THURSDAY, JUNE 3, 1886

BRITISH FUNGI

Hymenomycetes Britannici—British Fungi (*Hymenomycetes*). By Rev. John Stevenson, Author of "Mycologia Scotica." Vol. I. Agaricus—Bolbitius. 8vo, pp. 372, with Cuts. (Edinburgh: William Blackwood and Sons, 1886.)

A QUARTER of a century ago, the number of persons in this country who made any pretence to study the fungi might have been counted on the fingers, and almost on the fingers of one hand. At that time Berkeley's "Outlines of British Fungology" had just appeared, but with it came no visible evidence of an increased number of students. An unfortunate desire to limit the volume to a definite size and price acted injuriously upon its contents. Half the book was a mere list of names without descriptions, and in the other half the descriptions were reduced to short diagnoses, quite insufficient except for those who were somewhat expert in the study. The young student struggling to get some knowledge of these obscure plants had no alternative but to fall back on the supplementary volume of Hooker's "English Flora" for the information he needed, oftentimes with much disappointment. Hence it is not surprising that only a few had the courage to persevere in a study for which there was no adequate text-book. It was not until 1871 that Cooke's "Hand-book of British Fungi" supplied what was required, and imparted a stimulus to the pursuit of that section of British botany, which has gradually increased in force, until at the expiration of another fifteen years, the "Hand-book" is out of print, and out of date, with a greatly augmented body of students looking anxiously for a new edition, or an entirely new work.

At this crisis, and under these circumstances, the work now before us has made its appearance, opportunely, and it is to be hoped satisfactorily, to fill a vacant place. No apology is offered, and none is required, where there is no rivalry, and a manifest necessity has been created by the flux of time. If the new work fulfils all the conditions of such a "Hand-book" of mycology as the student would require, there is a good and valid case in its favour. It must be conceded that although his previous "Mycologia Scotica" was little more than a localised catalogue, there was every reason to believe that the Rev. John Stevenson would bring practical experience and literary ability to his task, and acquit himself well in the production of a more elaborate work. In the result his friends have no reason to be disappointed. He has laboured conscientiously, and although in some things we do not agree with him, has accomplished a useful task.

It is hinted in the preface, although not clearly stated, what is the character of the book, namely, that it is practically a translation of Fries's "Monographia" in so far as the British species are concerned. There is no doubt that this was the best course to adopt, because there can be no two opinions of the value of Fries's observations, and the book in which they are written is very rare, and beyond the reach of the ordinary student. Still it would have been better not to have left this point in suspense, since a long detailed description which can be attributed without reservation to Fries is of infinitely more value than the most careful compilation would be. Unfortunately, any one who opens the book to consult it for the first time will at once conclude that the descriptions are the original production of the author, whose name appears on the title-page. We do not for a moment imagine that there was any desire to appropriate wholesale and take credit for the product of another man's brains, but unfortunately that *is* done sometimes in scientific books, and an honest author should be above suspicion.

Of the type, paper, and general appearance of the work, including the woodcuts by Mr. Worthington Smith, we have nothing to say except in strong commendation. But we cannot help quoting one sentence from the preface, which at least is original—"The tendency in recent years has been to multiply species unnecessarily, and ultimately many so-called species must disappear. The pruning-knife must be unsparingly used; but this must be the work of a Congress of Cryptogamic Botanists, not of individual authors." This quotation is made without intention of dissenting from it, but as a prelude to a statement of the fact that in the present volume two sub-genera and about fifty species (good, bad, or indifferent) which have been recorded as British, some on the authority of the Rev. M. J. Berkeley, and many of them figured, are entirely excluded without comment or apology. Was this "the work of a Congress of Cryptogamic Botanists or of an individual author?"

Some writers, and compilers, of the present day exercise a questionable originality in the correction, or alteration, of the orthography of generic names which have been in use for, perhaps, half a century. No useful purpose is served, except the gratification of personal vanity, and the multiplication of synonymy. We note, on p. 304, an instance of this kind, where *Psalliota* is written *Psaliota*. Without inquiring which is most accurate, or most elegant, surely its uniform use by Fries, in the previous form, since 1821, should have been sufficient to protect it from the "pruning-knife," and given it some title to usage in perpetuity. To such manipulators of names we would commend the following sentence from De Candolle's Commentary on the Laws of Botanical Nomenclature:—"In these kinds of questions, it must be borne in mind that the fixity of names is of superior importance."

We observe also two or three instances in which the orthography of specific names has undergone a change, but as it is just possible that these may be referred to typographical errors, and not to any intentional mutilation, we will accord the author the benefit of the doubt.

Some apology is made in the preface for a departure in the present work from the ordinary method of giving first a short diagnosis of the species, and afterwards a detailed description. "I am aware," it says, "that the departure from this method will touch existing prejudice; but it seems desirable to avoid repetition, to the extent of one-third, or one-half, in the account of each species, and thereby to secure space for fuller description. Moreover the *diagnosis* is not lost. From the arrangement which is adopted in printing, the student, if he is a student at all, can at a glance pick it out for himself." We confess that we are not conscious ourselves of any prejudice which this arrangement touches inconveniently, since the diagnoses, by themselves, can be obtained in another form.

This first volume extends to the end of the genus *Bolbitius;* a second volume is proposed to complete the work, embracing all the British Hymenomycetes. Thus far we have descriptions of 822 species, corresponding to 485 which were included in the "Hand-book of British Fungi" in 1871, and 383 in Berkeley's "Outlines" in 1860, whilst all the European species included in Fries's "Hymenomycetes" up to the same point was 1271. Hence it would appear that two-thirds of the species enumerated by Fries as European have been found in the British Isles. This may not be absolutely accurate, since there are some included in the present volume which are not to be found in Fries, but the proportion is small and will not much affect the ratio. It is an interesting fact that the number of British species has been nearly doubled in fifteen years, which at least must be taken to indicate a larger number of observers and increased activity, for which there was doubtless some good and sufficient cause. Although coloured figures of upwards of 700 out of the 822 species have been published in this country since 1881, that would scarcely have been an appreciable factor in the result.

Criticisms of particular species would prove of little interest to any but practical mycologists, and therefore we forbear. In these times, when authority is held to have such slender claims, and independence of opinion is esteemed more highly than respect for the convictions of the old masters, it is a great consolation to encounter such an earnest and faithful disciple of the good old mycologist of Upsal as we meet with in the author of the book before us. Yet, notwithstanding this good trait, he has evidently a weak place in his human nature, without the tact to conceal it, and this is to be regretted, since rancour—like young chickens—comes home to roost.

M. C. C.

A MEDICAL INDEX-CATALOGUE

Index Catalogue of the Library of the Surgeon-General's Office, United States Army. Vol. VI. Heastie-Insfeldt. (Washington: Government Printing-Office, 1885.)

AMONGST the vast and rapidly-increasing mass of scientific literature it is a singular satisfaction to meet with a first-rate work such as this "Index Catalogue," which holds out good promise of being a clue to some parts at least of what is far too large for any single grasp. And if in any department of science it is more important than in another to trace generalisations to their foundations upon observations, and to have the facts before one, it is in medicine, which still contains so many dogmas whose foundations are not beyond attack, and so many observations in want of an adequate theory to explain them. In giving a clue to medical knowledge this "Index Catalogue" is in one respect at least, and in one very important respect, unique among its class; for under subject-headings such as, in this volume, hernia, hooping-cough, hydrophobia, hip-joint, hospitals, hygiene, insanity, &c., it gives a list not only of all the books and pamphlets in the library dealing with them, but also a list of the full titles of all the articles on them in all the periodical literature that it possesses, *Journals*, *Transactions*, *Reports*, *Reviews*, *Bulletins*, &c.; and when we reflect that the list of such periodicals taken in by the Surgeon-General's Office amounts now to at least 3005 (of which a very considerable proportion are weekly or monthly publications), such a careful classification of their separate articles would seem to be beyond all hope. However, the unexampled energy of Mr. J. S. Billings and his able assistants, which gives us every month the *Index Medicus*, has proved equal to this gigantic task, which it would have seemed to most men mere foolishness to attempt. The advantage to the student is immense; for in such periodical literature, by modern fashion, a great number of important facts in medicine lie buried, and there would hardly be a chance of finding them without some such help as is given us here. For though the literature of science is far less at present in bulk than the literature of some other subjects, most notably divinity, yet the literature of natural science, even in one of its many subdivisions, such as medicine, is paralysing in its profusion. To take as an instance the literature of a disease which, though just at present it is the fashion to talk much about it, is yet so rare that many doctors with considerable experience have never seen it, viz. hydrophobia, we find catalogued here not only 368 books dealing with it specially, but also the full titles of more than 1900 signed articles, not in the general but the medical press of the European languages, that have to do with it as well; and yet that is not a fifth part of what is catalogued under "Cholera" in Vol. III., and not a tenth of what is catalogued under "Fever" in Vol. V. The subdivision and arrangement of the masses of information so gathered together is admirable, and that, for subjects so difficult to deal with as hospitals and hygiene, which occur in this volume, is not a little to be proud of, and one that any student will appreciate. To the accuracy of every entry it would be absurd to pretend to testify on our own investigation, but frequent use of the five preceding volumes and some testing of this sixth volume leave us in little doubt that a very high standard was previously reached, and will be found to be maintained, and of course that is one of the points of cardinal importance in what is practically a dictionary of reference.

The Washington Library, or, as we should say more accurately, the "Library of the Surgeon-General's Office, United States Army," is one of the two or three largest collections of medical books in the world, and its growth has been astonishingly rapid. It was begun in 1830, and, after the first thirty years, in 1860, it contained only 350 volumes. To what size, at the end of the next thirty years, in 1890, we may see it grow we hardly venture to speculate; but in 1883 it stood at about 60,000 books and 66,000 pamphlets, and took in more than 2600 periodicals; and yet a careful critic last year estimated that for every hundred medical books that were in both the Washington Library and the British Museum there were also another hundred in each that were not in the other. If that be true, it would not astonish us to hear that for every hundred held in common there were fifty or more in the Bibliothèque Nationale at Paris, which were not to be found in either of them. The largest medical specialist library in England, that of the Medical and Chirurgical Society, cannot claim to be more than half the size of the Washington Library, or to contain many books that are not to be found elsewhere; and it does not grow with all the rapidity of the New World.

For some time probably all seekers after the most difficult and most complete medical knowlege will have to turn to this "Index Catalogue," and will trust that Mr. Billings may be able to go on year after year putting forth his modest quarto of 1000 pages, until six or seven years may see him at the end of his great work.

A. T. MYERS

OUR BOOK SHELF

Mémoires de la Société des Sciences Physiques et Naturelles de Bordeaux. 3e série, tome i. (Paris: Gauthier-Villars, 1885.)

WE have frequently had occasion to direct our readers' attention to the high-class memoirs which this energetic Society puts forth. The volume before us is one of a kind that we should like to see brought out by our own scientific Societies. Under the title "Niels-Henrik Abel, sa vie et son action scientifique," it contains a full and most valuable sketch, by Prof. C. A. Bjerknes, of Christiania, of the writings and life of one of the ablest and acutest mathematicians of modern times. That the account is a full one will be evident when we say that the work occupies 365 octavo pages: it is a translation in French from the original memoir, and is further enriched by a considerable appendix. The labour of seeing the present form of the work through the press has principally fallen upon M. Hoüel, to whom the author warmly expresses his thanks. Abel was born at Findö, Christiansand, on August 5, 1802, and died near Arendal on April 6, 1829, and was interred at Froland.

The main body of the work consists of fifteen chapters, and the appendix occupies thirteen chapters more. His works, originally edited by M. Holmboe, the professor under whom he studied, were published in 1839, and quite recently a new edition was referred to in these columns. We give two or three extracts which show the appreciation of his powers amongst his contemporaries, an appreciation which has rather increased than decreased since his death. Jacobi writes of a *deduction* Abel had drawn as being "elle est au-dessus de mes éloges, comme elle est au-dessus de mes travaux." Legendre says, "il me tarde beaucoup de voir les méthodes qui vous ont conduit à de si beaux résultats; je ne sais si je pourrais les comprendre, mais ce qu'il y a de sûr, c'est que je n'ai aucune idée des moyens que vous avez pu employer pour vaincre de pareilles difficultés. Quelle tête que celle d'un jeune Norvégien!" Gauss expresses similar views, and on hearing of Abel's death, wishes for particulars of the life "de cette tête eminemment distinguée." We could easily add other extracts from Prof. Bjerknes' admirable record of the distinguished Norwegian's life, which is a fitting companion to the before-cited edition of "the works," but forbear. Should any desire, with Gauss, to have his portrait, they will see here in the frontispiece the well-known, to some of us, lineaments.

Solid Geometry. By Percival Frost, D.Sc., F.R.S. Third Edition. (London: Macmillan and Co., 1886.)

IT would have been superfluous to recommend the third edition of Dr. Frost's "Solid Geometry," even if the third edition had been merely a reprint of the second. The book has now taken its position alongside the very best mathematical treatises in use, and requires "no bush." What we have got to do with, however, is no mere reprint: there is once again presented to us a notable increase of matter—much more than a cursory glance is likely to detect—and there has been considerable improvement generally. One change, greatly to the student's advantage, is the careful graduation of the problems at the end of each chapter, and the separation of them into groups. There is still a lack of references to original memoirs, and though, apparently, the author is conscious of it, he needs reminding that it is not sufficient merely to say that this or that is due to Cayley, Chasles, or any one else. Such incomplete statements serve only to give discoverers their dues; they do not assist the advanced and inquiring student.

We have pleasure in learning that an Appendix is about to be issued giving hints for the solution of the problems, but the pleasure is far more than counterbalanced by observing that the title-page bears no longer the words "Vol. I.," the inference being that Dr. Frost has followed the sad example of Thomson and Tait. There is no dearth of men willing and on the whole able enough to write mathematical text-books for beginners: those who could produce a volume to follow Frost's "Solid Geometry" are rare as white crows. When found —by press delegates—they should not only be made a note of, but coerced.

LETTERS TO THE EDITOR

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

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

Flora of South Africa

No one, who ever spent much of the impressionable period of his youth at the Cape, that land of lowly plants with exquisite flowers,—but will be vividly interested in the masterly description of those plants' geographical regions of habitat, as given by Mr. Bolus, per your reviewer, "J. D. H.," on pp. 77–79 of your last week's issue.

But what can either one, or other, of those gentlemen mean by saying of "the Natal region" that it is "bounded on the east and south-east by the Atlantic"!

By the Indian Ocean if you like; and then you have a ready means of conveyance for those "Indian types of plants, both in genera and species" which the above-quoted authors say do abound along that eastern coast of South Africa,—but which the Atlantic could never have brought to it.

There is, however, a further local difference in the qualities of the two oceans, of such overwhelming importance to all vegetation, that I wonder no mention appears of it in a Cape botanical essay.

The Natal coast, for instance, on the east, is washed by a warm current from the equator, giving out so much steamy moisture that not only, as your article truly states, are there "the herbage- and bush- and tree-foliage greener, and the leafage larger" than elsewhere; but there, in that region of luxuriously fed, densely growing plants, does game abound; there do Kaffir tribes congregate and establish their kraals; and thereto do Dutch Boers emigrate out of the old, dried-up, southern colony, and found new republics; while therein have we also, every few years, to wage successive wars either with them, or with Zulus or Amakosi tribes of various power, until British lives have been sacrificed by thousands, and British money expended by millions.

But the west coast of South Africa, bless it, being washed by a cold current of the Atlantic coming from Antarctic seas, and giving out little or no vapour, even under a nearly vertical sun, —can hardly but be, even just as it is, an arid desert, where only a few starving Boschjesmen wander miserably up and down, existing perhaps on an occasional antelope, or roasted ants and stray locusts; and no one fights there for permanent possession of the ground.

Now all this egregious contrast between human society, as well as the flora, on the one side, *versus* the other, of Southern Africa (excepting some details dependent on the soil and the prevailing direction of the wind) are due to the Indian Ocean imparting to the air on the east coast an invisible, yet most potent quality which the Atlantic does not confer on the western coast. Could there then be found a more expressive emblazon, suitable to the present day, for a coat of arms for one of the flourishing new Governments on the eastern side of South Africa, than a wet, and dry, bulb hygrometer pictured with both bulbs marking 85° F., and with the surf of the Indian Ocean beating in the distance? C. PIAZZI SMYTH

May 29

The Composition of the Edible Bird's-Nest

As I have been much interested in the controversy concerning the composition of the edible bird's-nest, and particularly in the bearing of Mr. Green's investigations, which are given at length in your last issue (p. 81), would you permit me to give the result of some observations I made on this subject in the Solomon Islands. It will be remembered that it was the association of these nests with a so-called "fungoid growth" in the caves of North Borneo that led Mr. Pryer to consider that he had found the source of the material of which the nests are made, a supposed discovery which led to the re-opening of the controversy (NATURE, vol. xxx. p. 271). This low plant-substance was determined by Mr. George Murray to be the result of the growth of a microscopic alga, a species, probably new, of *Glœocapsa* (*Proc. Zool. Soc.*, 1884, p. 532).

In the Solomon Islands I was only able to obtain the edible nest in one locality (Oima Atoll) since the bird usually frequents inaccessible sea-caves and cliffs. The nests were of inferior quality, and were for the most part composed of fibrous materials derived from the vegetable drift (the husks of pandanus seeds especially). The gelatinous substance thickly incrusted the interior of the nests, and attached them to the rock. The surface of a cliff in the vicinity of the cave frequented by the swifts was coated by a reddish gum-like growth, which proved on examination to be an aggregation of the cells of a protophytic alga about 1/2500 of an inch in size. Unfortunately my specimens of this growth have miscarried, but I feel assured that it is very similar to that observed by Mr. Pryer in the Borneo caves, samples of which, through the kindness of Mr. George Murray, I had the opportunity of seeing at the British Museum. A similar growth is commonly to be found coating the coral-limestone cliffs in this group. It may be seen in all stages, the older portions being dark-coloured and rather tough, and the fresher portions being, as Mr. Pryer aptly remarked, like half-melted gum tragacanth. There are but few cells in the fresh alga, the mass being apparently composed of cellular debris, immersed in a rather diffluent material, the whole somewhat resembling the third section given in Mr. Green's paper.

That the salivary glands are especially concerned in the production of the gelatinous nest-substance there can now be but little doubt, and the investigations of Mr. Green have established the nature of its composition; yet it is possible, and I make the suggestion with great diffidence, that a *vegetable mucin*, or a substance closely allied to this animal product, may be found in these low plant-growths. H. B. GUPPY

95, Albert Street, N.W., May 29

"Arithmetic for Schools"

IN NATURE of May 20 (p. 51) there appears a criticism of my "Arithmetic for Schools," in which your reviewer states:—"In the purely arithmetical part of the book logical accuracy is attempted with considerable success. Want of grasp is much more evident in the part which deals with the applications. Then the division into subjects is strangely illogical, and slight inaccuracies of thought and language occur. Is it really the case, for example, that rate of interest (p. 181) is totally independent of *time?*" These are very serious charges to make against a book of the kind, and ought not to be made without very good reason. As your reviewer suggests the inferences (1) that the book is divided into parts, one of which contains the "pure arithmetic," and the other the "applied," and (2) that it is stated that *rate of interest is totally independent of time*, and as neither of these inferences has any foundation in fact, it seems only fair to myself that your reviewer should be asked to quote *verbatim* the other slight inaccuracies on which he bases his general statement.

Gonville and Caius College, May 24 JOHN B. LOCK

SUNSPOTS AND PRICES OF INDIAN FOOD-GRAINS

IN the volume of the *Bombay Gazetteer* which deals with the province of Kathiawar, there is at page 217 a long list of prices of the principal food-grains at Bhavnagar. The list contains, along with other information, the price of Indian millet for nearly every year from 1783 to 1882. This series of figures is long enough to afford the means of testing whether there is any tendency, in India, for times of scarcity, and consequent dearness of food, to recur after more or less regular intervals of years.

Ever since the discovery by Schwabe of the periodicity of the sunspots, and the further discovery by Sabine of the same periodicity in the variations of the earth's magnetism, there has been a growing belief in the minds of scientific men that the varying condition of the sun exerts a far greater influence on terrestrial affairs than is usually thought at all probable, and various investigators have traced, with more or less definiteness, a periodicity of eleven years—coinciding with that of the sunspots—in the variations of the rainfall, in those of the temperature and pressure of the atmosphere, and in the frequency of storms, &c. The late Prof. Stanley Jevons went so far as to express the opinion that even trade depressions are the remote effects of corresponding variations in the condition of the sun.

I am not aware that any attempt has hitherto been made to trace out any direct connection between the variations of prices in India and solar phenomena. The apparent hopelessness of the task has probably acted as a sufficient deterrent, for although it may be reasonable to suppose that solar variations influence the rainfall and other purely physical phenomena, yet it is well known that there are many causes of variation of price which cannot, with any show of reason, be attributed directly to the sun. Such, for instance, are wars, the gradual increase of the population, variations in the quantity of money in use, changes in the total volume of trade, &c. These circumstances complicate the problem very much, but it does not necessarily follow that it is hopeless to attempt to trace the possible influence of solar periodicity on the prices; for there are statistical methods by which most of the disturbing influences can be approximately, if not entirely, eliminated. Indeed, when these methods of elimination have been applied, it may be found that the solar periodicity is more decidedly traceable in the prices than in the rainfall: for, in the one case, the produce of every field exercises its due share of influence in determining the price; while, in the other case, the quantity of rain actually measured is but an infinitesimal portion of the whole quantity which falls, and may therefore very imperfectly represent the total rainfall over the whole of a district.

In considering a price in relation to the causes of variation to which it is subject, it may be thought of as divided into portions, each portion being assigned to its own particular cause. What is wanted here is to separate as distinctly as possible that portion which may be due to the variation of the influence of the sun from all the rest. But before any satisfactory attempt can be made to distinguish that portion of the price variation which may be due to variation of solar influence from the portion due to the average amount of solar influence and to other causes, it is necessary to adopt some standard of comparison which may reasonably be supposed free from solar effects of a periodically variable nature. Now as the physical state of the sun is known to go through a complete cycle of changes in a period of almost exactly eleven years, the average price for any consecutive eleven years will be affected by the average amount of solar influence, and the difference between this average price and the actual price for the middle year of the eleven will be affected by the difference between the average condition of the sun and its actual condition in that middle year. This difference of price may also include the effects of other extraneous and non-periodic causes. Eleven years after the middle year just mentioned the sun will again be in its former condition, and a similar price difference for that year may be calculated. The same process may be carried on to the twenty-second, thirty-third, &c., years, and it will then produce a series of price differences equally affected by equal periodical solar influence. Non-periodic causes will, however, sometimes tend to unduly raise these price differences, sometimes to depress them, but on the average such disturbances will, in a long series of years, tend to balance each other, leaving the periodical portion of the solar influence outstanding. If, for instance, the years for which the calculations of the price differences have been made are those in which the sunspots are at a maximum, the average price difference will show how much prices tend to be raised or depressed by that condition of the sun which produces most spots. A similar series of calculations may be made for the years in which the spots are at a minimum, also for the intermediate years when the spots are increasing, and for those years when the spots are decreasing. A set of eleven average price differences, one for each year of the sunspot cycle of eleven years, will thus be obtained, and if, on arranging them in consecutive order, they show that prices are, on the average, decidedly high in those years when there are few sunspots, and decidedly low when the sunspots are numerous, or if they show any other decided and systematic variation in the sunspot period, the conclusion will be that the sunspot cycle does really affect the prices. If, on the other hand, the prices do not change in any systematic manner in the different years of the sunspot cycle, the conclusion will be against the hypothesis of a periodical variation of the prices corresponding to the periodical variation of the sunspots.

There is one point of view from which this method of taking differences is open to some objection. Suppose, merely for the sake of illustration, that the average price of millet throughout some particular sunspot period of eleven years is 50 pounds for a rupee, but that in the year of maximum sunspots the solar influence is such as to double the crop and lower the money price or raise the quantity price proportionately, that is, to 100 pounds for a rupee. The price difference for that year would be 50. If, however, by reason, say, of a more plentiful supply of money, the average price of millet for the whole of another sunspot period of eleven years is only 25 pounds for a rupee, and the crop in the year of maximum sunspots is, through solar influence, similarly doubled, the quantity price would only rise to 50 pounds, and the price difference would be only 25, although the solar influence, which is supposed to have produced the change, is the same as before. The difference between the two results would be due simply to the more plentiful supply of money, not at all to a difference of solar influence. This shows that it is needful to adopt some modification of the method, which will allow for gradual changes in the amount of money in use, and other similar causes of alteration of price. Such a modification will be made if, instead of taking price differences, the actual price of the middle year of the eleven is expressed as a percentage of the average price. Expressed in this way, the percentage for the year of maximum sunspots in each of the above examples would be 200, that is to say, in each case the number of pounds for a rupee would be 100 per cent. greater than the average number.

Table I. contains the Bhavnagar price list expressed in the percentage form in the manner just described. In the original table the prices are expressed in pounds for a rupee. If, therefore, the number for any year in Table I. is 125, it means that the number of pounds of grain for a rupee is 25 per cent. greater than the corresponding eleven-yearly average; and if the number is 75 it means that the number of pounds for a rupee is 25 per cent. less. In other words the excess above or the defect below 100 shows how much per cent. the number of pounds for a rupee is above or below the corresponding eleven-yearly average.

TABLE I.—*Percentages, Bhavnagar.*

Years.	1	2	3	4	5	6	7	8	9	10	11
1783 to 1793 . .	57	66	56	143	157	172	185	104	24	60	61
1794 to 1804 . .	66	69	140	163	145	131	108	82	78	75	63
1805 to 1815 . .	70	117	97	139	124	115	106	78	38	69	85
1816 to 1826 . .	118	159	162	103	68	81	78	111	71	51	74
1827 to 1837 . .	141	98	137	96	121	131	135	71	78	79	81
1838 to 1848 . .	91	58	100	92	81	141	164	93	86	107	66
1849 to 1859 . .	132	96	96	102	104	100	106	112	109	84	122
1860 to 1870 . .	103	100	103	86	52	62	87	105	104	92	84
1871 to 1881 . .	93	93	133	126	126	107	89	75	71	89	118
1882	100	.									
Means, including 1863 to 1866 .	97	95	114	117	109	116	118	92	73	78	84
Means, excluding 1863 to 1866 .	97	95	114	120	116	122	121	92	73	78	84
Smoothed means.	93	100	111	117	118	120	114	94	79	78	86

The numbers of Table I. are arranged in lines of eleven numbers each, so that the numbers occurring at equal intervals of eleven years, beginning with 1783, all fall in the first column, those occurring at equal intervals beginning with 1784, all fall in the second column, and so on. Now if there is any decided tendency for high or low prices to recur at more or less regular intervals of about eleven years, the great majority of the high prices should be found in a few contiguous columns in one part of the table, and the great majority of the low prices in a few contiguous columns in another part of the table. An examination of the numbers of Table I. shows that this is the case, for in columns 9, 10, and 11, no less than twenty-two out of the twenty-seven numbers are below 100, and only five of them are above 100; while in columns 3 to 7 the great majority of the numbers are above 100.

The average results are given at the foot of the table. They show that there is a decided tendency for years of high and low prices to recur, with some regularity, in a period of eleven years, five consecutive years being good years, when money prices are below the average; and the six following years being bad years, when money prices are above the average. The years which give the highest average money price, or the smallest number of pounds for a rupee, are those in column 9. The average number of pounds for a rupee in those years is 27 per cent. below the eleven-yearly average. The years which give the lowest average money prices are those in columns 4, 6, and 7. The average number of pounds for a rupee in those years is about 17 per cent. greater than the eleven-yearly average. There is thus an average difference of 44 per cent. between the years of low prices and those of high prices. This percentage difference would have been considerably greater if the prices had been reckoned in rupees for a fixed quantity of grain, instead of in pounds of grain for a rupee. To show that this is the case it is only necessary to convert the three prices 117, 100, and 73 regarded as pounds for a rupee, into their corresponding rupee prices, that is to say, into the number of rupees which would in each case be required to purchase 100 pounds. These are 0·85, 1·00, and 1·37 respectively, giving a difference between the highest and lowest of 0·52, or no less than 52 per cent. of the average price, which is 8 per cent. more than the corresponding difference in the pound prices. Although this illustration by no means exhausts the question of the difference between quantity prices and money prices, it suffices for the purpose of guarding against the erroneous supposition that results worked out in quantity prices are directly applicable to money prices.

Having now found such remarkable evidence of regularly recurring periodical variations of the price of the staple food-grain at Bhavnagar, amounting on the average to more than 50 per cent. of the average money price, it seems desirable to inquire whether similar variations of price have taken place from year to year in other districts. For this purpose I have selected from the various volumes of the *Bombay Gazetteer* all those price lists which extend over periods of fifty years or more. These are for the districts of Ahmedabad, Kaira, Surat, Khandesh, Poona, Bijapur, Dharwar, Belgaum, and Kanara, and to these I have added Madras, for which station a long price list is given in the Report of the Indian Famine Commission.

The best way of testing whether any considerable portion of the variations of price in these districts can be regarded as regularly recurrent in a period of eleven years, corresponding to that of the sunspots, is to calculate the average eleven-yearly variation by the method already applied to the Bhavnagar prices. These calculations have been made. The results are entered in Table II. The corresponding average sunspot variation is also given.

TABLE II.

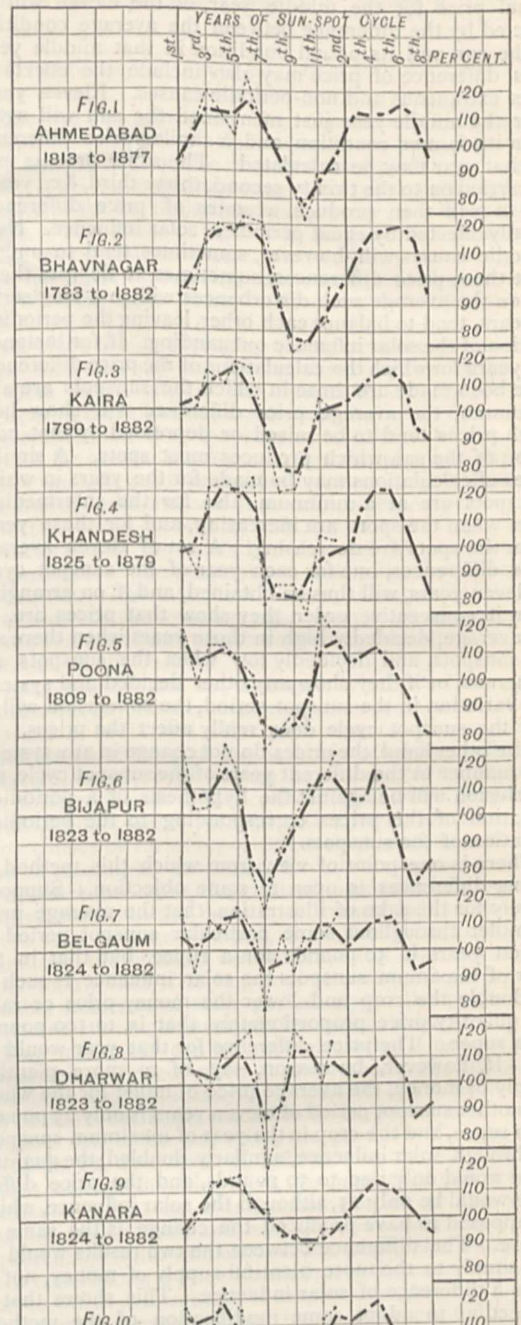
Districts.	Ahmedabad.	Bhavnagar.	Kaira.	Khandesh.	Poona.	Bijapur.	Belgaum.	Dharwar.	Kanara.	Madras.	Sunspots.
Years.	1813 to 1877	1783 to 1882	1790 to 1882	1825 to 1879	1809 to 1882	1823 to 1882	1824 to 1882	1823 to 1883	1824 to 1882	1811 to 1877	1810 to 1875
[1] 1 .	91	97	99	101	119	124	113	115	95	116	84·4
2 .	101	95	101	89	99	101	91	102	102	109	72·1
3 .	120	114	115	121	113	102	111	98	112	110	58·4
4 .	110	120	110	123	113	127	108	112	114	123	45·0
5 .	104	116	119	118	108	114	117	106	115	115	32·0
6 .	126	122	116	126	102	80	106	120	105	89	19·6
7 .	110	121	95	78	75	67	78	69	103	83	9·4
8 .	98	92	75	83	81	88	106	92	93	75	12·2
9 .	82	73	76	83	89	101	92	120	93	77	33·2
10 .	73	78	87	75	81	111	103	115	88	87	64·0
11 .	89	84	105	104	126	112	103	100	95	113	92·3

In calculating the average sunspot variation the sunspot numbers before 1811 have been excluded, partly because they are very much less reliable than the numbers for the later years, from lack of continuous observations, partly because the mean variation for the later years will be more directly comparable with the price variations, which, except in two cases, are deduced from the data of the years following 1810. In calculating the average eleven-yearly price variations the data for the years 1863 to 1866 have been excluded, because it is known that in those years prices were very much raised by the influence of the American war.

There is some irregularity in the eleven-yearly price variations (especially in those for Dharwar and Belgaum) which can hardly be attributed directly to the solar influence. The best way of removing this irregularity will be to take the means of each consecutive pair of the eleven

[1] The year 1871 is taken as the first year of the sunspot cycle of eleven

PRICES OF FOOD GRAINS IN INDIA
RECKONED IN POUNDS FOR A RUPEE.



average numbers which constitute the eleven-yearly price variation, and to repeat the process on the new means. This has been done, and the results are given in Table III.

TABLE III.

Districts.	Ahmedabad.	Bhavnagar.	Kaira.	Khandesh.	Poona.	Bijapur.	Belgaum.	Dharwar.	Kanara.	Madras.	Sunspots.
Years	1813 to 1877	1783 to 1882	1790 to 1882	1825 to 1879	1809 to 1882	1823 to 1882	1824 to 1882	1823 to 1883	1824 to 1882	1811 to 1877	1810 to 1875
1 .	93	93	101	99	116	115	105	108	97	113	83·2
2 .	103	100	104	100	107	107	101	104	103	111	71·7
3 .	113	111	110	113	109	108	105	102	110	113	58·5
4 .	111	117	113	121	112	117	111	107	114	118	45·1
5 .	111	118	116	121	108	109	112	111	112	110	32·1
6 .	116	120	111	112	97	85	102	104	107	94	20·1
7 .	111	114	95	91	83	75	92	87	101	82	12·6
8 .	97	94	80	82	81	86	95	93	95	77	16·7
9 .	84	79	78	81	85	100	98	112	92	79	35·6
10 .	79	78	89	84	94	109	100	112	91	91	63·3
11 .	85	86	99	96	113	115	105	107	93	107	83·2

These smoothed results are graphically represented by the dots connected with black lines in Figs. 1 to 10. To show the effect of the smoothing process the original unsmoothed numbers, viz. those of Table II., are graphically exhibited over the smoothed curves by the dots joined with faint dotted lines. It will be seen from these figures that the application of the smoothing process has got rid of almost all the irregularity. At the same time it has somewhat unduly reduced the range of the eleven-yearly variations. The amount of this reduction may be roughly estimated by applying the same smoothing process to the eleven average sunspot numbers given in the last column of Table II. This has been done in the last column of Table III. The results are curved in Fig. 11. The range of the original unsmoothed numbers is 82·9, that of the resulting smoothed numbers is 70·6; that is to say, the range of the smoothed numbers would have to be increased by 17 per cent. of itself to obtain the full range of the original numbers. From this it may be inferred that the range of each of the smoothed eleven-yearly price variations represented by Figs. 1 to 10 is too small, and should be increased by about 17 per cent. of itself to obtain the full range of the variation. On the other hand, the extreme range of the unsmoothed numbers will probably be somewhat too great in most cases, because the data do not extend over a sufficient number of years to eliminate completely the effects of casual fluctuations. The true mean range of the variation caused by solar influence will therefore probably lie somewhere between the range of the unsmoothed numbers and that of the smoothed numbers. The ranges of both the unsmoothed and the smoothed variations are shown below for each district. The range of each smoothed variation increased by 17 per cent. of itself is also given.

	Ahmedabad.	Bhavnagar.	Kaira.	Khandesh.	Poona.	Bijapur.	Belgaum.	Dharwar.	Kanara.	Madras.
Unsmoothed .	53	49	44	51	51	60	39	51	27	48
Smoothed . .	37	42	38	40	35	42	20	25	23	41
Smoothed, plus 17 per cent.	43	49	44	47	41	49	23	29	27	48

Now these results reveal the remarkable fact that, amid all the apparently irregular fluctuations of the yearly prices, there is in every one of the ten districts a periodical rise and fall of prices once every eleven years, corresponding to the regular variation which takes place in the number of the sunspots during the same period. They also show that in seven out of the ten districts the range of the eleven-yearly variation of prices lies between 40 and 50 per cent. of the average price, and that in the remaining three districts the range lies between 20 and 30 per cent. The ranges are greatest in those districts where scarcity and famine are most frequent, smallest in those which enjoy the greatest immunity in these respects. In Bijapur and the neighbouring districts of Belgaum and Dharwar the highest prices occur in the year of minimum sunspots; in Madras, Poona, and Khandesh a year or two later; in Kanara, Kaira, and Bhavnagar two or three years later; and in Ahmedabad three years later. The lowest prices occur in all the districts from three to five years after the year of maximum sunspots, that is to say, three years after at the southern stations; four or five years after at the northern. Bijapur and Poona are the first to show a very decided rise of prices, and this rise takes place in the year preceding the year of minimum sunspots. At all the other stations a very decided rise takes place a year or two later.

From what has been said it follows that the intervals of time between the year of minimum sunspots and the years of highest prices are less than the intervals between the year of maximum sunspots and the years of lowest prices. This shows that the eleven-yearly price variations do not exactly correspond to the eleven-yearly sunspot variation. The reason may be that on the occurrence of scarcity prices rise very rapidly, while on the return of a season of plenty they fall much more slowly, because the reserve stocks of grain consumed during a period of scarcity cannot be fully replaced until good crops for several successive years have been secured. If it were possible to obtain data showing the actual out-turn of the crops of each year, it would perhaps be found that the eleven-yearly variations calculated therefrom would correspond to the sunspot variation even more closely than the price variations correspond to it.

In estimating the significance of these eleven-yearly variations it must be remembered that quantity prices, not money prices, have been dealt with, and that the corresponding money prices would show a much greater percentage rise in dear times, and a less percentage fall in cheap times than are shown by the quantity prices. Indeed, to a person accustomed to thinking of money prices the quantity prices are apt to be very misleading if the difference is not constantly borne in mind, as may be seen from the consideration that if the quantity price, that is, the number of pounds for a rupee, becomes 50 per cent. less, that is dearer, than usual, the corresponding money price is 100 per cent. higher; while if the quantity price becomes 50 per cent. more, that is cheaper, the corresponding money price is only 33 per cent. lower. From a money point of view, therefore, a fall of 50 per cent. in the number of pounds for a rupee is much more serious than it seems to be, while a rise of 50 per cent. in that number is less advantageous than might at first sight be supposed. For financial purposes it would probably be best to convert the quantity prices at the beginning into their money equivalents, because it is impossible accurately to convert results (such as averages and the like) worked out in quantity prices into corresponding results, expressed in money prices.[1] Such conversions always give a too favourable appearance as regards cheap-

[1] For purely scientific purposes it would perhaps be best to work with the logarithms of the original prices, instead of with the prices themselves, regardless as to whether the prices are expressed in pounds for a rupee, or in rupees for a fixed quantity of grain. It would then be possible to pass directly from the results of one system to those of the other, without having to go through the labour of recalculation.

ness of food in times of plenty; and make the dearness of food in times of scarcity appear far less serious than it really is.

One of the most important practical results of this investigation probably is, that it affords a certain amount of power to predict the variations of prices in the coming sunspot cycle. Of course, until all those fluctuations which appear at present to be subject to no law have been explained and reduced to order, if ever that should be possible, exact prediction in any individual case is altogether out of the question, but as there is a regularly recurring eleven-yearly wave of prices running through the irregular fluctuations and following the sunspot wave in the manner defined by the curves, it is possible to form an estimate of the general level of prices in the different years of the coming sunspot cycle. There is thus some reason for believing that the present period of low prices following the last maximum of sunspots, which appears to have occurred about the end of 1882 or early in 1883, will not last very much longer, a brisk rise of prices being due in the Deccan and in Madras five years after the sunspot maximum, that is, in 1887 or 1888, and in more northern districts a year or two later.

This estimate will, of course, be subject to modification if it should be found that the sunspot curve is declining towards its minimum more or less rapidly than usual. The last period of sunspots appears to have been somewhat longer than the average, that is, about twelve years from the maximum of 1870 to that of 1882, instead of the normal length of almost exactly eleven years; and the coming minimum may possibly follow the last maximum more quickly than usual. Fortunately, the sunspot observations are not the only indicators of this cosmical periodicity, for, as I have shown in a paper communicated to the Royal Society in 1884, the magnetic observations recorded at the Colaba Observatory afford far smoother and more definite indications of this periodicity than the sunspot observations; and, what is even more important, the eleven-yearly magnetic variation precedes the sunspot variation by almost exactly six months, so that the magnetic indications are given half a year earlier than those of the sunspots. FREDERICK CHAMBERS

Bombay, April 1886

THE PHYSICAL APPEARANCE OF MARS IN 1886

A SERIES of observations of Mars were obtained here in March and April last with a 10-inch silver-on-glass reflector by With of Hereford. The powers employed were 252 and 475, but I found no advantage from the latter, which seemed too high for the purpose. As a rule a single lens magnifying 252 was amply sufficient, though there were several occasions when a power of about 350 would have been a decided acquisition.

The planet came to opposition on March 6, but during the first three weeks of March we had intense frosts, and it was not feasible to commence observations until towards the end of that month. The opposition magnitude of Mars was only 16″·6, so that as regards apparent diameter the planet was far from being favourably placed. At the opposition of 1877 the diameter was no less than 29″·5. But at the recent opposition the north hemisphere of the planet (which has not hitherto been so thoroughly examined as the south hemisphere, and does not exhibit so many striking features) was well presented for observation, the latitude of the centre of the disk being about 22° N. in March and April.

The markings seen were both numerous and diversified. There is evidently a mass of detail on the planet, which is, however, most difficult to trace out in reliable characters. Many faint lineaments reach the eye with sufficient distinctness to prove their existence, but they cannot be held steadily enough or with that perspicuity to allow of the delineation of their outlines, or to enable their relative positions to be correctly assigned. Only the more pronounced features can be drawn satisfactorily. The small diameter of Mars during the recent observations has in a great measure induced this uncertainty as to the physical aspect of the disk. Another cause is found in the rarity of really good telescopic images. Not only must the atmosphere be peculiarly favourable to sharp definition, but there must be an absence of wind. A complicated system of markings cannot be made out under the influence of annoying vibrations. Moreover, this planet, considered as a telescopic object, is far less satisfactory than either Jupiter or Saturn, and this circumstance, with the other drawbacks alluded to, have given rise to that uncertainty, and to many of the discordances, in regard to the visible markings observed on his surface.

My intention in the present paper is merely to describe general results, as a particular description would scarcely be intelligible without drawings. Between March 23 and April 30 the planet was examined on twenty-one evenings, and a considerable number of sketches were completed. During the period mentioned the weather afforded an unusual number of clear nights, and whenever the seeing was fairly good the visible features were carefully noted, the results being afterwards compared with each other and with former work in the same direction. My drawings correspond very closely amongst themselves, and there is a fair agreement in the main features with those depicted on the charts of Green, Schiaparelli, Knobel, and others. I have also compared them with the views given in Terby's work on Mars and with Boeddicker's drawings of 1881 and 1884 (with Lord Rosse's 3-foot reflector) published in the scientific *Transactions* of the Royal Dublin Society, and find in many instances a substantial confirmation. Some of the differences are larger than would have been considered probable, but experience has taught us that it is useless to expect uniformity in delineations of planetary details.

During the five weeks over which my observations extended I saw no conclusive evidences of physical changes in any of the markings. But the period was too limited, and the circumstances affecting the review altogether too unfavourable, to enable me to speak definitely on this point. The slight differences apparent amongst my drawings are merely such as were occasioned by changes in local atmospheric conditions. On a bad night faint markings, previously distinguished, would appear obliterated, and on thoroughly good nights I saw delicate appearances which were utterly beyond reach on less auspicious occasions. I am convinced that these changes in the character of the seeing, exercise great influence on the distinguishable features of a planet; more so, in fact, than observers usually concede. Inferences of real change are sometimes hastily adopted in consequence, but they can only be substantiated after the most searching examination and the most convincing proofs.

The exterior edges of many of the well-defined seas on Mars are very brilliant, and their boundaries very definite. These brilliant outlying borders remind one of the light areas often abutting on the dark spots of Jupiter, only in the case of Mars they are more extensive, more permanent, and altogether dissimilar in form. I may instance a particular case of this bright bordering in the immediate region east of the Kaiser Sea on Mars. On several occasions this was so striking as to vie with the bright patch about the north pole. This shimmering extends several degrees east of the dark outline of the sea, but is limited by a faint and irregularly-condensed marking extending northwards, with an inclination east, from the knot in longitude 290° just east of the north extremity of the Kaiser Sea as figured in Mr. Green's chart. This marking runs over a considerable tract, and its east extension underlies Davies' forked bay and Burton Bay, to both of which it is connected by faint ligaments of shade, reminding one of the "canals" of Schiaparelli. This special marking, which is not included in Mr. Green's map, may be identical with the network of dark narrow streaks figured in this region by Schiaparelli in his chart for January and February, 1882. It is also more or less definitely shown in some other drawings, notably on one by Schmidt, which forms No. 17 in Dr. Terby's Areography.

As to the Kaiser Sea, it appears very faint and narrow, if not really broken, in the region some 10° or 15° south of its north extremity. This peculiarity is well drawn in Herr Boeddicker's drawings of December 27, November 19, and December 26, 1881 (Nos. 11, 13, and 14) in the scientific *Transactions* of the Royal Dublin Society for December, 1882. Consulting other drawings I cannot find that this feature is sufficiently indicated. It is obvious, however, that it would only be well detected when placed near the apparent centre of the disk as during the recent opposition.

Mr. Knobel's drawings in 1873 (*Monthly Notices*, vol. xxxiii., facing p. 476) agree generally with mine far closer than those he has published in the *Memoirs*, vol. xlviii. part ii., 1884. I always see Knobel Sea on Green's chart separated on its south side from the fainter curving band running east, as in the sketches Nos. 6, 7, 8, and 9, 1873. This break is not depicted in the subsequent drawings of 1884, so that the appearance has either been subject to actual variation of aspect or the difference of inclination has originated the want of uniformity. Probably the latter is the real cause, for the inclination of Mars in April and May, 1873, was nearly identical with that of March and April, 1886, and it is for these periods the drawings are so nearly alike in their more conspicuous forms. I see the northern boundary of Knobel Sea distinctly separate from the dark longitudinal strip immediately contiguous to the north polar cap. The drawing No. 12, May 19, 1873, by Mr. Knobel, portrays the leading features of this region much as I have more recently observed them. In 1884, Mr. Knobel delineated the whole mass of shading outlying the north pole as blended uninterruptedly, but these differences are unquestionably due to the changes of inclination, which must necessarily introduce such discordances into the apparent forms of the markings as observed at different epochs.

As to the canal-shaped features of Schiaparelli, first seen in 1877 and 1878, and subsequently confirmed, I have distinguished a large number of appearances highly suggestive of such a configuration, but the Italian drawings made during the three months from October, 1881, to February, 1882, give them a definite character, and (apart from their duplication) a straightness of direction and general uniformity of tone which my observations do not confirm. The more delicate and complex markings on the planet appear to my eye, under the best circumstances, as extremely faint, linear shadings with evident gradations in tone and irregularities occasioning breaks and condensations here and there. If they existed under the same aspect and with the same boldness as delineated by Schiaparelli, they would have been readily detected here whenever the seeing was fairly good, for these objects are referred to as readily observed in the 8-inch refractor of the Milan Observatory in February, 1882, when the planet's diameter was only 13″. The duplication of these lines was also traceable under the same unfavourable conditions. The wonder is, not that the eminent Italian astronomer has discovered such a marvellous extent of curious detail on this planet, because this detail unquestionably exists, though scarcely in the form and character under which it is represented, but that he should have observed its more complex and difficult configuration at the very period when Mars was so very unfavourably situated for observations of this critical nature.

The surface markings of this planet are so numerous and varied that they are far from being adequately represented on existing charts. In certain regions the disk is so variegated as to give a mottled appearance. Dark lines, and spots, and bright spaces are so thickly interspersed, and so difficult to observe with sufficient steadiness to estimate their positions and forms, that I found it impossible to make thoroughly satisfactory drawings. An observer has to be content with endeavours to depict the more prominent marks only, and even in connection with these there is always some element of uncertainty. The rotation-period of the planet is, however, so slow, the hourly rate being only 14°·6 in comparison with 36°·7 in the case of Jupiter, that plenty of time is afforded for drawing the leading markings before they show a displacement obvious to the eye. In addition to this a drawing of Mars may be made to rest on several successive evenings of observation if the observer comes 37·4 min. later to the telescope on each occasion. In regard to Jupiter the difficulty of suitably drawing the details is far greater, though they admit of more ready observation. The rapid rotation of this planet displaces objects in a few minutes, and makes it imperative that the work both of observing and charting should be very hastily performed; and it is not feasible in this case to base a sketch on observations of following nights, because the markings are influenced by different velocities, and suffer large relative displacements even at short intervals of time.

During the past few months the north polar cap of Mars has been very bright, sometimes offering a startling contrast to those regions of the surface more feebly reflective. Some of the other parts were also notably brilliant. These luminous regions of Mars require at least as much careful investigation as the darker parts, for it is probably in connection with them that physical changes (if at present operating on the planet's surface) may be definitely observed. In many previous drawings and descriptions of Mars sufficient weight has not been accorded to these white spots.

Many of our leading treatises on astronomy attribute a dense atmosphere to Mars, but nothing has been observed during my recent observations to corroborate this theory. It seems to me far more plausible to assume that the atmosphere of this planet is extremely attenuated. The chief spots are invariably visible, and the phenomena occasionally observed are rather to be imputed to the vagaries of our own atmosphere than to that of Mars. Jupiter and Saturn are doubtless enveloped in dense vapours shrouding their real surfaces from terrestrial eyes. Their markings are atmospheric, though in some cases very durable, and constantly undergoing changes of aspect and displacements of position by longitudinal currents. On Mars a totally different nature of things prevails. Here the appearances descried are absolute surface markings displaying none of the variations which are so conspicuously displayed in the markings on Jupiter. It is probable that many, if not all, the changes supposed to have occurred in the features of Mars are simply attributable to the constantly varying conditions under which the planet has necessarily to be observed. Were the circumstances of observation more equable there would be much greater unanimity amongst observers of this interesting object. It seems to me that the very pronounced character of the markings and their great permanency are quite opposed to the idea that the planet is surrounded by a dense cloud-laden atmosphere.

W. F. DENNING

M. CORNU ON THE HYDROGEN FUNCTION OF CERTAIN METALS[1]

WHEN we examine on different photographs those groups of lines which reappear periodically with a particular regularity, we find that these groups belong

[1] Translation from an article in the *Journal de Physique*.

precisely to the category of those which reverse themselves; for some are reversed and the others are on the point of being so. For the same metals, the reversals are more or less complete according to the conditions of the experiment, and for different metals according to their chemical and physical properties.

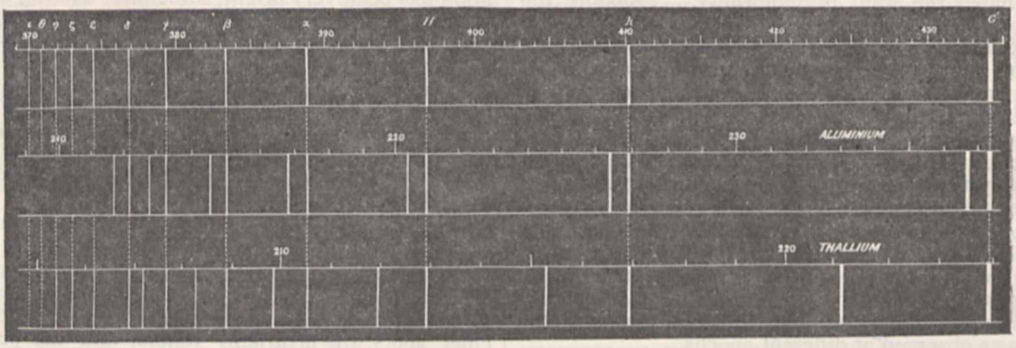
The law of distribution of these groups presents another common character relatively to the succession of distances and intensities: the lines get nearer together towards the more refrangible end, and diminish in intensity. This character is much the more striking when the number of reversed lines is considerable, because the field on which they appear is more uniform. It seems that with the elevation of temperature the spectrum tends towards a limit, that of a continuous brilliant background despoiled of all lines except the regular series of the self reversing ones. It is to this constitution that I wish to draw the attention of observers.

The number of metallic spectra capable of giving a regular series of spontaneously reversed lines on a continuous background is considerable; but the most beautiful series that I have observed were supplied by two metals which one could scarcely have anticipated, from a chemical point of view, to find side by side; these are aluminium and thallium, whose equivalents are at the extremity of the list of those of the simple bodies. The diagram gives an idea of the distribution of these reversed lines; one sees that they form in each spectrum a series of doublets fulfilling the conditions of distance and intensity given above.

I shall not stop to indicate the fruitless trials of numerical calculations that I have taken in hand in order to represent each of these series by the substitution of the series of entire numbers in a simple function; I may add that I had given up these researches until the discovery of Dr. Huggins on the spectra of white stars brought back my attention to this subject.

These spectra present, in fact, a common series of dark lines, that is to say, reversed, fulfilling precisely the conditions of distance and intensity which characterise in metallic spectra the spontaneously reversed lines: they prolong the series of well-known lines of the spectrum of hydrogen, C, F, G, *h*. One could then foresee that the whole series belonged to them; that is what has since been confirmed by Vogel, though this result is still not quite certain. The interest of this identification was such that I sought to prove it myself, which I could not realise till lately. The experiment is not without difficulty; but in taking more minute precautions to get rid of all impurity in the hydrogen, I have seen the impurity lines obliterated, and finally I succeeded in obtaining photographs showing the series of star-lines in all their purity.

The spectrum of hydrogen is placed on the first line in the above diagram: the comparison has been rendered easier by the choice of scales showing intuitively the identity of the law of distribution of lines in the three spectra.



DESCRIPTION OF THE DIAGRAM.—The graduations define the lines according to their wave-lengths. The first line represents the dark lines of the violet and ultra-violet spectra of the white stars. The second represents a double series of inverted lines in the ultra-violet spectrum of aluminium (electric arc). The scale of the drawing has been chosen in a manner to make G and δ coincide with the homologous lines of the first series (first line of each doublet). One could have operated in the same way with the second series (second lines). This mode of representation advantageously replaces the numerical tables, showing the verification of the two empiric formulas—

First series ... ... $\lambda_1 = 47{\cdot}30 + 0{\cdot}43783\,h$

Second series ... ... $\lambda_2 = 47{\cdot}18 + 0{\cdot}43678\,h$

which give the length of the wave of each line in function of the wave-length *h* of the corresponding line of hydrogen; the difference between the calculation and the observation is of the order of the experimental errors. The third line represents a double series of inverted lines in the ultra-violet spectrum of thallium (electric arc). The scale of the drawing was chosen like the one above; the empiric formulas which represent these two series are:—

$$\lambda_1 = 94{\cdot}61 + 0{\cdot}29776\,h$$
$$\lambda_2 = 111{\cdot}31 + 0{\cdot}75294\,h.$$

We might compare in the same way the more complex groups, like magnesium, zinc, sodium, &c.; the only difficulty is to establish the agreement of the groups; we do this immediately by a quite simple graphic construction. We arrive at the following statement, which resumes the whole of my researches. In the metallic spectra certain series of lines, spontaneously reversed, present sensibly the same law of distribution and intensity as that of the hydrogen lines.

It is not necessary to dwell on the importance of this relation: it makes evident the existence of a law which is general relatively to the emissive powers of incandescent vapours, and, again, it shows that this law of succession of spectral lines, common to so many series, seems to be expressed by the help of the same function, which one might call the hydrogenic function, which should play the principal part in these studies: the result then appears to constitute a first step towards the solution of the great problems which the spectroscope brings on for solution.

R.

VEGETATION OF SOUTH GEORGIA

ON Tuesday, January 17, 1775, Capt. Cook landed on this remote island, which is situated about 1000 miles east of Cape Horn, in about 54° S. lat. and 37° W. long., and took possession of it in the name of King George the Third, after whom he named it. Capt. Cook landed in three different places, and the ceremony of adding the island to the British dominions, he informs us, was performed under a waving of colours and a discharge of small arms. Whether any British subject has ever set foot on it since that day I know not; but the description of the island by its famous discoverer was not likely to tempt any one to go out of his way with that object in view. Although lying only as far south of the equator as York is north of it, South Georgia is covered, in the higher parts at least, with permanent snows and glaciers, and is altogether of a most wild and desolate aspect. Large masses of ice were continually breaking off from the perpendicular cliffs and falling into the sea with a noise like cannon. "The inner parts of the country," says Cook, "were not less savage and horrible. The wild rocks raised their lofty summits till they were lost in the clouds, and the valleys lay covered with everlasting snow. Not a tree was to be seen, nor a shrub even big enough to make a toothpick. The only vegetation we met with was a coarse strong-bladed grass growing in tufts, wild burnet, and a plant like moss, which sprung from the rocks."

Animal life, however, was more abundant. Seals were plentiful, and the penguins the largest ever seen by Cook; some which were taken on board weighed from twenty-nine to thirty-eight pounds. Eight kinds of "oceanic birds" are enumerated, and one, a yellow bird, was found to be delicious food. All the land birds observed were "a few small larks." From Cook's narrative it appears that Forster, the botanist, was one of the landing party, hence it might have been expected that few flowering plants would have escaped observation, especially as the visit was made in January, the midsummer of the southern hemisphere. Forster himself states ("Observations made during a Voyage round the World," p. 16) that South Georgia is an isle of about eighty leagues in extent, consisting of high hills, none of which were free from snow in the middle of January, except a few rocks near the sea. And he adds that there was no soil except in a few crevices of the rocks.

No further information respecting this island has been published, so far as I am aware, until since the return of a recent German Expedition, which made the island one of its stations for meteorological and other observations. When collecting the materials to illustrate the flora of the very much broken coldest southern zone of vegetation for the "Botany of the *Challenger* Expedition," I had to be content with Cook and Forster's very meagre accounts of South Georgia; but from the published northern limits of drift ice in different longitudes in the southern hemisphere, it was not expected that South Georgia possessed much more than the scanty flora they attributed to it, though Macquarie Island, in the same latitude, and nearly in the longitude of New Zealand, was known to support a comparatively luxuriant vegetation. Dreary and barren as it is, however, South Georgia is not so bad as it has been painted. The officers of the German Expedition spent nearly a year on the island, and appear to have explored it thoroughly, botanically and otherwise. During this period the atmospheric pressure was subject to extraordinary fluctuations, the extremes exhibiting a difference of 64 millimetres, or a fraction over $2\frac{1}{2}$ inches, while the range of temperature during the same period was only 48°·6 Fahr., or in round numbers, from 8° to 57° Fahr.; thus showing the freezing-point to be nearly midway in the range. The actual mean temperature of the year was 35°·06 Fahr.; of June, the coldest month, 25°·6 Fahr.; and of February, the warmest month, 41°·6 Fahr.

With regard to the flowering plants collected in the island by Dr. Will, one of the officers of the Expedition, we are indebted to Dr. Engler for an enumeration of them in his *Jahrbücher*, vol. vii. p. 281. They are thirteen in number, and their general distribution is so extremely interesting that I may be pardoned for giving it in detail:—

(1) *Ranunculus biternatus*, Sm. (Ranunculaceæ).—Fuegia, Falklands, Tristan d'Acunha (?) Marion, and Kerguelen Islands.

(2) *Colobanthus subulatus*, d'Urville (Caryophyllaceæ).—Fuegia, Campbell's Island, New Zealand, and Alps of Victoria, Australia.

(3) *Colobanthus crassifolius*, d'Urville (Caryophyllaceæ).—Fuegia and Falklands.

(4) *Montia fontana*, L. (Portulaceæ).—Fuegia, Marion, Kerguelen, Campbell's Island, and widely diffused.

(5) *Acæna adscendens*, Vahl. (Rosaceæ).—Fuegia, Marion, Crozets, Kerguelen, Macquarie Islands, and New Zealand.

(6) *Acæna lævigata*, Ait. (Rosaceæ).—Fuegia.

(7) *Callitriche verna*, L. var. (Halorageæ).—Fuegia, Marion, Kerguelen, Heard Islands, New Zealand, and widely diffused.

(8) *Juncus novæ-zealandiæ*, Hook. f. (Juncaceæ).—New Zealand.

(9) *Rostkovia magellanica*, Hook. f. (Juncaceæ).—Andes, Fuegia, Falklands, and Campbell's Islands.

(10) *Aira antarctica*, Hook. f. (Gramineæ).—Fuegia, Falklands, South Shetlands, and Kerguelen Island.

(11) *Phleum alpinum*, L. (Gramineæ).—Magellan's Straits, and widely dispersed in the cold regions of the northern hemisphere.

(12) *Festuca erecta*, D'Urville (Gramineæ).—Fuegia, Falklands, and Kerguelen.

(13) *Poa flabellata*, Hook. f., syn. *Dactylis cæspitosa*, Forst. (Gramineæ).—Fuegia and Falklands.

From the collector's remarks, appended by Engler to each species, it appears that some of the foregoing plants flourish luxuriantly in South Georgia, especially the species of *Acæna* (the burnet of Cook's narrative), and *Aira antarctica* and *Poa flabellata*. The *Ranunculus* was abundant by the side of a stream and elsewhere, and *Colobanthus subulatus* (doubtless the moss-like plant mentioned by Cook) formed large tufts on the south side of the hills. Nine out of the thirteen plants in South Georgia are also found in the eastern part of this southernmost zone of vegetation from Kerguelen to New Zealand, taking these islands together. One, *Juncus novæ-zealandiæ*, had not previously been found in what may be termed the American part of the zone; but, as Prof. Buchanan, to whom Dr. Engler submitted the South Georgian specimens, remarks, this is so nearly allied to the South American *Juncus stipulatus* that it may be cited as another instance of representative and closely-allied species in the American and Australian regions.

Thus are we gradually obtaining a knowledge of the vegetation of the detached fragments of the Antarctic flora; yet several islands are still quite unknown botanically or only very imperfectly. Concerning Diego Alvarez, or Gough Island, situated about 4° south of the Tristan d'Acunha group, we know nothing except that the vegetation is said to be similar to that of Tristan d'Acunha, and to include *Phylica nitida*, the only arboreous member of the latter flora. Then there is a group of islands, including Lindsay, Bouvet, and Thomson, in about the same latitude as South Georgia, but 35° eastward, of which nothing is known botanically.

W. BOTTING HEMSLEY

NOTES

THE Visitation of Greenwich Observatory takes place on Saturday next.

THE Ladies' *Soirée* at the Royal Society takes place on the evening of Wednesday, the 9th inst.

THE honour of C.M.G. has been conferred on Mr. Charles Meldrum, Director of the Royal Alfred Observatory, Mauritius.

THE explosion of the 43-ton gun has led to the appointment of a Committee of Inquiry, in which the name of Mr. Anderson is conspicuous by its absence, although surely no greater authority on the points at issue exists. A year ago, in his important lectures at the Society of Arts, he drew attention to the want of relation between the sections and pressures, and predicted disasters.

Sir Bernhard Samuelson, M.P., and Mr. Philip Magnus, of the City Guilds of London Institute, have been appointed by the Education Department English representatives at the International Congress on Technical Education, to be held at Bordeaux in September next.

Prof. Flower, the Director of the Natural History Department of the British Museum, has allowed the zoological collections made by Brigade-Surgeon J. E. T. Aitchison, C.I.E., the naturalist lately attached to the Afghan Delimitation Commission, to be placed on view temporarily at the South Kensington Department. To those interested in the zoology of those regions and in the geographical range of species, a view of these collections in their entirety will be found most interesting. We believe that at an early date this collection will be broken up to be sent to India, and distributed to various museums and countries, and that it is only localised here until such time as a report on its details is furnished to the Government of India.

Mr. Nicholson has been appointed Curator of Kew Gardens, in the room of Mr. Smith, resigned. Mr. Nicholson has been one of the chief assistants at the Gardens for some years.

A series of Conferences on the "Mineral Resources of the Colonies and India" will be held by the Geologists' Association in the Colonial and Indian Exhibition on Saturday afternoons, commencing at 3 p.m. After the reading of the paper there will be a discussion, terminating at 4.30. The Conference will then adjourn to the Courts, where further explanations of the exhibits will be given. The first meeting will be on Saturday next, when an address will be given on the Mineral Resources of India and Burmah, by Prof. V. Ball, F.R.S.; Sir Richard Temple will preside. The arrangements for succeeding Saturdays are as follow:—June 19, South Africa, by Prof. T. R. Jones, F.R.S.; Sir Ch. Mills in the chair. July 3, Canada, by Dr. A. R. Selwyn; the Marquis of Lorne in the chair. July 17, New Zealand, by Dr. J. Von Haast. July 24, Australia, by Mr. F. W. Rudler. There will probably also be a lecture by the President of the Geologists' Association (Mr. W. Topley), on the Coaling Stations in Relation to the Fuel Deposits of the Empire; but the date of this is not yet fixed. Conferences of the Anthropological Institute on the Races of the British Empire will also be held in the Conference Hall of the Colonial and Indian Exhibition. The first was on Tuesday on the Races of Africa. The others are:—Monday, June 7: Races of America (West Indies). Tuesday, June 22: Races of Australia. Tuesday, June 29: Races of New Zealand, Fiji. Tuesday, July 6: Races (Aboriginal) of India. Tuesday, July 13: Races of Ceylon, Straits Settlements, Borneo. The chair will be taken at 4 p.m. The memoirs read and discussed in the Conference Hall will be illustrated by selections from the exhibits. Afterwards, but not later than 5 o'clock, the Conference will adjourn to the Courts, and there inspect and hear explanations of the remaining exhibits connected with the subject of the day.

The Lick Trustees have decided to purchase from Messrs. Feil and Mantois a 36-inch crown disk, which was made by them at the same time with the crown disk of the objective now in the hands of the Clarks. The Clarks "have received the order to figure this disk as a third (photographic) lens for the large objective."

A curious phenomenon, the *Scotsman* reports, was witnessed at Stonehaven on Sunday afternoon, May 23. At intervals, just before and after high tide, without any apparent cause, the water along the coast rose and fell from 10 to 18 inches at a time, the subsidence leaving as much as 15 to 18 feet of the beach dry. The disturbance continued for three hours, commencing at about half-past 4 o'clock. There was no wind, and the sea was quite smooth, but the water advanced and retired with a speed equal to the run of a large river during a spate, and caused so much commotion in the harbour that the fishermen had to secure their boats with extra moorings to prevent damage being done. Indeed, it is seldom that there is so much commotion in the harbour, even during stormy weather. It is surmised that the phenomenon was due to some eruption or subsidence in the sea bottom.

The Executive Committee of Aberdare Hall, Cardiff, has issued a most satisfactory report of the progress of Aberdare Hall during its first term. Seven students were entered when this Hall for lady students was opened in October 1885. Two of these are studying for the Intermediate Science Examination (London University), one for the Intermediate in Arts, and four for the Matriculation Examination. Two scholarships tenable at Aberdare Hall were awarded. At the beginning of the next session several large scholarships and many exhibitions will be offered for competition at University College, Cardiff, and three exhibitions tenable at Aberdare Hall. The institution deserves every encouragement.

The New York Assembly has passed the Bill providing for the appropriation of 20,000 dollars annually to the Metropolitan Museum of Art and the American Museum of Natural History, in order that they may be kept open to the public, free of charge, on Sundays. It is expected that it will soon be favourably reported by the Senate Committee, and become law.

Up to Saturday morning the accounts from Catania were reassuring; the flow of lava was much slower and was rapidly cooling, and Nicolosi was considered almost safe. But at 4 p.m. a fresh outpour of lava manifested itself, and flowing over the earlier stream which had partially hardened, it again menaces Nicolosi and Belpasso. At 9.15 p.m., the lava stream which threatens Nicolosi showed a front 180 metres wide, from 6 to 10 metres high, and was moving at the rate of 10 metres per hour. According to latest reports the eruption is as active as ever.

On April 28 a lovely mirage was seen at about noon at Östersund, in Northern Sweden. In the south-west, above the Storsjö, a great lake, the lofty Oviks Mountains, covered with snow, were seen reflected on the sunlit clouds. Below them was a dark broad belt of forest sloping down to an ice-covered lake, in which some woody islands could be seen. At the beginning the western sky was clear, but gradually a dark bank of clouds rolled up, at last obscuring the mirage, but it reappeared several times when the sun broke through.

Mr. Penhallow, who has resided for some years in the service of the Japanese Government in Yezo, contributes to the last number of the *Canadian Record of Science* an article on the physical characteristics of the Ainos. Referring to the many contradictory reports as to the great hairiness of the Yezoines, his conclusion is that, although there are many exceptions, they generally possess a more than ordinarily hairy body, enough so at least to make them deserve the epithet of "hairy Kuriles." The bushy appearance of the hair and beard is doubtless due as much to the fact that the men never shave and seem rarely even to clip their beards, as to any natural excess of growth. The Aino of Saghalien offers a striking departure from the rule of hairiness which essentially characterises the Yezoine; and this would appear therefore not to be a race characteristic, but to be due to the peculiar and widely different conditions of life, dress, and exposure to which these people have been subjected. From a considerable number of measurements, Mr. Penhallow summarises the physical characteristics of the Ainos as follows:—The forehead is usually high, though narrow; eyebrows heavy and overhanging; nose somewhat inclined to flatness, though but little more so than in Europeans; mouth wide, but well formed; chin well formed and medium size; eyes straight, brown, and dull; cheek-bones inclined to be prominent; facial angle high, the mean of the measurements giving an angle of 72°; the body is compact, well built, and muscular; much more than ordinarily hairy, skin of light colour, comparable to that of Europeans, and the average height is about 5 feet 2 inches.

THAT frogs have a formidable enemy in the common mouse is evidenced by the following incident. A correspondent, Mr. W. August Carter, of South Norwood, states that he observed, a short time since, several mice pursuing some frogs in a shed which was overrun with these reptiles. The alacrity of the latter, however, rendered the attacks of the mice futile for a considerable period. Again and again the frogs escaped from the clutches of their foes, but only to be recaptured, severely shaken, and bitten. The energy put forth by these reptiles was so great that they actually swayed their captors to and fro in their efforts to wrest themselves from their grasp. At length the wounds inflicted upon them rendered the frogs incapable of further resistance, and they were easily overpowered by the mice, which devoured a certain part of them.

IN a lecture recently delivered before the Scientific Society of Bamberg, Dr. Hartwig, the Director of the new Astronomical Observatory there sketched out the future work of that institution. It was well, he said, that an observatory should devote itself to some specialty, with which its name would be associated, as that of Paris was with the determination and mapping of the fixed stars, Greenwich with the movements of the moon, Vienna with comets, and so on. In a similar way Bamberg would occupy a certain limited field, and labour therein. In the first place it would undertake the systematic investigation of the parallaxes of the fixed stars, a work which had already been partially performed at the Cape Observatory for the southern, and at Newhaven in the United States for the northern hemisphere. Bamberg will be provided with a new 7-inch heliometer, the largest of its kind at present in the world, although the Cape Observatory will shortly be provided with one of the same size. The present Cape heliometer is a 4-inch, and that at Newhaven a 6-inch one. Dr. Hartwig said that this 7-inch heliometer is at present the finest instrument known to astronomy. He pointed out that at present the parallaxes of only eight or ten fixed stars were calculated, while about three thousand remain to be done, and this, he said, would take a single qualified observer more than thirty years to accomplish. He hoped that as Leipzig and Göttingen were about to be provided with heliometers, they would participate in the work, so that in a comparatively short time we may obtain a more accurate notion of the distance of many fixed stars and of their grouping in space. Another work which Bamberg would undertake is the investigation of the physical libration of the moon—a problem that has been studied at Königsberg since 1845, and in Strasburg since 1870. After describing at some length the instruments with which the new Observatory is provided, Dr. Hartwig concluded by assuring his hearers that with these an observatory would be established which would take a high place amongst existing astronomical institutions, and which would be excelled in Germany by the Observatories of Strasburg and Potsdam alone. The Bamberg Observatory, it should be stated, owes its existence to the munificence of a private individual, the late Dr. Remeis, a member of the Scientific Society of Bamberg.

THE *Darling Downs Gazette* of March 20 describes some recently discovered caves fifteen miles from Rockhampton, Queensland. A party, headed by Mr. W. M'Ilwraith, of the Rockhampton Natural History Society, recently visited the caves. From some wells on the route they saw the peaks of an uncommon range of hills. "They stand up in a fine sharp profile like the pinnacles and turrets of a stately Gothic pile. The vestibule of the wonderful structure is formed by an immense chasm in the rocks. Two walls of limestone or marble rock set in an acute angle rise on either side to a height of about 60 feet, and converge in front at a higher elevation. At 9 o'clock at night the party began exploring, and after clambering over a mass of detached, sharp-edged, pock-pitted rocks, got into a rocky chamber. Its walls were beautifully white in parts, and show the rock to be of limestone formation. They visited in succession caves of different dimensions, and named one the 'Chinese Joss-house.' It is a little recess off the passage; the walls are beautifully white, and stalactites and stalagmites unite to form beautiful pillars, the whole being wonderfully beautiful, reminding the visitors of Chinese ivory carved work. In the morning they continued their exploration, wandering through numerous passages, and crawling and slipping till they came to a large cavern. In one of the passages the bats extinguished their candles, and they returned to the upper regions. They then saw daylight streaming from the opposite side of the mountain, and estimated the distance from light to light at five chains or more. They returned to the starting-point, climbed a ladder, and traversed other passages, and crossed a gulf on a bridge formed of saplings. Eventually they reached a wide opening, and the light poured in from an opening in the caves. This latter is a large chamber, and in it are the roots of a tree, which have taken hold in the bottom of the cave, and hang like ropes. The most striking stalagmites in it resemble the head of an elephant and the bust of a man. Various caves were discovered, and also openings leading from one main suite of caves to another one. The cave particularly alluded to is called 'The Cathedral.' It is 50 feet long from the porch to the pulpit stairs, 30 feet across, and the ceiling is so lofty that the gleams of the candle did not reach it. There are stalactitic formations on the ceilings and floor, but the walls are plain, and have niches in some parts. Some of the party descended 60 feet here, and in another failed to reach the opening. The writer says, 'Wherever we went almost underground our footsteps had a hollow sound, and the conclusion we come to at present is that the region has been a hot-spring area, and the caves were formed by the action of hot water.'"

THE various species of Salmonidæ hatched out and reared by the Buckland Museum authorities have been turned into the Thames at Penton Hook, with a view of replenishing the stock of fish in that river. The Thames Angling Preservation Society are making arrangements to receive a consignment of land-locked salmon fry at their nursery again this year, in order to rear them for the Thames. The exertions now being made to re-stock the unpolluted portions of this river are sure to terminate in good results, indeed many of the trout taken lately are said to be the result of previous efforts made by pisciculturists in this direction.

ORNITHOLOGISTS, antiquarians, and librarians will in a few days have the opportunity of possessing a book which is said to be the only work published on the subject of duck decoys. It will be in quarto, with many illustrations, coloured and woodcut. Its author, Sir Ralph Payne-Gallwey, is already known to naturalists by his book on wild-fowl, issued some few years since by the publisher of the present volume, Mr. Van Voorst.

DR. VON HAAST writes that the large geological relief model of New Zealand, referred to in our recent article on the Colonial and Indian Exhibition, has been prepared by Dr. James Hector, the Director of the Geological Survey of New Zealand, and forms part of the large exhibit of that gentleman. There are several large labels inside the glass case, in which the necessary explanations are given.

THE additions to the Zoological Society's Gardens during the past week include a Ring-tailed Lemur (*Lemur catta*) from Madagascar, presented by Mr. Angus Ogilvy; two Black-tailed Parrakeets (*Polytelis melanura*) from South Australia, presented by Mr. James Thomson; an Indian Cobra (*Naia tripudians*) from India, presented by Messrs. H. Thwaites and V. A. Julius; a Common Viper (*Vipera berus*), British, presented by Mr. W. H. B. Pain; a Loggerhead Turtle (*Thalassochelys caouana*) from the Atlantic Ocean, presented by Mr. R. G. Fraser, R.N.; a Rook (*Corvus frugilegus*), British, presented by Mr. H. J. Peckover; a Black-faced Spider Monkey (*Ateles ater*) from Eastern Peru, a Crab-eating Raccoon (*Procyon cancrivorus*) from West Indies; an Indian Cobra (*Naia tripudians*) from India, deposited; two Spotted Hyænas (*Hyæna crocuta*) from South Africa, two Side-striped Jackals (*Canis lateralis*) from West Africa, a Griffon Vulture (*Gyps fulvus*), a Smooth Snake (*Coronella lævis*), a Viperine Snake (*Tropidonotus viperinus*), European, purchased; two Triangular Spotted Pigeons (*Columba guinea*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

A CATALOGUE OF "COMPARISON" STARS.—Dr. N. M. Kam of Schiedam has published in *Verhandelingen der Koninklijke Akademie van Wetenschappen*, Deel. xxiv. (Amsterdam), a star catalogue compiled from the places of stars determined by meridian observations, which have been extracted from vols. i. to lxvi. of the *Astronomische Nachrichten*, and reduced to the epoch 1855·0. The positions of the stars contained in this catalogue were determined in connection with observations of planets and comets, and it was in compliance with Argelander's express desire that the work of collecting them and reducing the positions to a common epoch was commenced by Hoek, then Director of the Utrecht Observatory. Dr. Kam, who was Hoek's assistant, continued the work after the death of the latter, and has at length been able to publish his results. The principal catalogue contains the completely determined places of 4350 stars, and is followed by two subsidiary catalogues, the first giving the places of 236 stars, and the second those of 335 stars; all of the latter, however, are incomplete, *i.e.* the place is given in one element only. The catalogues are followed by a comparison of the places of the stars contained in them with their places as given in the Bonn *Durchmusterung*, or, for stars south of $-2°$ Decl., with other authorities. Notes on proper motions, corrigenda, &c., are appended, which are of considerable interest and value. We hope that the work of collecting and cataloguing the class of stars here dealt with will be continued either by Dr. Kam or by some other astronomer as well fitted for the task as he has proved himself to be.

THE PARIS OBSERVATORY.—Admiral Mouchez, Director of the Paris Observatory, has recently published his annual report to the Council of the Observatory. It is a very instructive and interesting document, and affords gratifying evidence of the enterprise and energy with which the work of this great institution is carried on.

The most striking portion of the report is that which deals with the work of the Bros. Henry in astronomical photography, but as this, as well as M. Lœwy's ingenious device for determining the amount of astronomical refraction, have already been noticed in NATURE, it will not be necessary to again refer to them. Leaving these two great undertakings therefore on one side, the rest of the report exhibits a large amount of solid work. The meridian service has comprised 16,173 observations, 795 of the sun and planets. The instruments of the Salle Méridienne have been devoted to the observation of Lalande's stars. As the great Catalogue approaches completion, the stars still to be observed become more widely scattered, and fewer observations are necessarily secured. The division-errors of the Gambey circle are being carefully investigated by M. Périgaud, and the Garden circle has been used for the determination of the absolute positions of a number of circumpolar stars. A new flexure apparatus has been constructed by M. Gautier, and 603 stars have been already observed with it. The same ingenious artist has also devised a new mode of supporting a mercury trough, for freeing it from the effect of tremors, which has been found to work very satisfactorily. The equatorials have been employed as usual in observations of comets, minor planets, and nebulæ; the equatorial of the east tower having been employed by MM. Henry in the revision of some of their photographic charts containing very faint stars, especially the Pleiades and the regions round Vega and ε Lyræ. In the department of the calculations, the calculations for the great Catalogue had been completed as far as 8h. of R.A., and were being carried on from 8h. to 12h. The Catalogue itself was printed up to No. 3800, and the manuscript prepared up to No. 4700. Of the volume of observations for 1882, seventy-three sheets had been printed, and the rest was in the printer's hands. The volume for 1883 had been commenced, and of the *Mémoires*, tome xviii., had been distributed, and tome xix. was in course of publication.

Several important investigations have also been carried on by individual members of the staff. M. Lœwy has devised a new method for determining the absolute co-ordinates of circumpolar stars, and M. Renan has published two notes on his experiments in application of these methods. M. Callandreau has published several notes on the theory of the figure of the planets and of the earth, and numerical tables for assisting in the calculation of ephemerides for minor planets; whilst M. Prosper Henry has been engaged in devising suitable methods for the measurement and reduction of the photographic star-charts, which differ so widely from ordinary astronomical observations. A new determination of the length of the seconds pendulum has also been made by Capt. Defforges, of the Geographical Service, the length corrected to sea-level being found to be 0·9939.4m. Amongst the works to be carried out in the present year is the study of the movements of the soil by the aid of a multiplying seismograph devised by M. Bouquet de la Grye. The report concludes with a reproduction of a photograph of the Pleiades and a comparison of the results thus obtained by photography in a single hour with those obtained by M. Wolf in his study of the same group through the toil of years.

NOTES ON VARIABLE STARS.—Mr. Espin, the special observer to the Liverpool Astronomical Society, has recently commenced the issue of circulars calling attention to various variable stars or stars suspected of variation. Circular No. 1 gives an ephemeris for 10 Sagittæ, the next maximum, mag. 5·6, falling due June 5·4d., and the next minimum, mag. 6·4, June 11·1, period 8·317d. Circular No. 2 calls attention to the star D.M. + 8°, No. 3780, R.A. (1885·0) 18h. 32m. 51s., Decl. 8° 43′·5 N., as a probable variable. Circular No. 3 gives new elements for U Hydræ, R.A. 10h. 31·9m., Decl. 12° 40′·7 S., from whence it would appear that the next maximum is due 1886 June 25·5d. Circular No. 4 gives provisional elements for W. Cygni, R.A. (1886·0) 21h. 31m. 44s., Decl. 44° 51′·0 N., as follows:—P = 120 to 130 days, V = 5·8 ± to 7·5 ±, M = 1886 May 19 ±, m = 1886 Feb. 14 ±.

THE "CANALS" OF MARS.—M. Terby, in a note presented some little time ago to the Royal Academy of Belgium, drew attention to the occurrence in the drawings of Mars made by Herschel and Schrœter of several markings resembling the well-known Kaiser Sea in size and distinctness, and pointed out that M. Schiaparelli, in his observations of 1881–82, represented the "canal" Indus as developed to dimensions almost as great as those of the Kaiser Sea, and that this development coincided with the "gemination" or doubling of almost all the other canals. M. Faye now announces at the last meeting of the Académie des Sciences that M. Perrotin and the other observers at the Nice Observatory have recently been able to re-detect M. Schiaparelli's canals. The reality of the existence of the delicate markings discovered by the keen-sighted astronomer of Brera seems thus fully demonstrated, and it appears highly probable that they vary in shape and distinctness with the changes of the Martial seasons.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 JUNE 6–12

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

At Greenwich on June 6

Sun rises, 3h. 47m.; souths, 11h. 58m. 23·3s.; sets, 20h. 9m.; decl. on meridian, 22° 41′ N.: Sidereal Time at Sunset, 13h. 10m.

Moon (at First Quarter on June 9) rises, 8h. 10m.; souths, 15h. 49m.; sets, 23h. 17m.; decl. on meridian, 15° 7′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	3 25	11 29	19 33	21 45 N.
Venus	2 10	9 7	16 4	10 20 N.
Mars	11 47	18 18	0 49*	5 28 N.
Jupiter	12 31	18 48	1 5*	2 43 N.
Saturn	5 26	13 37	21 48	22 43 N.

* Indicates that the setting is that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

June	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
10	B.A.C. 4043	6½	0 5	0 51	74 325
11	38 Virginis	6	1 0	near approach	200 —

June	h.	
9	9	Mars in conjunction with and 0° 6′ north of the Moon.
9	22	Jupiter in conjunction with and 0° 1′ north of the Moon.
11	5	Mercury at least distance from the Sun.
12	2	Mercury in superior conjunction with the Sun.

Variable Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·2	81 16 N.	June 9,	2 16	*m*
S Canis Minoris	7 26·5	8 34 N.	,, 11,		*m*
W Virginis	13 20·2	2 47 S.	,, 8,	21 40	*M*
δ Libræ	14 54·9	8 4 S.	,, 6,	0 50	*m*
U Coronæ	15 13·6	32 4 N.	,, 7,	1 16	*m*
U Ophiuchi	17 10·8	1 20 N.	,, 11,	0 42	*m*
X Sagittarii	17 40·4	27 47 S.	,, 12,	2 20	*M*
W Sagittarii	17 57·8	29 35 S.	,, 6,	2 25	*M*
T Herculis	18 4·8	31 0 N.	,, 11,		*m*
η Aquilæ	19 46·7	0 43 N.	,, 11,	21 30	*M*
R Sagittæ	20 8·9	16 23 N.	,, 10,		*m*
δ Cephei	22 24·9	57 50 N.	,, 6,	0 0	*m*
			,, 12,	21 35	*M*

M signifies maximum; *m* minimum.

Meteor Showers

Radiants near β Ophiuchi, R.A. 261°, Decl. 5° N., from Sagitta, R.A. 292°, Decl. 15° N., and from Vulpecula, R.A. 312°, Decl. 24° N., are represented at this time of the year, as well as the *Cygnids II.*, R.A. 319°, Decl. 32° N.

GEOGRAPHICAL NOTES

THE French forces in Tonquin having now succeeded in occupying Lao-Kai, near the Chinese frontier, the capital of the Black Flag State, the whole course of the Red River in Tonquin is for the first time open to exploration. Accordingly two flat-bottomed gunboats with an exceedingly small draught have been built and equipped, and left Hanoi on April 3 to ascend the river, having on board officers whose duty it is to survey the river and the adjacent country, to fix the positions of the most important points, and to produce a map of the whole.

AT the meeting of the Geographical Society of Paris on the 21st ult., M. de Lesseps referred to the works on the Panama Canal, and argued that locks or dams were unnecessary. M. Aubry gave a summary of a journey which he made in 1883 and 1884 to Choa and the Gallas country in pursuit of a mission with which he was charged by the Minister of Public Instruction. He collected a large number of mineralogical specimens, and studied the region from a geological and palæontological point of view. He also surveyed the courses of two rivers.

THE Government of British North Borneo has secured the services of Capt. Beeston for the purpose of making a mineralogical and geographical survey of the country. He has started for the Segama River, which has already been visited by Frank Hatton, to investigate the localities in which gold is said to have been found.

AT the instance of the Société de Géographie Commerciale of Nantes, a Commercial-Geographic Exhibition will be held in that city between June 15 and August 15 next. According to the programme the Exhibition will be divided into five classes: (1) scientific geography; (2) ethnography; (3) travelling and means of communication; (4) French and French-Colonial produce; (5) educational material.

ON RECENT PROGRESS IN THE COAL-TAR INDUSTRY[1]

THOSE who have read Goethe's episodes from his life, known as "Wahrheit und Dichtung," will remember his description of his visit in 1741 to the burning hill near Dutweiler, a village in the Palatinate. Here he met old Stauf, a coal philosopher, *philosophus per ignem*, whose peculiar appearance and more peculiar mode of life, Goethe remarks upon. He was engaged in an unsavoury process of collecting the oils, resin, and tar obtained in the destructive distillation of coal carried on in a rude form of coke oven. Nor were his labours crowned with pecuniary success, for he complained that he wished to turn the oil and resin to account, and save the soot, on which Goethe adds that, in attempting to do too much, the enterprise altogether failed. We can scarcely imagine, however, what Goethe's feelings would have been could he have foreseen the beautiful and useful products which the development of the science of a century and a half has been able to extract from Stauf's evil-smelling oils. With what wonder would he have regarded the synthetic power of modern chemistry, if he could have learnt that not only the brightest, the most varied colours of every tone and shade can be obtained from this coal-tar, but that some of the finest perfumes can, by the skill of the chemist, be extracted from it. Nay, that from these apparently useless oils, medicines which vie in potency with the rare vegeto-alkaloids can be obtained, and lastly, perhaps most remarkable of all, that the same raw material may be made to yield an innocuous principle, termed *saccharine*, possessed of far greater sweetness than sugar itself. The attainment of such results might well be regarded as savouring of the chimerical dreams of the alchemist, rather than expressions of sober truth, and the modern chemist may ask a riddle more paradoxical than that of Samson, "Out of the burning came forth coolness, and out of the strong came forth sweetness"; and by no one could the answer be given who had not ploughed with the heifer of science, "What smells stronger than tar, and what tastes sweeter than saccharine?" That these are matters of fact we may assure ourselves by the most convincing of all proofs—their money value, and we learn that the annual value of the products now extracted from an unsightly and apparently worthless material amounts to several millions sterling, whilst the industries based upon these results give employment to thousands of men.

Sources of the Coal-tar Products.—In order to obtain these products, whether colours, perfumes, antipyretic medicines, or sweet principle, a certain class of raw material is needed, for it is as impossible to get nutriment from a stone as to procure these products from wrong sources. All organic compounds can be traced back to certain hydrocarbons, which may be said to form the skeletons of the compounds, and these hydrocarbons are divisible into two great classes: (1) the paraffinoid, and (2) the benzenoid hydrocarbons. The chemical differences both in properties and constitution between these two series are well marked. One is the foundation of the fats, whilst the other class gives rise to the essences or aromatic bodies. Now all the colours, finer perfumes, and antipyretic medicines referred to, are members of the latter of these two classes. Hence if we wish to construct these complicated structures, we must employ building materials which are capable of being cemented into a coherent edifice, and therefore we must start with hydrocarbons belonging to the benzenoid series, as any attempt to build up the colours directly from paraffin compounds would prove impracticable. Of all the sources of hydrocarbons, by far the largest is the natural petroleum oils. But these consist almost entirely of paraffins, and hence this source is commercially inapplicable for the production of colours. We have, however, in coal itself, a raw material which

[1] A Discourse by Prof. Sir Henry E. Roscoe, M.P., LL.D., F.R.S. delivered at the Royal Institution, Friday, April 16, 1886.

by suitable treatment may be made to yield oils of a valuable character. Of these treatments, that followed out in the process of gas-making is the most important, for in addition to illuminating gas in abundant supply, tar is produced which contains principally that benzenoid class of substances already referred to, and which, to use the words of Hofmann, "is one of the most wonderful productions in the whole range of chemistry." The production of these latter as distinguished from the paraffinoid group appears to depend upon a high temperature being employed to effect the necessary decomposition.

The quantity of coal made into coke for use in the blast furnace is larger than that distilled for gas-making, no less than between eleven and twelve million tons of coal being annually consumed in the blast furnaces of this country in the form of coke, and capable of yielding two million tons of volatile products. Up to recent times, however, the whole of these volatile products has been burnt and lost in the coke ovens. But lately, various processes have been devised for preventing this loss, and for obtaining the oils, which might be made available as colour-producing materials. It is, moreover, a somewhat remarkable fact that only in one or two cases have the conditions been complied with which render it possible to obtain the necessary benzenoid substances. In the ordinary coking ovens, as well as in the blast furnaces, although the temperature ultimately reached is far in excess of that needed to form the colour-giving hydrocarbons, yet the heating process is carried on so gradually that the volatile products from the coal are obtained in the form of paraffinoid bodies mainly, and hence are useless for colour-making purposes. Amongst the few coking processes in which the heat is suddenly applied, and consequently a yield of colour-giving

TABLE I.—*One Ton of Lancashire Coal yields when distilled in Gas Retorts on an Average*

Gas (cubic feet).	Ammoniacal Liquor, 5° Tw.	Equal to Ammonium Sulphate.	Coal (Gas) Tar, sp. gr. 1·16.	Coke.
10,000	20 to 25 gallons.	30 lbs.	12 gallons = 139·2 lbs.	13 hundredweights.

Twelve Gallons of Gas-Tar yield (*Average of Manchester and Salford Tar*)

Benzene.	Toluene.	Phenol proper.	Solvent Naphtha for India-rubber, containing the three Xylenes.	Heavy Naphtha.	Naphthalene.	Creosote.	Heavy Oil.	Anthracene.	Pitch.
lb. 1·10 = Aniline 1·10	lb. 0·90 = Toluidine 0·77	lb. 1·5	lb. 2·44 yielding 0·12 Xylene = 0·07 Xylidine	lb. 2·40	lb. 6·30 = α Naphthylamine 5·25 = α or β Naphthol 4·75 = Vermilline Scarlet, RRR 7·11 or = Naphthol Yellow[1] 9·50	lb. 17·0	lb. 14	lb. 0.46	lb. 69.6
= Magenta 0·623 or 1·10 lb. Aniline yields 1·23 lb. Methyl Violet.		Aurin 1·2						Alizarin 20 %. 2·25.	

Dyeing Power of Colours from 1 *Ton of Lancashire Coal.*

lb. 0·623 Magenta or dye 500 yards 27 in. wide Flannel a full shade.	lb. 1·23 Methyl Violet dye 1000 yards 27 in. wide Flannel a full Violet.	lb. 9·50 Naphthol Yellow dye 3800 yards 27 in. wide Flannel a full Yellow.	lb. or 7·11 Vermilline dye 2560 yards 27 in. wide Flannel a full Scarlet.	lb. 1·2 Aurin dye 120 yards 27 in. wide Flannel a full Orange.	lb. 2·25 Alizarin 20 % dye 255 yds. Printer's cloth a full Turkey Red.

Dyeing Power of Colours from 1 *lb. of Lancashire Coal.*

Magenta or a piece of Flannel 8 in. by 27 in.	Violet a piece of Flannel 24 in. by 27 in.	Yellow or a piece of Flannel 61 in. by 27 in.	Scarlet a piece of Flannel 41 in. by 27 in.	Orange a piece of Flannel 1·93 in. by 27 in.	Turkey Red a piece of Flannel 4 in. by 27 in.

[1] The Naphthol Yellow is a representative colour from α Naphthol, while the Vermilline Scarlet is a representative colour from the combination of α Naphthylamine with β Naphthol.

hydrocarbons is obtained, may be mentioned the patented process of Simon-Carvès, the use of which is now spreading in England and abroad. The tar obtained in this process is almost identical in composition with the average gas-works tar, whilst the coke also appears to be equal for iron-smelting purposes to that derived from other coke ovens. A third source of these oils yet remains to be mentioned, viz. those obtained as a by-product in blast furnaces fed with coal.

Another condition has, in addition, to be considered in this industry, and that is the nature of the coal employed for distillation. It is a well-known fact that if Lancashire cannel be exclusively employed in gas-making a highly-luminous gas is obtained, but the tar is too rich in paraffins to be a source of profit to the tar-distiller, whilst, on the other hand, coal of a more anthracitic character, like that from Newcastle or Staffordshire, yields a tar too rich in one constituent, viz. naphthalene, and too poor in another, viz. benzene. It is also known to those engaged in carbonising coal principally for the sake of the tar that the coal from different measures, even in the same pit, yields tars of very different constitution. That under these varying conditions products of varying composition are obtained is a result that will surprise no one who considers the complicated chemical changes brought about in the process of the destructive distillation of coal.

History of Benzene and its Derivatives.—Having thus sketched the principles upon which the formation of these valuable tar colours depends, we should do wrong to pass over the history of the discovery of benzene (C_6H_6), which contributed so much to the unlocking of the coal-tar treasury.

Faraday in 1825 discovered two new hydrocarbons in the oils obtained from portable gas. One of these was found to be butylene (C_4H_8); to the other Faraday gave the name of bicarburet of hydrogen, as he ascertained its empirical formula to be C_2H ($C = 6$). By exploding its vapour with oxygen, he observed that one volume contains 36 parts by weight of carbon to 3 parts by weight of hydrogen, and its specific gravity compared with hydrogen is therefore 39.[1]

Mitscherlich, in 1834, obtained the same hydrocarbon by distillation of benzoic acid, $C_7H_6O_2$, with slaked lime, and termed it benzin. He assumed that it is formed from benzoic acid simply by removal of carbon dioxide. Liebig denied this, adding the following editorial note to Mitscherlich's memoir:—"We have changed the name of the body obtained by Prof. Mitscherlich by the dry distillation of benzoic acid and lime, and termed by him benzin, into benzol, because the termination 'in' appears to denote an analogy between strychnine, quinine, &c., bodies to which it does not bear the slightest resemblance, whilst the ending in 'ol' corresponds better to its properties and mode of production. It would have been perhaps better if the name which the discover, Faraday, had given to this body had been retained, as its relation to benzoic acid and benzoyl compounds is not any closer than it is to that of the tar or coal from which it is obtained."

Almost at the same time Péligot found that the same hydrocarbon occurs, together with benzone, $C_{13}H_{10}O$ (diphenylketone, $CO(C_6H_5)_2$), in the products of the dry distillation of calcium benzoate.

The different results obtained by Mitscherlich and Péligot are represented by the following formulæ:—

$$C_7H_6O_2 + CaO = C_6H_6 + CaCO_3.$$
$$(C_7H_5O_2)_2Ca = C_{13}H_{10}O + CaCO_3.$$

TABLE II.

	1. *Benzene.*	2. *Toluene.*	3. *Phenols.*	4. *Xylene.*	5. *Naphthalene.*	6. *Anthracene.*
Yellows	Orange Yellow, or Acid Yellow	...	Picric Acid	...	Manchester Yellow (Dinitronaphthol)	Alizarin (pure
	Metanil Yellow	...	...	...	Naphthol Yellow	Anthrapurpurin
	Auramine	...	...	...	...	
Browns	Brown, Y	Bismarck Brown, R	...	...	...	Flavopurpurin
Oranges	Diphenylamine Orange (Blackley Orange)		...		...	
	Chrysoidine, Y	Chrysoidine, R	Aurin		...	
	Orange I. (mixture of 1 and 5)	...	...	...	...	
	Orange II. (1 and 5)	...	...	...	...	
	Orange III. (Helianthine)	...	...	...	...	
	Orange IV.	...		...	...	
Reds	Safranin	Magenta, R	Eosin	...	Bordeaux	
	...	Magenta, B	Safrosin	...	Vermilline Scarlet, R	
	...	...	Cyanosine	...	Vermilline Scarlet, R R R	
	...	...	Rose Bengal	...	Vermilline Scarlet, B B B	
	...	...	Phloxin	...	Roccellin	
	...	...	Erythrosin	(Mixture of Xylene and Naphthalene)	(Mixture 1 and 5)	
					New Red	
	...	...	...	Xylidine Scarlet	Biebrich Scarlet	
	...	...	...	(Mixture of Cumene and Naphthalene)	Crocein Scarlet	
	...	...	...	Cumidine Scarlet	...	
					(Mixtures of 1 and 5)	
Blues	Diphenylamine Blue	Blackley Blue, R	...	...	Victoria Blue, 1	
	Methylene Blue	Blackley Blue, 1	...	...	Victoria Blue, 5	
	Indulin (Campbelline)	Alkali Blue, R	...	...	...	
	...	Alkali Blue, 6 B	...	...	...	
Violets	Methyl Violet, 6 B	...	...	...	...	
	Methyl Violet, R	...	...	...	...	
Greens	Malachite Green	...	...	...	...	
	Brilliant Green	...	...	...	...	
	Acid Green (Acid Green)	...	...	...	...	

Péligot obtained benzene only as a by-product, exactly as in the preparation of acetone (dimethylketone) from calcium acetate a certain quantity of marsh gas is always formed.

It is not clear how Liebig became acquainted with the fact that benzene is formed by the dry distillation of coal, as his pupil Hofmann, who obtained it in 1845 from coal-tar, observes: "It is frequently stated in memoirs and text-books that coal-tar oil contains benzene. I am, however, unacquainted with any research in which this question has been investigated." It is, however, worthy of remark that about the year 1834, at the time when Mitscherlich had converted benzene into nitrobenzene, the distillation of coal-tar was carried out on a large scale in the neighbourhood of Manchester; the naphtha which was obtained was employed for the purpose of dissolving the residual pitch, and thus obtaining black varnish. Attempts were made to supplant the naphtha obtained from wood-tar, which at that time was much used in the hat factories at Gorton, near Manchester, for the preparation of "lacquer," by coal-tar naphtha. The substitute, however, did not answer, as the impure naphtha left, on evaporation, so unpleasant a smell, that the workmen refused to employ it. It was also known, about the year 1838, that wood-naphtha contained oxygen, whilst that from coal-tar did not, and hence Mr. John Dale attempted to convert the latter into the former, or into some similar substance. By the action of sulphuric acid and potassium nitrate, he obtained a liquid possessing a smell resembling that of bitter almond oil, the properties of which he did not further investigate. This was, however, done in 1842 by Mr. John Leigh, who exhibited considerable quantities of benzene, nitrobenzene, and dinitrobenzene, to the Chemical Section of the British Association meeting that year in Manchester. His communication is, however, so printed in the Report, that it is not possible from the description to identify the bodies in question.

Large quantities of benzene were prepared in 1848, under Hofmann's direction, by Mansfield, who proved that the naphtha

[1] *Phil. Trans.*, 1825, p. 440.

in coal-tar contains homologues of benzenes, which may be separated from it by fractional distillation. On the 17th of February, 1856, Mansfield was occupied with the distillation of this hydrocarbon, which he foresaw would find further applications, for the Paris Exhibition, in a still. The liquid in the retort boiled over and took fire, burning Mansfield so severely that he died in a few days.

The next step in the production of colours from benzene and toluene is the manufacture of nitrobenzene, $C_6H_5NO_2$, and nitrotoluene, $C_7H_7NO_2$. The former compound, discovered in 1834 by Mitscherlich, was first introduced as a technical product by Collas under the name of artificial oil of bitter almonds, and Mansfield in 1847 patented a process for its manufacture. It is now used for perfuming soap, but mainly for the manufacture of aniline ($C_6H_5NH_2$) for aniline blue and aniline black and for magenta. It is made on a very large scale by allowing a mixture of well-cooled fuming nitric acid and strong sulphuric acid to run into benzene contained in cast-iron vessels provided with stirrers.

To prepare aniline from nitrobenzene, this compound is acted upon with a mixture of iron turnings and hydrochloric acid in a cast-iron vessel. Commercial aniline is a mixture of this compound with toluidine obtained from toluene contained in commercial benzene. Some idea of the magnitude of this industry may be gained from the fact that in one aniline works near Manchester no less than 500 tons of this material are manufactured annually. From the year 1857, after Perkin's celebrated discovery[1] of the aniline colours, up to the present day, the history of the chemistry of the tar products has been that of a continued series of victories, each one more remarkable than the last.

Coal-tar Colours.—To even enumerate the different chemical compounds which have been prepared during the last thirty years from coal-tar would be a serious task, whilst to explain their constitution and to exhibit the endless variety of their coloured derivatives which are now manufactured would occupy far more time than is placed at my disposal. On the industrial importance of these discoveries the speaker reminded his audience of the wonderful potency of chemical research, as shown by the fact that the greasy material which in 1869 was burnt in the furnaces or sold as a cheap waggon grease at the rate of a few shillings a ton, received two years afterwards, when pressed into cakes, a price of no less than one shilling per pound, and this revolution was caused by Gräbe and Liebermann's synthesis of alizarin, the colouring matter of madder,[2] which is now manufactured from anthracene at a rate of more than two millions sterling per annum; and it is stated that an offer was once made, in the earlier stages of its history, by a manufacturer of anthracene to the Paris authorities to take up the asphalt used in the streets for the purpose of distilling it, in order to recover the crude anthracene.

Again, we have in the azo-scarlets derived from naphthalene a second remarkable instance of the replacement of a natural colouring matter, that of the cochineal insect, by artificial tar-products, and the naphthol-yellows are gradually driving out the dyes obtained from wood extracts and berries. It is, however, true that some of the natural dye-stuffs appear to withstand the action of light better than their artificial substitutes, and our soldiers' red coats are still dyed with cochineal.

The introduction of these artificial scarlets has, it is interesting to note, greatly diminished the cultivation of cochineal in the Canaries, where, in its place, tobacco and sugar are now being largely grown.

Let us next turn to inquire as to the quantities of these various products obtainable by the distillation of one ton of coal in a gas-retort. The six most important materials found in gas-tar from which colours can be prepared are:—

1. Benzene.	4. Metaxylene (from solvent naphtha).
2. Toluene.	5. Naphthalene.
3. Phenol.	6. Anthracene.

The average quantity of each of these six raw materials obtainable by the destructive distillation of one ton of Lancashire coal is seen in Table I. Moreover, this table shows the average amount of certain colours which each of these raw materials yields, viz.:—

1. } Magenta 0·623 lb.	4. (*Xylidine* 0·07 lb.)
2. }	5. Vermilline scarlet 7·11 lbs.
3. Aurin 1·2 lb.	6. Alizarin 2·25 lbs. (20 per cent.)

Further, it shows the dyeing power of the above quantities of each of these colours, all obtained from one ton of coal, viz.:—

1 and 2. Magenta, 500 yards of flannel.
3. Aurin, 120 yards of flannel 27 in. wide.
4 and 5. Vermilline scarlet, 2560 yards of flannel.
6. Alizarin, 255 yards Turkey red cloth.

Lastly, to point out still more clearly these relationships, the dyeing power of one pound of coal is seen in the lowest horizontal column, and here we have a party-coloured flag, which exhibits the exact amount of colour obtainable from one pound of Lancashire coal.

Let us moreover remember, in this context, that no less than ten million tons of coal are used for gas-making every year in this country, and then let us form a notion of the vast colouring power which this quantity of coal represents.

The several colours here chosen as examples are only a few amongst a very numerous list of varied colour derivatives of each group. Thus we are at present acquainted with about sixteen distinct yellow colours; about twelve orange; more than thirty red colours; about fifteen blues, seven greens, and nine violets; also a number of browns and blacks, not to speak of mixtures of these several chemical compounds, giving rise to an almost infinite number of shades and tones of colour. These colours are capable of a rough arrangement according as they are originally derived from one or other of the hydrocarbons contained in the coal-tar. The fifty specimens of different colours exhibited may thus be classified, but in Table II., for the sake of brevity, only the commercial names and not the chemical formulæ of these compounds is given.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Prof. Liveing has been appointed Chairman of the Examiners for the Natural Sciences Tripos, and Mr. James Ward of those for the Moral Sciences Tripos. There were 106 candidates for the first part of the Natural Sciences Tripos recently held.

Attention has recently been given to the preservation of University buildings from fire, and serious defects have been, or are being, remedied. Such matters should be carefully thought out in regard to every museum and library, and it is to be hoped that attention will be constantly given to the efficiency of means of prevention and extinction of fires. The report on this subject in No. 636 of the *Cambridge University Reporter* is well worthy of the study of officials concerned in guarding precious scientific collections.

Prof. Darwin will lecture in the Long Vacation on the Theory of the Potential, Attractions, and the Figure of the Earth, the first lecture being on Tuesday, July 13.

A recent discussion of a report by the Special Board on Medicine emphasised the desirability of teaching elementary physics as part of general education to those intending to become medical students, and showed that the new "extra subjects" of the Previous Examination do not satisfactorily secure this, dynamics and a mathematical treatment being required, rather than experimental acquaintance with the physical forces. Mr. Oscar Browning said the interests of education were suffering terribly from the want of agreement as to what schoolboys ought to be taught. Mr. Shaw remarked on the importance of a training in inductive reasoning for medical students, for their whole practice would consist in drawing inductions.

The grants from the Worts Fund to Messrs. Bateson, Seward, Gadow, and Potter, to which we recently referred, have been voted by the Senate.

Prof. Alfred Marshall is giving a prize of 15*l.* annually for Political Economy, to be open to all members of the University under the M.A. degree. The examination is to consist of the papers on Political Economy in Part I., and on Advanced Poli-

[1] See Lectures by Prof. Hofmann, F.R.S., "On Mauve and Magenta," April 11, 1882, and W. H. Perkin, F.R.S., "On the Newest Colouring Matters," May 14, 1869, *Proc. Roy. Inst.*; also President's Address (Dr. Perkin, F.R.S.), *Journal of Society of Chemical Industry*, vol. iv., July 1884, on Coal-Tar Colours.

[2] "On the Artificial Production of Alizarine, the Colouring Matter of Madder," by Prof. H. E. Roscoe, *Proc. Roy. Inst.*, April 1, 1870; also Dr. Perkin, F.R.S., "On the History of Alizarine," *Journal Society of Arts*, May 30, 1879.

tical Economy in Part II. of the Moral Sciences Tripos. The first award is to be in June 1887. He desires to concentrate the attention of some students more systematically than hitherto, noting that on some sides Natural Science studies constitute the best preparation.

During the last ten years, grants from the Worts Fund for Antiquarian and Literary subjects have amounted to 1100*l.*; for Biological and Geological subjects, to 1225*l.*; and for Medical subjects, to 100*l.*

Sir J. Lubbock's Rede Lecture will be delivered on Wednesday, June 9, at 2 p.m., in the Senate House, subject, "On the Forms of Seedlings and the Causes to which they are due."

SOCIETIES AND ACADEMIES

London

Royal Society, May 27.—"The Influence of Stress and Strain on the Physical Properties of Matter. Part I. Elasticity (continued). The Effect of Magnetisation on the Elasticity and the Internal Friction of Metals." By Herbert Tomlinson, B.A. Communicated by Prof. W. Grylls Adams, M.A., F.R.S.

The principal object of this investigation was to test the soundness of the view advanced by Prof. G. Wiedemann respecting the cause of the internal friction of a torsionally oscillating wire. According to this view, the internal friction is mainly due to permanent rotation to-and-fro of the molecules about their axes; it seemed probable, therefore, that experiments on the effects of magnetising a wire, either longitudinally with a helix, or circularly by passing a current through it, would aid in elucidating the matter.

The following are the principal results which have been obtained:—

(1) When the deformations produced by the oscillations are small, the internal friction of a torsionally vibrating wire of iron or steel is not affected by sustained longitudinal magnetisation of moderate amount. The internal friction is also not affected by the sustained magnetisation even when the latter is carried to the point of saturation, provided the magnetising current be, previously to experimenting, reversed a great number of times. When no previous reversals have been made, the internal friction is slightly increased by intense magnetisation.

(2) When the deformations produced by the oscillations are large, the internal friction is very sensibly increased by sustained longitudinal magnetisation of large amount.

(3) The torsional elasticity is entirely independent of any sustained longitudinally magnetising stress which may be acting upon an iron or steel wire, provided the deformations produced by the torsional oscillations be small. When the deformations are large, the number of oscillations executed in a given time is very slightly lessened by sustained longitudinal magnetisation of large amount.

(4) When the magnetising current is interrupted and, to a greater extent, when it is reversed repeatedly whilst the wire is oscillating, the internal friction is increased, provided the magnetising stress be of moderate amount. The increase of internal friction may become very considerable when the magnetising stress is great.

When the number of interruptions or reversals in a given time of the magnetising current exceeds a certain limit, the effect on the internal friction begins to decline.

(5) When the deformations produced by the oscillations are small, the torsional elasticity is not affected by either repeatedly interrupted or reversed longitudinal magnetisation even when the magnetising stress is large.

(6) There exists a limit of magnetic stress within which no permanent rotation whatever of the molecules is produced. This limit may be widened by previous repeated reversals of a large magnetising stress.

(7) The passage of a moderate electric current, whether sustained or interrupted, through a torsionally vibrating wire of iron, steel, or nickel does not affect, except by heating, either the internal friction or the torsional elasticity, provided the deformations produced by the oscillations be small.

(8) The effect of longitudinal magnetisation, even when carried to the point of saturation, on the longitudinal oscillation of an iron or steel wire, is *nil*.

(9) The passage of an electric current, whether sustained or interrupted, through a longitudinally oscillating wire of iron or steel does not, except by heating, affect the number of oscillations executed in a given time.

Chemical Society, May 6.—Dr. Hugo Müller, F.R.S., President, in the chair.—Messrs. John W. King, William Herbert Hyatt, and George T. Holloway were admitted Fellows of the Society.—The following papers were read:—Paranitrobenzoylacetic acid and some of its derivatives, by Dr. W. H. Perkin, jun., and Dr. E. Bellinot.—An acetic ferment which forms cellulose, by Adrian J. Brown.

Victoria Institute, May 28.—Annual Meeting.—The chair being taken by Prof. Stokes, P.R.S., Capt. Francis Petrie, as Honorary Secretary, read the report, which showed that the home, colonial, and American members were now upwards of 1150, and an increasing number of leading men of science had contributed to its transactions, and the Institute was much indebted to many other scientific men of eminence, at present outside its ranks, who had kindly given their aid and advice, so that the Institute might the more worthily foster a true appreciation of the results of scientific inquiry.—Prof. Hull, F.R.S., Director of the Geological Survey of Ireland, delivered the address, in which he gave an account of the work, discoveries, and general results of the recent Geological and Geographical Expedition to Arabia and Western Palestine, of which he had charge. Prof. Hull, having sketched the course taken by the scientific Expedition (which to a considerable extent took the route ascribed to the Israelites), the physical features of the country, evidences of raised beaches, &c., showed that at one time an arm of the Mediterranean had occupied the valley of the Nile as far as the First Cataract, the level of the land being 200 feet lower than at present (an opinion which had also been arrived at by another of the Institute's members, Sir W. Dawson), and that, at the time of the Exodus, the Red Sea ran up into the Bitter Lakes, and clearly must have formed a barrier to the travellers' progress at that time; he then alluded to the great changes of elevation in the land eastward of these lakes, mentioning that the waters of the Jordan valley once stood 1300 feet above their present height. The various geological and geographical features of the country were so described as to make the address a condensed report of all that is now known of that part of the East.—A vote of thanks was accorded to Dr. Hull, after which the members and their guests adjourned to the museum, where refreshments were served.

Edinburgh

Mathematical Society, May 14.—Dr. R. M. Ferguson, President, in the chair.—Mr. J. S. Mackay gave a construction, due to the Right Hon. H. C. E. Childers, for solving the problem of medial section; Mr. W. Peddie read the second part of a paper on the theory of contour lines and its application to physical science; and Mr. A. Y. Fraser submitted a paper, by Mr. Charles Chree, on the vibrations of a spherical or cylindrical body surrounded by or containing fluid.

Paris

Academy of Sciences, May 24.—M. Jurien de la Gravière, President, in the chair.—Order of appearance of the first vessels in the leaves of the Cruciferæ: mixed formation (part 5), by M. A. Trécul. In a previous paper the author showed that the primary lobes in the type of mixed formation presented by certain Cruciferæ appear on either side of the young leaves in two superimposed series—a lower *basipetal* and an upper *basifugal*. He now proves that the first vessels of the nervous system corresponding to these lobes usually appear in the same order. Those opposed to the lobes of the basifugal series follow from below upwards, while those opposed to the lobes of the basipetal series make their appearance successively from above downwards.—A study of the movements communicated to the air by the action of a bird's wing: M. Müller's experiments, by M. Marey. A description is given of M. Müller's mechanical experiments, which are conducted at night by the aid of phosphorescent vapours, and during the day by means of smoke in the way adopted by Tyndall.—Note accompanying the presentation of M. Verbeek's fresh studies on the Krakatão eruption, by M. Daubrée. Besides a detailed account of the eruption this comprehensive work contains a full description of the meteorological and magnetic phenomena attending it, together with some theoretical considerations on their causes. The author calculates that the quantity of matter ejected was at least 18 cubic kilometres in volume, all incoherent, consequently unaccompanied by any flow of lava.—Presentation of various maps of France, Algeria, Tunisia, and Africa, issued by the Geographical Service of the Army, by M. Perrier. Amongst these maps are one of France, scale 1 : 200,000, comprising the districts of Amiens, Melun, Lille, Mézières; one of Algeria, part 6, scale 1 : 50,000, districts of Azeffun, Jebel-Filfila, Jemmapes, Ben-Harun, Aine-Bessem, Rio Salado; and one of Tunisia, scale 1 : 200,000, districts of Nefta, Rejem-Matong, Dwirat, Wed-Fessi.—Note on a new form of purulent infection following an acute attack of pneumonia, by M. Jaccoud.—Researches on the organisation of the star-fish, by M. Edm. Perrier. Amongst the collections brought back by the Cape Horn Mission were several specimens of a new species of star-fish (*Asterias hyadesi*, E. P.), with their young still attached, a circumstance which has helped to throw fresh light on some disputed points connected with the anatomical structure of these animals.—Observations of the new comets 1886 *a* (Brooks I.) and 1886 *b* (Brooks II.) made at the Observatory of Nice (Gautier equatorial), by M. Charlois.—On the geography of the Central Tunisian seaboard, by M. Rouire. A careful survey of the section of the coast between Hammamet and Susa has determined the existence of a large marine inlet at the head of Hammamet Bay, which receives all the drainage of Central Tunisia. It was also ascertained that at some more or less remote period the Halk-el-Mengel Sebkha was certainly navigable.—Determination of the absolute value of the wave-length of the ray D_2, by M. J. Macé de Lépinay. A fresh attempt to settle this disputed point gives the general result—

$$5 \cdot 8917 \times 10^{-5} \text{ (millilitre)}^{\frac{1}{3}};$$

and in the air, at 0°, normal pressure—

$$5 \cdot 8900 \times 10^{-5} \text{ (millilitre)}^{\frac{1}{3}}.$$

—On a visual illusion: apparent motion of a small object when slightly illumined amid the surrounding darkness, by M. Aug. Charpentier.—A new electric fuse for exploding mines charged with powder or dynamite, by MM. Scola and Ruggieri. For this fuse the authors claim that it prevents all accidents from slow combustion, and also removes some other dangers and difficulties attending mining operations.—Note on an apparatus intended to test the efficacy, or ascertain defects in the preparation, of electric fuses, by M. Ducretet.—Description of the cyclone that swept over Madrid on May 12, by M. A. F. Noguès.—On two different conditions of the black oxide of copper, by M. Joannis.—Action of the air, silica, and kaolin on the alkaline haloid salts: new methods of preparing hydrochloric acid, chlorine, and iodine, by M. Alex. Gorgeu.—On the oxidation of oils, by M. Ach. Livache.—On a little-known cause of corrosion in steam-boilers, by MM. D. Klein and A. Berg.—On a new means of employing the iodo-ioduretted reaction in the research of the alkaloids, and especially of the leucomaïnes in urine, by MM. Chibret and Izarn.—A fresh study of Entoniscus (*E. kossmanni*, *E. fraissi*, *E. moniezii*), by MM. A. Giard and J. Bonnier.—On the embryogeny of Comatula (*C. mediterranea*), by M. J. Barrois.—Observations regarding the nervous system and certain organic features of the scutibranch gasteropods, by M. E. L. Bouvier.—On a new Ichthyobdella, by M. R. Saint Loup. This species, which the author describes under the name of *Scorpænobdella elegans*, was recently observed in the Marine Zoological Laboratory at Marseilles.—On the superficial vascular apparatus of fishes, by M. P. de Sède.—On a fungus developed in the human saliva, by M. Galippe. This fungus, discovered in some saliva filtered by Pasteur's apparatus, and cultivated in Van Tieghem's cellules, belongs to the family of the Monilia. The author proposes to name it *Monilia sputicola* (sp.n.).—Remarks on the fifth volume of M. Habich's *Anales de Construcciones civiles y de Minas*, presented to the Academy, by M. Daubrée. To this volume M. Chalon contributes a paper on the prehistoric monuments of Peru, which show a remarkable resemblance to the menhirs, cromlechs, dolmens, and other "Druidical" remains in the west of Europe. They occur in large numbers in every part of the country.—At the request of M. de Lesseps, the President appointed a Commission comprising the members of the Sections for Geography, Navigation, and Astronomy, with MM. Daubrée, Favé, Lalanne, and de Jonquières to study the differences of level caused by the tides in the Pacific and Atlantic Oceans.

STOCKHOLM

Academy of Sciences, April 14.—On the results of some experiments on the condition of electricity in a vacuum, by Prof. E. Edlund.—On the power and fineness of the hollow muscles of the frog, by Herr C. G. Santesson.—On the oxidation of cymal, and on nitrocymal, by Prof. O. Widman and Dr. J. O. Bladin.—Mineralogical notes, by Dr. G. Flink.—Some remarks on the geological map of Sweden, by Herr E. Törnebohm.—Determination of the definite elements of the orbit of the Comet VIII. (1881), by Dr. K. G. Olsson.—Micrometrical determinations of some telescopic star clusters, by Prof. H. Schultz.—Contributions to the theory of wave-motions in a gaseous medium, by Prof. A. V. Bäcklund.—On the integration of the differential equation in the problem of N bodies, by Prof. G. Dillner.

May 12.—On a new method for determining the velocity of the electric molecules in a current of a certain power, by Prof. Edlund.—Contributions to the knowledge of the discharge of the Ruhmkorff coil, by Hr. T. Moll.—A method for increasing the convergence of periodical series, by Hr. C. Charlier.—Research on a non-linear differential equation of the second order, by Prof. H. Gyldén.—An account of the Zoological Station of Christineberg, in the province of Bohus, belonging to the Academy, by Prof. Sven Lovén.—Researches on the changes of the arsenious oxide in contact with putrid animal matters, by Prof. Hamberg.—A balance constructed by Hr. F. J. Lemcke for determining the consumption of the normal light in the measurement of the power of the light, exhibited by Prof. F. L. Ekman.—New or imperfectly known Isopoda, part 3, by Dr. C. Bavallius.—On naphtoë acids, by Dr. Ekstrand.

BOOKS AND PAMPHLETS RECEIVED

"Ling-Nam," by B. C. Henry (Partridge).—"Infant School Management," by S. S. Hale (Stanford).—"The Romance of Mathematics," by P. Hampson (E. Stock).—"Handy Guide to Norway," by T. B. Willson (Stanford).—"Chemical Arithmetic," by J. M. Coit (Heath, Boston).—"Summary Report of the Operations of the Geological and Natural History Survey of Canada," part 3 (Maclean, Ottawa).—"Earthquakes of Ischia," by H. J. Johnston-Lavis (Dulau).—"La Mythologie," by A. Lang; traduit de l'Anglais par Léon Parmentier (A. Dupret).—"Determination of Rock-forming Minerals," by Dr. E. Hussack, translated by Dr. E. J. Smith (Wiley, New York).—"Studies from the Biological Observatory, Johns Hopkins University," vol. iii. No. 6.—"Catalogue No. 10 of Physical Apparatus for Universities and Superior Schools" (F. Ernecke, Berlin).—"Account of the Graphic Method in Use for Determining the Co-ordinates of the Secondary Trigonometrical Stations of the Ordnance Survey," by J. O. Farrell (Eyre and Spottiswoode).—"Modern Armour for National Defence," 2nd edition, by W. H. Jacques.—"Ericsson's Destroyer and Submarine Gun," by W. H. Jacques.—"Heavy Ordnance and National Defence," by W. H. Jacques (Putnam, New York).—"Circulars of Information of the Bureau of Education," No. 4, 1885: Education in Japan (Washington).—"John Bunyan and the Gipsies," by J. Simson (Maclachlan, Edinburgh).

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