another very curious fact is that the tenths, one, two, three, four, chosen in the chronograph methods, are all *less* than the corresponding ones in the other methods, while the opposite occurs for the tenths five to nine.

Tenths	0	1	2	3	4	5	6	7	8	9	Total
Eye and Ear . .	157	97	134	134	100	94	82	81	74	57	1000
Chronograph . .	164	79	96	90	94	129	104	94	81	69	1000

THE SIRIUS SYSTEM.—Dr. A. Auwers contributes to the *Astronomische Nachrichten*, Nos. 3084 and 3085, a long discussion with reference to our "Knowledge of the Sirius System." The problem which he undertook was to investigate whether the measures of the companion obtained during the period extending from 1862 to 1890 would satisfy an ellipse with a 49·4 year revolution; to determine the most probable value of the place elements for every measurement on the assumption of the revolution; and to inquire whether the observations of the principal star could be represented by means of the so determined elements. The author divides the discussion into the following three parts:—(1) A summation and sifting of all the measures that have been made of this companion for the above-mentioned period. (2) The derivation of the normal places, and the correction of the elements. (3) A comparison of the meridian observations of Sirius with the elements derived from the measurements of the companion. The result of the discussion is that a slight correction is necessary to reduce the right ascension and declination of the bright star to the centre of gravity of the two bodies (the masses of the chief star and of the companion being taken as 2·20⊙ and 1·04⊙). The table showing these corrections indicates that the right ascension between the years 1850 and 1890 has to be increased by a quantity which reaches to 0·232s., while between 1890 and 1896 5 a diminution takes place. The greatest correction for the declination is + 2″·268, which occurs in 1882·0, and this correction becomes negative also about 1893·5.

THE ANCIENT CIVILIZATION OF CENTRAL AMERICA.

IN Central America there are abundant traces of the existence of a great race which must at one time have attained to a comparatively high state of culture. It was undoubtedly a race of American Indians, and as undoubtedly closely connected with the present Indian inhabitants of the country.

No trace, however, of the ancient culture and knowledge can be found amongst the Indians of to-day, and the numerous ruins which lie scattered over the country are the remains of towns which have neither names nor history attached to them.

Very little information can be gathered from the published writings of the Spaniards who overran the country at the close of the fifteenth and beginning of the sixteenth centuries; but, apart from their bearings on Spanish history and biography, these writings have received very imperfect examination and criticism.

The Spaniards have been severely censured for their remiss-

ness in omitting to record the wonders of the Indian civilization which they are supposed to have met with, and especially for having failed to tell us about the towns and highly decorated buildings the ruins of which have been frequently described by modern travellers; but this censure appears to be to a great extent unmerited, for their writings, if carefully searched, do reveal a considerable amount of information about the Indians as they found them, and they failed to describe the ancient buildings because, as I hope to prove later, in many cases these buildings were even then as deeply buried in the recesses of the forests as they are at the present day.

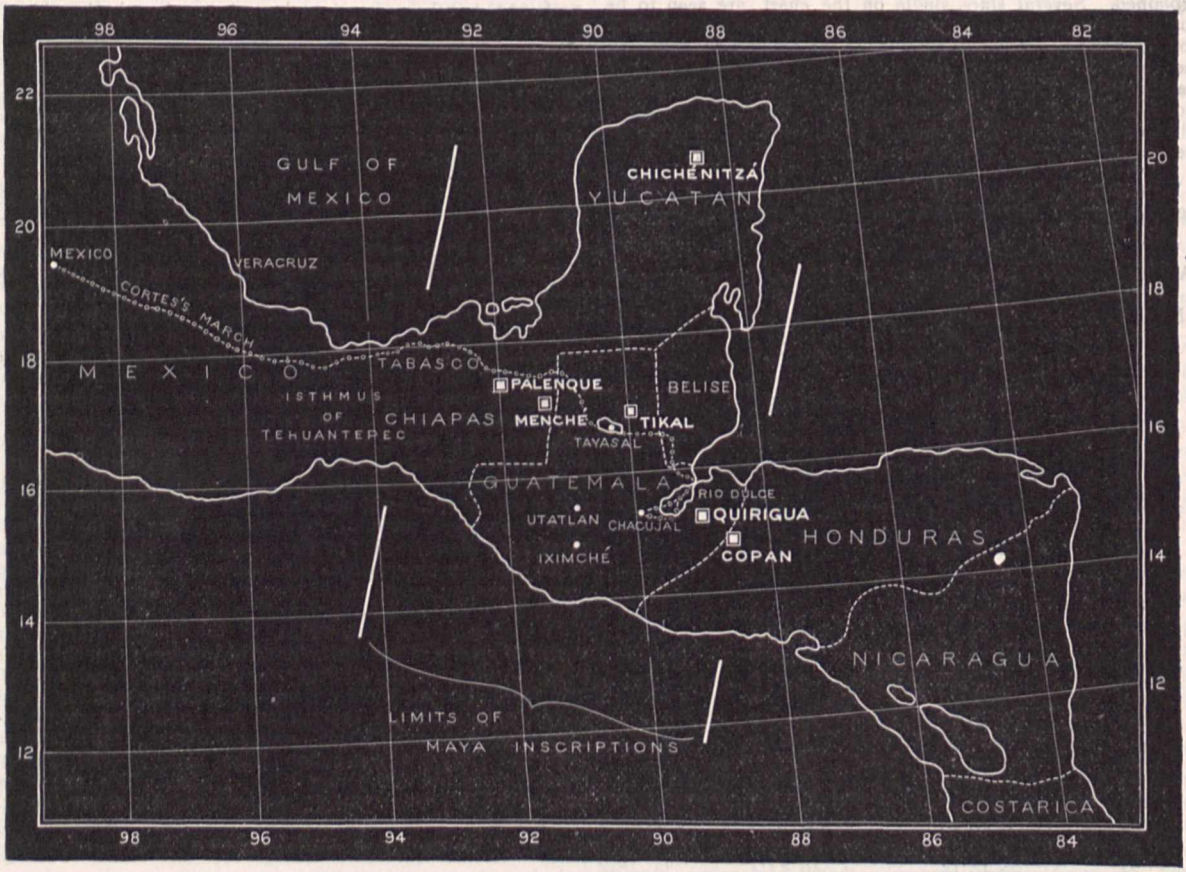
We naturally want to know more about this lost civilization, and there are many ways of attacking the problem. First of all, there is a large amount of correspondence, and a great number of reports written by the soldiers, officials, ecclesiastics, and other early settlers in the New World, which, not bearing on the main historical events of the conquest, have escaped publication, but which, if carefully examined, may afford valuable information regarding the native Indians. Then a study of the customs, languages, and folk-lore of the living races, may throw much light upon the condition and belief of their forerunners; and, above all, a careful examination of the burial-places and of the architectural and monumental remains, and their numerous hieroglyphic inscriptions, which lie hidden away in the vast forests, may reveal something of the history of the people who raised them.

It has been my good fortune to be able to devote my time during seven winters to the collection of materials which I trust may enable the study of Central American archæology to be pursued with greater ease and success than has hitherto been possible.

All the moulds of inscriptions and other sculptures made during my expeditions have been handed over by me to the authorities of the South Kensington Museum, and casts have already been taken from the greater number of them, which, as well as some original stone carvings, are now exhibited in the Architectural Court of the Museum. Maps, plans, photographs, and drawings, are in course of publication in the archæologi a section of the "Biologia Centrali-Americana."

The Editor of this journal has asked me to give some general account of the work on which I have been engaged, and its results, and this I will now attempt to do; but I must ask the reader to bear in mind that I started on the work almost by chance, and without any previous training or archæological knowledge, that I am but little acquainted with the literature of the subject, and have almost entirely confined my efforts to the collection of accurate copies of sculptures and inscriptions, in hope that some students may be found willing to make use of them. The following notes must therefore not be looked on as anything more than an attempt to clear the ground before an attack which I hope some day to see made on a difficult problem.

The remains of the more civilized races of North America



can be traced from the Isthmus of Panama as far north as the ruined Pueblos in the Cañons of Colorado. This great extent of country can again be roughly divided into three portions—one extending from Colorado to the Isthmus of Tehuantepec, a second from Tehuantepec to a line running nearly along the western frontiers of Honduras and Salvador, which may be called the Maya district, and a third from this line to the Isthmus of Panama.

So far as I know, no remains of stone buildings have been found in this last district, but much pottery is found—some of which is distinguished by great beauty of form, as well as excellence of decoration.

It is in the centre province, which includes Guatemala, Chiapas, Tabasco, and Yucatan, that my collections have been made, and the accompanying map shows the most important ruins visited.

It is impossible within the compass of an article, and

without the aid of numerous plans and drawings, to give an adequate account of the ruins as they can now be seen, but the following short summary gives the characteristics of the principal groups found to the south of Yucatan :—

Quirigua.—Thirteen monoliths covered with elaborate carved decoration and inscriptions. These are of two classes, upright stelæ, of which six still stand erect, the tallest measuring 25 feet high from the ground, 5 feet across back and front, and 4 feet across the sides, and large rounded blocks of stone cut into the form of some grotesque animal, the largest of them weighing about 20 tons. No buildings remain standing, but there are numerous mounds, only one of which has been dug into, and was found to contain on its summit the ground-work of a stone-built temple.

Copan.—Sixteen stelæ averaging 12 feet in height, of which eight are now standing, and numerous other sculptured monuments. Both figures and inscriptions are carved in higher relief than at Quirigua. Numerous stone-faced mounds, which can be ascended by well-laid stone stairways. There is no sign of a wall either of house or temple above ground, but the lower parts of both temples and houses can be found by digging into the masses of broken masonry on the tops of the mounds and terraces. Broken stone ornaments, which once decorated these buildings, are found lying in profusion at the foot of the mounds.

Menché.—A town built on stone-faced terraces rising one above the other from the banks of the River Usumacinta. There are many mounds of stone, and there are a few stone-roofed houses and temples still standing with carved stone lintels over the doorways. No separate carved monolithic monuments of importance.

Tikal.—Five cell-like temples with enormously thick walls, raised on pyramidal foundations of great height. The measurement of the largest, from the ground to the top of the temple, is about 160 ft., the base of the foundation measuring about 280 ft. square. These temples had beautifully carved wooden lintels over the doorways. Some of this carved wood is now preserved in the Museum at Basle, and some (a few smaller pieces) in the British Museum. There are several other smaller temples and numerous houses with stone roofs still standing. All these buildings had wooden lintels over the doorways, and some of the wooden beams are in a perfect state of preservation. There are seven or eight small stelæ, usually flat slabs of stone with carving on the front and sides only, all unfortunately much damaged and weather-worn.

Palenque.—One group of stone-roofed houses, commonly known as the palace, raised on a high stone-faced foundation. Four separate temples on similar foundations, and numerous other temples, houses, and tombs, some half-ruined, and others mere heaps of stone and rubbish. Only one carved monolith has been found which stood apart, but several large stone slabs beautifully carved with figures and inscriptions in low relief were let into the interior walls of the temples, and almost all the buildings have been lavishly ornamented with figures and inscriptions moulded in a hard and durable stucco.

The principal fact ascertained from the examination of the remains throughout this district (including Yucatan) is that the art as exemplified both by monuments and buildings is one and the same, and that the inscriptions are all carved in the same characters.

The chief difference to be noted is that whereas in the ruins which I assume to be of earlier date the art and workmanship is lavished on the decoration of large monoliths, whilst the temples and other buildings are comparatively insignificant, as time went on the elaborate carving of separate stone monuments was neglected, and the whole efforts of the artists were devoted to the erection and adornment of larger and more imposing buildings, and the carved stone glyphs of the monoliths gradually gave way to stucco and painted inscriptions on the walls of the temples and to manuscript books.

The age to be ascribed to these remains is purely a matter of conjecture ; but there are some historical facts which bear on the subject which I have already called attention to in another publication, but which may with advantage be here repeated.

Hernando Cortes, after the conquest of Mexico, started from that city in the year 1525, accompanied by some hundreds of Spaniards and a large number of Indians, with the intention of marching direct to Honduras. When Señor Don Pascual de Gayangos, in the year 1867, translated for publication by the Hakluyt Society the letter written by Cortes to Philip II. of Spain, giving an account of this expedition, he states in the preface that :—"To determine the spots visited by him in this extraordinary march through almost impenetrable forests, swampy plains, or lofty mountains, has by some writers been pronounced a hopeless task ; and though we possess the narrative of the stout-hearted and sturdy soldier, Bernal Diaz, who formed part of the expedition and carefully noted down its principal events ; though the various provinces traversed by the devoted army have since been more or less explored by travellers of all nations, few are the indications—and those very slight—of the route they followed. He must have passed near the ruins of Palenque, since the small village of Las Tres Cruzes is said to derive its name from three wooden crosses left in that locality."

A comparison of the recent and more accurate maps of Tabasco published by the Mexican Government, and of my own surveys in the region of the head waters of the Sarstoon and Mopan Rivers, with certain old maps and documents which have recently been brought to light from the Archives of the Indies at Seville, now enables us to trace Cortes's line of march with some degree of accuracy.

After passing the Isthmus of Tehuantepec, he found himself involved in the intricate waterways of the delta of the Tabasco and Grijalva Rivers. He and his followers suffered the greatest hardships, but after cutting their way through the tangled vegetation of the swamps, and with infinite patience and labour building bridges over the almost innumerable streams and lagoons, he crossed the River Usumacinta, somewhere in the neighbourhood of Tenosique.

There can be no doubt that towards the end of this part of this march, at a time when Cortes and his followers, lost in the forests of the delta, were suffering the last extremities of hunger, and were eagerly searching for a track which might lead them to an Indian settlement—they were traversing a plain actually overlooked by the temples of Palenque, and not more, and probably much less, than twenty miles distant from them. If Palenque had then been the great centre which it at one time must have been, and if the foot-hills of the Sierra on which it stands had then been as thickly peopled as the numerous remains indicate, it would have been impossible for a body of men as numerous and as much on the alert as were the followers of Cortes, to have missed the discovery of the many tracks which must have led thither.

Moreover, Cortes had been furnished with a map of the country, prepared by the Indian chiefs at Guacacualco ; and although it has been suggested that the chiefs systematically deceived him so as to prevent his visiting their richest and most sacred towns, such deception was not likely to have been successful with him, and it is still less likely to have imposed upon the large number of Mexican Indians who accompanied him. Yet, if Palenque was then inhabited, we are compelled either to believe that Cortes and his followers were indeed successfully imposed upon, or to give credit to the still more unlikely alternative that the Indian auxiliaries preferred to suffer such extremities of hunger that they were driven to eat the bodies of their companions who had died by the way, rather than give any information which would have been of service to their foreign leaders.

It hardly appears possible, therefore, to resist the conclusion that, in the year 1525, Palenque was already abandoned, and lost in the forest.

But if the information afforded to Cortes is to be relied on, then the same fate must also have overtaken the town of Menché on the Usumacinta, for Cortes was strongly advised by the natives not to continue his march along the banks of the river (and if he had done so he must have passed near the site of the ruins of Menché), as the country in that direction was uninhabited.

Accepting this advice, Cortes took the road by Acalá and Peten, and thence through part of what is now British Honduras, to the mouth of the Rio Dulce.

The inhabitants of Acalá appear to have been more civilized than any others whom Cortes met with during his long march. He states that the country was thickly peopled, and that the towns were large and full of mosques or idol-houses, yet no important ruins have ever been found in that district, and neither Cortes nor Bernal Diaz gives us any description which would lead us to suppose that they ever met with such imposing buildings as those still standing at Palenque or Menché.

From Acalá the expedition marched through a very thinly-peopled country until they arrived at the Lake of Peten.

Cortes visited the town of Tayasal, built on a small island in the lake, which, we are told, was the chief town of the district, and which was doubtless then, as it was later, the stronghold of the warlike Itzaes. Now, fortunately, we know something of the subsequent history of this town, for Tayasal was visited by missionaries from Yucatan in 1618, 1619, and 1623. This last missionary expedition ended disastrously, as the missionary and his followers were murdered by the natives; and we then have but scanty information about the Itzaes until the country was invaded by the Spaniards from Yucatan, and Tayasal captured in 1697. A curious story shows us that Tayasal is not likely to have suffered any serious disturbance between Cortes's visit and the year 1618.

In his letter to the King he states that, "At this village, or, rather, at the plantations that were close to the lake, I was obliged to leave one of my horses, owing to his having got a splinter in his foot. The Chief promised to take care of the animal and cure him, but I do not know if he will succeed, or what he will do with him."

On the day after the arrival of the missionary fathers Fuensalida and Orbita, in 1618, the Chief of the Itzaes showed them round the town, "in the middle of which, on the rising ground, were numerous and large buildings, 'cues' or oratories of their devilish and false gods. Entering into one of them, they saw in the centre of it a large idol in the form of a horse, well modelled in stone and plaster. It was seated on the ground, on its haunches.

"These barbarians reverenced it as the God of Thunder, and called it Tzimindiac, which means 'the horse of thunder and lightning.'"

This sight was too much for the religious zeal of Padre Orbita, who, seizing a great stone, jumped on to the idol and hammered it to pieces. It is hardly necessary to add that the Chief had the greatest difficulty in saving the lives of the missionaries from his infuriated people, and that they were compelled to leave the island at once.

It was afterwards learnt from the natives that they had thought the horse to be the god of thunder and lightning because they had seen the Spaniards firing their guns from horseback, and that when they found the horse to be ill, "they gave it to eat fowls and other meat, and presented it with garlands of flowers, as it was their custom to do when their own chiefs were ailing," and that, on its death, a council of chieftains was called, and it resolved to make an image of the horse in stone.

In the year 1700, the historian Villagutieres published a detailed account of the conquest of Itza by the Spaniards, and a description of the town of Tayasal, stating that "it was full of houses, some with stone walls more than a yard high, and, above these, wooden beams and roofs of thatch, and others of wood and thatch only"; and "of the twenty-one oratories which General Ursua found in the island, the principal and largest was that of the high priest Quincanek, cousin of the king Canek; this was rectangular (*cuadrada*), with a beautiful breastwork (*pretil*) and nine handsome steps, and each front was about twenty yards long and very high."

Speaking from memory, I should say that the island is not more than 500 yards across, and there are no signs whatever at the present time of any ancient foundations. It is now covered with poorly-built adobe houses, and in the centre is a church, which probably occupies the site of the ancient 'cues.' Now, within a day's walk from the north shore of the lake are the very remarkable ruins of Tikal, of which a short description has already been given; yet nothing whatever is told us either by Cortes, by the missionaries, or by Villagutieres, of the existence of a town on this site, and the ruins were unknown to the Spaniards until the year 1848.

The missionaries, on their journeys from the Spanish outpost at Tipu to Tayasal must have passed within a few miles of the site of the ruins; and it is impossible to believe that, so long as Tikal was inhabited, Tayasal could have been the chief town of the district, or, indeed, that Tikal could have been inhabited at all without the fact coming to the knowledge of the Spaniards.

If any further evidence were needed to show that the great structures raised during the epoch of higher civilization had already been deserted at the time of the Spanish conquest, it can be found in what Cortes himself states with regard to the town in Guatemala which he calls Chacujal.

When, after having crossed the base of the peninsula of Yucatan, the starving army arrived at the mouth of the Rio Dulce, it was only to find the Spanish colony it had come in search of reduced to a similar extremity of famine.

The scanty Indian population in the neighbourhood had been rendered hostile by the exactions of the settlers, and it was immediately necessary to scour the country for long distances in search of food. The most important of these raids, and, indeed, the only successful one, was led by Cortes himself, who landed on the south side of the Golfo Dulce, and marched about two leagues inland (when he must have been within about twelve to fifteen miles of the site of the ruins of Quirigua), and then turned along the mountain-range to the south of the Rio Polochic, and finally succeeded in reaching Chacujal, which is situated between two small streams which run into the Polochic. The inhabitants had all fled, but Cortes was fortunate in finding a large store of Indian corn, and other food.

Cortes writes of the town as follows:—"Marching through the place we arrived at the great square, where they had their mosques and houses of worship, and as we saw the mosques and buildings round them just in the manner and form of those at Culua" (on the coast of Mexico), "we were more overawed and astonished than we had been hitherto, since nowhere since we had left Acalá had we seen such signs of policy and power. . . . On the following morning I sent out several parties of men to explore the village, which was well designed, the houses well built, and close to each other." I can find no record whatever of Chacujal subsequent to the date of Cortes's visit; but in 1884 I myself visited the ruins of the town, guided by Cortes's own description of the site. The ruins are now completely buried in the forest, but there was little difficulty in tracing the general plan of the town, and making out the foundations of the principal buildings.

It is easy to understand how Cortes may have been favourably impressed with the flourishing appearance of the place after his terrible and tedious journey through the forest, yet it is quite clear from the ruins that the structures themselves could never have been of any considerable importance. The walls of the principal buildings had only been built of stone to half their height, and the superstructure and roof must have been made of some perishable material—a great contrast to the thick stone walls and heavy stone roofs at Palenque, Tikal, Menché, and Copan. Another point of importance is that the plan and method of construction of the buildings at Chacujal is similar to that of the ruins on the hill-tops a little further inland near San Jeronimo, Rabinal, and Cubulco, some of which I have visited. These were undoubtedly the strongholds of those Indians of the Tierra de Guerra to whom no high culture has ever been attributed, and who were induced by the Padre Las Casas to leave their fastnesses and settle in the plain of Rabinal in the year 1537.

It can therefore now be stated without doubt that, although Cortes and his followers on his march from Mexico to Honduras passed within a short distance of several of the sites of the most important ruins in Central America, they heard nothing of their existence as living cities.

Let us now consider the case of the often-described ruins of Copan on the northern frontier of Honduras.

The earliest information dates back to the year 1576, when the ruins were visited by Palacio del Rio, who described them in a letter written to King Philip II. of Spain. After giving an account of the sculptured monoliths, he mentions the numerous mounds which could be ascended by stone stairways, but he says nothing whatever about houses or temples, which such a careful observer as Palacio could not have omitted to mention had they then been in existence. He further states in his letter that it was impossible to believe that the scanty Indian population of the districts could have raised such monuments as he found at Copan, and that his efforts to elicit information from the leaders of the Indians dwelling in the neighbourhood only showed that all knowledge of the people who had raised these monuments was lost in the mists of tradition.

Enough has now been said to show that the most important ruins in the whole of this Maya district (outside of Yucatan) were never known to the Spaniards as the sites of inhabited towns, and it now remains to say only a few more words about those towns in which the conquerors actually found the people dwelling. The descriptions already quoted from early writers, or given from my own observations of the ruins in the cases of Tayasal and Chacujal, give some idea of what these towns were like; and the correctness of these descriptions is strengthened by the results of a careful examination which I have made of the sites

of the towns of Utatlan and Iximché, the capitals of the Quichés and Cachiquels, who were the most powerful tribes in Guatemala when Alvarado conquered the country. Although the remains of these towns, which were known for certain to have been inhabited at the time of the Spanish conquest, bear some similarity in plan and arrangement to the older ruins, there is the great distinction to be observed that in no instance is there any indication of the former existence of stone-roofed buildings, that there are only a few stones which show any trace of ornamental carving, and that of the roughest description, and that there are no remains of any carved inscriptions.

It may be as well to say a word of warning against the exaggerated accounts of the magnificence of the Indian towns of Guatemala at the time of the conquest which have found their way into the histories of the country by Fuentes, Juarros, and others, and are still alluded to and sometimes accepted as facts by modern travellers. To give only one instance. In describing the palace of the Quiché kings at Utatlan, dimensions are given for this palace which exceed the whole extent of the land on which any building is possible, for the site of the town is most clearly defined, and limited by the great "barranca" or rift, some hundreds of feet deep, which almost encircles it. It was no doubt this peculiar situation, that of an almost inaccessible peninsula in the middle of an undulating plain, which gave the site so much value in the eyes of the Quichés.

There is, then, a clearly marked difference between the remains of the towns of which we have some historical knowledge and the more ancient ruins.

But when one considers the fair state of preservation of some of the buildings at Palenque and Menché, and the presence of sound wooden beams in the temples and houses at Tikal, it is hardly possible to ascribe even to these ruins any very great antiquity.

From my own observation of the state of the ruins themselves, and the style of art displayed in the carved ornaments and inscriptions, I should feel inclined to give to Quirigua the earliest date, Copan the next, then Menché, Palenque, and Tikal, in the order named.

We must now turn our attention to the province of Yucatan.

The central portion of the peninsula has always been more or less a *terra incognita*. The Spaniards never really brought its inhabitants into complete subjection, and to this day it is peopled by hostile Indians, and no Spaniard dares to enter it.

If this country contains traces of the old civilization, nothing definite is known of them. The northern portion of the peninsula was brought completely under Spanish control, and is known to be studded with the remains of groups of ancient stone buildings.

It was on the north-east coast of Yucatan that the Spaniards first came into contact with Indians who used stone as a building material, and there can be but little doubt that some of the many ruined structures now to be seen were inhabited by the natives at the time of the conquest.

I am myself inclined to the opinion that the north of Yucatan was the last stronghold of the more cultivated branch of the Maya race after that race had either been driven out of, or under the stress of unknown adverse circumstances had retrograded in, the country to the south. But it does not follow that the Indians of Yucatan were at the height of their power and prosperity when the Spaniards came amongst them. In fact, their conquerors learnt from them that for some time previously the country had been troubled with civil wars and dissensions, and that Mayapan, once the chief town, had been destroyed and abandoned. It seems quite probable that this statement may be enlarged on to a considerable extent, and that we may consider the country to have been in a state of decadence, and that not one but many of the chief centres of population had been more or less abandoned. However, the temples and sacred edifices appear still to have been held in reverence after the population had moved away, and were visited during festivals, and may have been kept in some sort of repair by the priests; much in the same way as I believe the ruined dagobas and temples at Pollonarua and Anuradhapura are reverenced and visited by the people of Ceylon.

This appears to me to have been most probably the case with regard to the important buildings which still mark the site of what must have once been the large town of Chichén Itzá.

It has, I know, been stated that Chichén was inhabited at the time of Francisco de Montejo's first abortive effort to conquer Yucatan, and that the Spaniards were for some considerable time encamped in the town; but this statement does not appear to me to be supported by any sufficient evidence. Nevertheless, religious ceremonies had been so recently observed in Chichén Itza, that, in answer to a despatch from Spain, a committee of the settlers in the neighbouring town of Valladolid were able to give some account of them in the year 1579.

My personal experience of the ruins in Yucatan is limited to a hasty visit to Labna and Uxmal, and a residence of five months in one of the ruined temples of Chichén Itzá. At Chichén my clearings and surveys extended over an area of nearly a mile square, and although this appeared to include all the principal edifices, it was impossible to walk into the bush in any direction from the edge of this area without coming on the traces of stone buildings.

The surface of the ground, even in the centre of the town, although generally level, was in some places composed of cavernous and broken limestone rock, and these portions had apparently been walled off as unfit for buildings. But, wherever the ground was suitable, there were numerous traces of slightly constructed buildings in addition to the more solid structures.

The hieroglyphic inscriptions at Chichén are few in number, and with one small exception very poorly carved, but there is enough to show that they did not differ in character from those in Guatemala and Chiapas. There is, however, one great distinction between the sculptures in Yucatan and the country to the south which must not be overlooked. In the latter there is an almost entire absence of weapons of war, and the figures of women occupy a prominent position. In Yucatan the change is complete: there are no women represented in the sculptures, and every man is a warrior armed with spears and throwing-stick.

Whether the Maya civilization extended to Yucatan during the time that it flourished at Copan or Palenque, it is at present impossible to determine; but I strongly incline to the opinion that all the buildings now standing in Yucatan are of a later date. It may be perhaps allowable to state the case somewhat as follows:—

That the civilized portion of the Maya race have at some time occupied all the country lying between the Isthmus of Tehuantepec and the western frontiers of Honduras and Salvador (excepting perhaps a strip of country along the Pacific sea-board); that this people spoke the same or nearly allied languages, which they wrote or carved in the same script; that they were followers of the same religion, and built stone-roofed temples and houses decorated with the same class of design and ornament.

That at the time of the Spanish conquest they had entirely abandoned all their towns and religious centres in the country to the south of Yucatan, although the good state of preservation of many of the buildings at the present time precludes the idea that this desertion of their towns could have ante-dated the arrival of the Spaniards by very many years. That the people whom the Spaniards encountered in this part of the country, although they may have been allied in blood to the Mayas, were undoubtedly in a lower state of culture, and that an examination of the sites of their principal towns yields no signs of the artistic culture which is universally found in the older ruins.

That in Yucatan, where the Spaniards found a dense population of Maya Indians, and encountered a fierce and stubborn resistance, there are still to be seen numerous remains of ancient buildings, both larger and in better preservation than those in Guatemala and Chiapas, but built in the same manner, decorated with the same ornaments, and with inscriptions carved in the same hieroglyphic script. That there is evidence, from the early Spanish writings, that some at least of those buildings were still occupied at the time of the conquest; but that both the observations of the Spaniards themselves, as well as the reports subsequently gathered by them from the Indians, point to the conclusion that the country was in a state of decadence, and that many of the larger centres of population had already been abandoned, although the more important religious edifices may still have been reverenced and kept in repair.

The early Spanish writers make frequent allusion to the large number of books written and preserved by the natives of Yucatan. These books were written in hieroglyphic characters in the Maya language, which, it must be remembered, is still spoken by the whole of the Indian population of Yucatan, as well as by nearly all the half-breeds and Spaniards.

Unfortunately, every effort was made by the Spanish priests to destroy this literature, which they looked on as the work of the devil; and it is very doubtful whether a single fragment of hieroglyphic manuscript is now in existence in the whole peninsula.

One of the chief of the iconoclasts was Archbishop Diego de Landa; but, luckily, his zeal was tempered by a considerable appreciation of the ingenuity of the Indians, and an interest in their manners and customs, which induced him to make some notes on their method of writing and recording events.

It is to this that we owe what is commonly known as "Landa's alphabet"; but, as this was an attempt to make an alphabet of a language which in all probability was not written alphabetically but syllabically, it was a signal failure, and has proved, to the few scholars who have attempted to employ it, about as puzzling as the hieroglyphics themselves. However, it may ultimately be of some use, and it was accompanied by an explanation of the calendar system, and a list of the signs for the days and months, with their names, which is of the greatest value.

Although no Maya books are known to exist in America, three examples of what are undoubtedly genuine Maya manuscripts have turned up in Europe.

No information whatever is forthcoming as to how they got here, but it is not unlikely that they were sent over as curiosities at the time of the Spanish conquest, and were afterwards lost sight of.

They are the "Codex Troano," now preserved in the Archæological Museum at Madrid, a chromolithographic copy of which was published by the Abbé Brasseur de Bourbourg; the "Dresden Codex," preserved in the Royal Library at Dresden, of which a beautiful photolithographic copy has been published under the direction of Prof. Förstemann; and the "Codex Peresianus," in the Bibliothèque Nationale at Paris. Another manuscript at Madrid, which has been called the "Codex Cortesianus," appears to be only a detached portion of the "Codex Troano."

An examination which I have made of the two first-mentioned Codices leaves no doubt on my mind about the similarity of the written to the carved inscriptions. Many of the glyphs are identical, and others only vary as much as might be expected by the change from carving on stone to writing on paper. In addition to this evidence of the eyes, there is the distinct statement of Cogolludo, the historian of Yucatan, that the Indians had "characters by which they could understand one another in writing, such as those yet seen in great numbers on the ruins of their buildings."

So that we arrive at the important conclusion that the language of the carved inscriptions of Copan, Quirigua, and Palenque is still a living tongue, although it has doubtless been much changed in the course of years.

ALFRED P. MAUDSLAY.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. C. E. Ashford, B.A. of Trinity College, has been appointed Assistant Demonstrator of Physics in the Cavendish Laboratory.

Dr. William Ewart and Mr. Frederick Treves have been appointed additional examiners in Medicine and Surgery respectively.

The Cavendish Professor announces a course of lectures on Electrolysis and Solution, to be given by Mr. W. C. D. Whetham on Thursdays and Saturdays during the present term.

Seventeen candidates were approved for the diploma in Public Health at the extra examination held at the beginning of the month.

T. Clifford Allbutt, M.D., F.R.S., the newly appointed Regius Professor of Physic, has been elected to a Fellowship at Gonville and Caius College.

The Shuttleworth Scholarship in Botany has been awarded to I. H. Burkill, B.A., Assistant Curator of the Herbarium.

The memorial in Westminster Abbey to the late Prof. J. C. Adams, will be placed in the sill of the window on the north side, nearest to the monument of Newton. A large and very influential committee has been formed for the purpose of establishing the memorial.

SCIENTIFIC SERIALS.

American Journal of Science, March.—Mount St. Elias and its glaciers, by Israel C. Russell. Account is given of the country explored by two parties sent to Alaska by the National Geographic Survey, in connection with the U.S. Geological Survey, in 1890 and 1891.—Hudson River "Fiord," by Dr. Arthur M. Edwards.—Contributions to mineralogy, No. 52, by F. A. Genth; with crystallographic notes by Samuel L. Penfield. The minerals described are hübnerite, hessite, bismutite, and natrolite.—Tschermak's theory of the chlorite group and its alternative, by F. W. Clarke.—Recent fossils near Boston, by Warren Upham. Fossil marine shells of the post-Glacial epoch have been lately discovered near Boston, indicating slight recent changes in the relative levels of land and sea, and proving considerable changes in the temperature of the sea there.—The highest old shore line on Mackinac Island, by F. B. Taylor.—On the nature of colloid solutions, by C. E. Linebarger. It is generally believed that solutions of colloid substances, such as albumen or silicic acid, differ in their nature from solutions of crystalloid substances. The author's experiments indicate that colloid solutions are solutions in the ordinary acceptation of the term, and not "suspensions."—Observations upon the structural relations of the Upper Huronian, Lower Huronian, and Basement Complex on the north shore of Lake Huron, by Raphael Pumpelly and C. R. Van Hise.—A phasemeter, by John Trowbridge. The phasemeter is an instrument devised for the investigation of questions of the phase of alternating electric currents in transformers and in branch circuits. Two telephone diaphragms have mirrors fixed upon them. A spot of light reflected from one of the mirrors is given a horizontal movement when the diaphragm is vibrating, while the other mirror, when its diaphragm moves, gives a spot of light a vertical motion. By the combination of the two motions, figures are obtained similar to those of Lissajous in the case of tuning-forks; and from these, the difference in phase of the currents which set the diaphragms in motion can be found.—Preliminary report of observations at the Deep Well, Wheeling, West Virginia, by William Hallock.—Mount Bob, Mount Ida, or Snake Hill, by T. W. Harris.

April.—On the action of vacuum discharge streamers upon each other, by Dr. M. I. Pupin. The experiments described show that two electric current filaments in a rarefied gas may repel each other in cases where electrodynamic action would produce an attraction. The repulsion does not appear to be due to electrostatic action, but rather to "a strain in the vacuum produced by the peculiar distribution of the gas pressure resulting from the peculiar distribution of temperature."—On a melilite-bearing rock (Alnoite) from Ste. Anne de Bellevue, near Montreal, Canada, by Frank D. Adams.—On an azure-blue pyroxenic rock from the Middle Gila, New Mexico, by George P. Merrill and R. L. Packard.—On the correlation of moraines with raised beaches of Lake Erie, by Frank Leverett.—Magnesium as a source of light, by Frederick J. Rogers. The results of this investigation are summed up as follow:—(1) The spectrum of burning magnesium approaches much more nearly that of sunlight than does the spectrum of any other artificial illuminant. (2) The temperature of the magnesium flame, about 1340° C., lies between that of the Bunsen burner and that of the air-blast lamp, although the character of its spectrum is such as would correspond to a temperature of nearly 5000° C. were its light due to ordinary incandescence. (3) The "radiant efficiency" is 13½ per cent., a value higher than that for any other artificial illuminant, excepting, perhaps, the light of the electric discharge *in vacuo* for which Dr. Staub, of Zürich, has found an efficiency of about 34 per cent. (4) The radiant energy emitted by burning magnesium is about 4630 calories per gram of the metal burned, or 75 per cent. of the total heat of combustion, as compared with 15 per cent. to 20 per cent. in the case of illuminating gas. (5) The thermal equivalent of one candle-power-minute of magnesium light is about 2·4 lesser calories, as against 3·5 to 4·0 for other artificial illuminants. (6) The total efficiency of the magnesium light is about 10 per cent., as compared with 0·25 per cent. for illuminating gas. (7) Taking into consideration the greater average luminosity of the rays of the visible spectrum of the magnesium flame, it is certain that *per unit of energy expended, the light-giving power of burning magnesium is from fifty to sixty times greater than that of gas.*—A method for the quantitative separation of barium from calcium by the action of amyl alcohol on the nitrates by P. E. Browning.—On plicated cleavage foliation, by T. Nelson Dale.—Geological age of the Saganaga syenite, by A. R. C. Selwyn.—A third occurrence of peridotite in Central New York, by C. H. Smith.—A fulgurite from Waterville, Maine, by W. S. Bayley.—Mineralogical notes on brookite, octahedrite, quartz, and ruby, by G. F. Kunz.—Recent polydactyle horses, by O. C. Marsh.

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, April 13.—Mr. Henry John Elwes, Vice-President, in the chair.—Mr. R. McLachlan, F.R.S., exhibited specimens of a Caddis-fly remarkable for the abbreviated wings of the male, the female having fully developed wings. He alluded to the *Perlidæ* as including species in which the males were frequently semi-apterous. Dr. Sharp, F.R.S., inquired if Mr. McLachlan was aware of any order of insects, except the Neuroptera, in which the organs of flight were less developed in the male than in the female. Mr. C. G. Barrett and Mr. H. J. Elwes cited instances amongst the *Bombycidæ* in which the wings of the male were inferior in size and development to those of the female.—Dr. Sharp exhibited specimens of both sexes of an apparently nondescript Phasmid insect allied to *Orobia*, obtained by Mr. J. J. Lister in the Seychelles Islands, together with *Phyllium gelonus*. He also exhibited specimens of both sexes of an insect remarkable for its great general resemblance to the *Phasmidæ*, though without resemblance, so far as is known, to any particular species. In reference to the *Phyllium*, Dr. Sharp called attention to the fact that the similarity of appearance of parts of their organization to portions of the vegetable kingdom was accompanied by a similarity, amounting almost to identity, of minute structure. He said that it had been stated that the colouring-matter is indistinguishable from chlorophyll, and that Mr. Lister had informed him that when in want of food a specimen of the *Phyllium* would eat portions of the foliaceous expansions of its fellows, although the *Phasmidæ* are phytophagous insects. The resemblance to vegetable products reached its maximum of development in the egg; and M. Henneguy had observed that when sections of the external envelope of the egg of *Phyllium* are placed under the microscope no competent botanist would hesitate to pronounce them to belong to the vegetable kingdom.—Mr. Barrett exhibited, for Major J. N. Still, a specimen of *Notodonta bicolora*, which had been captured in a wood near Exeter. Major Still had stated that the captor of the specimen was unaware of the great rarity of the species. Mr. Barrett also exhibited, for Mr. Sydney Webb, some remarkable varieties of *Argynnis adippe* and *Cœnonympha pamphilus;* also two specimens of *Apatura iris*, and two of *Limenitis sybilla* in which the white bands were entirely absent.—The Hon. Walter Rothschild exhibited, and contributed preliminary notes on, some hundreds of Lepidoptera, representative of a collection of about 5000 specimens recently made by Mr. W. Doherty, in the south-west of Celebes. Many of the species were new, and others very rare. Mr. Elwes, Colonel Swinhoe, and Mr. S. Stevens commented on the interesting nature of this collection.—Mr. E. B. Poulton, F.R.S., gave a lecture "On the Denudation of the Scales in certain Species of Lepidoptera," and illustrated it by a large number of photographs shown by means of the oxy-hydrogen lantern. Mr. G. F. Hampson, Mr. Elwes, and Mr. Poulton took part in the discussion which ensued.

Royal Meteorological Society, April 20.—Dr. C. Theodore Williams, President, in the chair.—Reference was made to the death of Dr. J. W. Tripe, who had held the office of Council Secretary for the last twenty years, and a resolution of sympathy with the family was passed by the meeting.—The following papers were read:—Anemometer comparisons, by Mr. W. H. Dines. This was a report on a valuable series of experiments which have been carried out at the request of the Council of the Society, with the view of obtaining a direct comparison of the various anemometers in common use, so that some opinion might be formed as to which type of instrument is the most suitable for general purposes. The Meteorological Council have defrayed the cost of the work. The anemometers which were compared were—(1) Kew pattern Robinson; (2) self-adjusting helicoid; (3) air meter; (4) circular pressure plate (one foot in diameter); and (5) a special modification of tube anemometer. Most of these instruments are of the author's own invention, as well as the apparatus for obtaining automatic and simultaneous records from all the instruments upon the same sheet of paper. It appears that the factor of the Kew pattern Robinson is practically constant, and must lie between 2·00 and 2·20. The helicoid anemometer is quite independent of friction for all excepting light winds, and different sizes read alike, but it is not so simple in construction as the cup form. The air meter consists of a single screw blade formed of thin aluminium, and made as nearly as possible into the exact shape of a portion of a helicoid. A similar instrument with a larger blade, and with the dial protected from the weather, would probably form a useful and correct anemometer. It would be light, and offer a very trifling resistance to the wind. The oscillations of the pressure plate must have been considerably damped by the action of the floating weight, but as it was, they were sufficiently violent. It seems probable that the remarkably high values sometimes given by the Osler pressure plate may be due to the inertia of the moving parts. The tube anemometer appears to possess numerous advantages. The head is simple in construction, and so strong that it is practically indestructible by the most violent hurricane. The recording apparatus can be placed at any reasonable distance from the head, and the connecting pipes may go round several sharp corners without harm. The power is conveyed from the head without loss by friction, and hence the instrument may be made sensitive to very low velocities without impairing its ability to resist the most severe gale.—The hurricane over the West Indies, August 18–27, 1891, by Mr. F. Watts. The author has collected a number of observations on this violent hurricane, which on August 18 swept from the Atlantic into the Caribbean Sea, and moved in a north-north-westerly direction over San Domingo, and thence northward and eastward. At Martinique the barometer, which at 5.30 p.m. stood at 29·80 inches, fell to 28·38 inches at 8.15 p.m., during the passing of the centre of the cyclone.

Chemical Society, March 30.—Annual General Meeting.—Prof. A. Crum Brown, F.R.S., President, in the chair.—The President delivered an address, in the first part of which he referred to the favourable position of the Society. In the remainder of his address he dwelt chiefly on the work which is being done on the border-lines of chemistry proper, referring both to that by which an approach is gradually being made towards understanding the chemistry of Nature's organic laboratory, and to the solution of chemical problems by the application of mathematical and physical methods of inquiry. A vote of thanks to the President was carried by acclamation.—After the usual reports by the officers of the Society had been presented, a ballot was taken for the election of officers and Council for the ensuing year. The following were subsequently declared elected:—President: A. Crum Brown, F.R.S. Vice-Presidents who have filled the office of President: Sir F. Abel, F.R.S.; W. Crookes, F.R.S.; E. Frankland, F.R.S; J. H. Gilbert, F.R.S; J. H. Gladstone, F.R.S.; A. W. Hofmann, F.R.S.; H. Müller, F.R.S.; W. Odling, F.R.S.; W. H. Perkin, F.R.S.; Sir L. Playfair, F.R.S.; Sir H. E. Roscoe, F.R.S.; W. J. Russell, F.R.S.; A. W. Williamson, F.R.S. Vice-Presidents: A. V. Harcourt, F.R.S.; W. N. Hartley, F.R.S.; J. Pattinson; W. Ramsay, F.R.S.; W. A. Tilden, F.R.S.; R. Warington, F.R.S. Secretaries: H. E. Armstrong, F.R.S.; J. M. Thomson. Foreign Secretary: R. Meldola, F.R.S. Treasurer: T. E. Thorpe, F.R.S. Ordinary members of Council: H. Bassett; N. Collie: H. Dixon, F.R.S.; J. Ferguson; R. J. Friswell; J. Heron; M. M. P. Muir; F. J. M. Page; W. H. Perkin, Jun. F.R.S.; S. U. Pickering; J. A. Voelcker; W. P. Wynne.—Correction of a note on a new acid from camphoric acid, by W. H. Perkin, Jun. The author desires to express regret that he had overlooked a previous paper by Damsky, in which an account is given of the acid recently described by him as new.

Mathematical Society, April 14.—Prof. Greenhill, F.R.S., President, in the chair.—The following six foreign mathematicians were elected Honorary Members of the Society, viz. Messrs. Poincaré, Hertz, Schwarz, Mittag-Leffler, Beltrami, and Willard Gibbs.—The following short communications were made:—Second note on a quaternary group of 51,840 linear substitutions, by Dr. Morrice.—Note on the skew surfaces applicable upon a given skew surface, by Prof. Cayley, F.R.S.—Mr. A. B. Kempe, F.R.S., made an *impromptu* communication on regular graphs.—Mr. J. J. Walker, F.R.S., Dr. M. J. M. Hill, Lieut.-Colonel Cunningham, and the President joined in the discussion on the above communications.

EDINBURGH.

Royal Society, April 4.—Sir Arthur Mitchell, Vice-President, in the chair.—Dr. Thomas Muir read a paper on a problem of Sylvester's in elimination, and also a note on Prof. Cayley's proof that a triangle and its reciprocal are in

perspective.—Prof. Blackie read a paper on the most recent phases of Greek literary style. The style of the educated Greek and the popular style were brought into closer correspondence than previously at the commencement of the present century, chiefly through the influence of Coraes. In this paper Prof. Blackie investigates the result of that amalgamation. Since 1830, the development of the Greek language has been most marked. The higher classical style has been constantly gaining ground, so that popular and literary Greek now differs as little from ancient classical Greek as Scotch does from English; while, previous to the time of Coraes, they were as distinct as present-day English is from the English of Chaucer. The author gives examples of the deviations of the literary and popular Greek of various epochs from ancient Greek, which prove a rapid return to the ancient purity of language. Thus, while in twelve lines of Romaic Greek eighteen or twenty deviations from the pure style may be found, in twelve lines of modern Greek only two or three such deviations appear. In the first five verses of the second chapter of Luke, nineteen deviations occur in the Romaic New Testament, while in the same passage in the English Bible Society's version of 1890 only four are found. In two pages of a recent number of a Greek newspaper only two deviations occur.—Dr. Berry Haycraft communicated a contribution, by Mr. F. E. Beddard, to the anatomy of *Sutroa*.

PARIS.

Academy of Sciences, April 19.—M. d'Abbadie in the chair.—Calculation of the diminution which is experienced by the mean pressure on a fixed horizontal plane, in the interior of a heavy liquid filling a basin and agitated by certain wave motions, by M. J. Boussinesq.—Note by M. Faye accompanying the presentation of celestial photographs obtained at Heidelberg by Dr. Max Wolf, Director of the Observatory. The photographs commented upon by M. Faye are those recently taken of a part of Cygnus, and that on which the trail of a new asteroid was detected; also a picture showing a shooting-star which crossed the field of observation during exposure. The photographs were taken by means of a portrait-lens 2½ inches in diameter.—On the optical measure of high temperatures, by M. A. Crova.—Researches on the formation of planets and satellites: memoir by M. E. Roger, presented by M. Jordan. The author has developed a complex relation connecting the distances of planets from the sun, and also one connecting the distances of planets from their satellites.—Observations of Swift's comet (1892 March 6), made with the Brunner equatorial of Lyons Observatory, by M. G. Le Cadet. Observations for position were made on April 3, 4, 8, 9, 11, and 15.—On differential invariants of a surface with respect to conformable transformations of space, by M. Arthur Tresse.—On the accuracy of comparisons of a *mètre à bouts* with a *mètre à traits*, by M. Bosscha.—Researches on the secondary wood of Apetales, by M. C. Houlbert.—On the relations existing between the form and nature of the beds of andalusite at Ariège, by M. A. Lacroix. It appears that at Ariège the form of the andalusite is characteristic in each bed to such an extent that, given a geological map of the region, it is possible to indicate *a priori* where the mineral would be found, and conversely, given a specimen of andalusite, the geological nature of the bed from which it was taken could be stated with very little chance of error. The facts described by M. Lacroix are thus as useful to the geologist as to the mineralogist.—On the loess of Turkestan, by M. Guillaume Capus.

BRUSSELS.

Academy of Sciences, March 5.—The following communications were read:—The male of certain Caligides, and a new species of this family, by M. P. J. Van Beneden. The author describes (1) the male of *Pandarus Cranchii*; (2) the male and female *Pandarus affinis*, n. sp.; (3) a new species, *Chlamys incisus*; and (4) the male of *Dinematoura elongata*.—Theoretical determination of the radius of the sphere of molecular activity of liquids in general, by M. P. De Heen. The conclusion is arrived at that the radius of the sphere of activity is proportional to the product of surface tension into molecular volume.—On the curve in conic sections, by M. Cl. Servais.—Researches on the physiology of respiratory centres, by Dr. Alfred Bienfait. The author adduces evidence to show that a single respiratory centre, isolated by two transverse sections from the accessory respiratory centres, controls the movements of the glottis.—On a new ptomaine obtained by the culture of *Bacterium Allii*, by Dr. A. B. Griffiths. In a former paper Dr. Griffiths described and named *Bacterium Allii*—a micro-organism found by him. This Bacteria produces a green pigment, soluble in alcohol, and possessing a particular absorption spectrum. In the presence of albuminoids, *Bacterium Allii* gives rise to a crystallizable ptomaine, which furnishes a chloroplatinate, having the formula, according to analyses, $(C_{10}H_{17}NHCl)Pt_2Cl_4$. The analysis of the base gave the formula $C_{10}H_{17}N$, which corresponds to that of chloroplatinate.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Apodidæ: H. M. Bernard (Macmillan).—Tanganyika: E. C. Hore (Stanford).—Epidemics, Plagues, and Fevers: Hon. Rollo Russell (Stanford).—Hand-book of Jamaica, 1892 (Stanford).—A Treatise on Physical Optics: A. B. Basset (Bell).—The Landfall of Lief Erikson, A.D. 1000: E. N. Horsford (Boston, Damrell and Upham).—A Guide to Electric Lighting: S. Bottone (Whittaker).—Elementary Lessons in Heat: S. E. Tillman, 2nd edition (Gay and Bird).—Les Altérations de la Personnalité: A. Binet (Paris, Alcan).—Thermodynamische Studien: J. W. Gibbs, translated by W. Ostwald (Leipzig, Engelmann).—English Botany, supplement to the 3rd edition, Part 1: N. E. Brown (Bell).—Progressive Mathematical Exercises, 2nd series: A. T. Richardson (Macmillan).

PAMPHLET.—The Wheat Plant, how it Feeds and Grows: W. Carruthurs (also 8 diagrams) (W. and A. K. Johnston).

SERIALS.—Proceedings of the Rochester Academy of Science, vol. i. Brochures 1 and 2 (Rochester, N.Y.).—Brain, Part 57 (Macmillan).—Journal of the Bombay Natural History Society, No. 4 vol. vi. (Bombay).—Journal of the Institution of Electrical Engineers, No. 97, vol. xxi. (Spon).—Bulletin of the New York Mathematical Society, vol. i. No. 7 (New York).—Physical Society of London, Proceedings, vol. xi. Part 3 (Taylor and Francis).—Proceedings of the Geologists' Association, vol. xii. Part 7 (Stanford).—Journal of the Royal Microscopical Society, April (Williams and Norgate).—A Manual of Orchidaceous Plants, Part 8 (Veitch).—Notes from the Leyden Museum, vol. xiv. Nos. 1 and 2 (Leyden, Brill).—American Journal of Mathematics, vol. xiv. No. 2 (Baltimore).—Transactions of the Royal Society of Victoria, vol. ii. Part 2, 1891 (Melbourne).—Report of the Geological Survey of India, vol. xxv. Part 1 (Calcutta).

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